

Association for Information Systems AIS Electronic Library (AISeL)

ICIS 2008 Proceedings

International Conference on Information Systems
(ICIS)

2008

On Assessment of Project Success in Community Source Development

Manlu Liu

The University of Arizona, manluliu@email.arizona.edu

Bradley C. Wheeler

Indiana University - Bloomington, bwheeler@indiana.edu

J. Leon Zhao

The University of Arizona, jlzhao@email.arizona.edu

Follow this and additional works at: <http://aisel.aisnet.org/icis2008>

Recommended Citation

Liu, Manlu; Wheeler, Bradley C.; and Zhao, J. Leon, "On Assessment of Project Success in Community Source Development" (2008). *ICIS 2008 Proceedings*. 121.

<http://aisel.aisnet.org/icis2008/121>

This material is brought to you by the International Conference on Information Systems (ICIS) at AIS Electronic Library (AISeL). It has been accepted for inclusion in ICIS 2008 Proceedings by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact elibrary@aisnet.org.

ON ASSESSMENT OF PROJECT SUCCESS IN COMMUNITY SOURCE DEVELOPMENT

Évaluation du Succès d'un Projet communautaire de Développement des logiciels libres

Research-in-Progress

Manlu Liu

The University of Arizona
Tucson, AZ 85721, USA
manluliu@email.arizona.edu

Bradley C. Wheeler

Indiana University
Bloomington, IN 47405
bwheeler@indiana.edu

J. Leon Zhao

The University of Arizona
Tucson, AZ 85721, USA
jlzhao@email.arizona.edu

Abstract

Community source has emerged as a unique way of developing enterprise software systems that require significant investments from partnering organizations. This new way of software engineering raises new questions on the issue of successful project development, which are significantly different from previous studies. The objective of this study is to develop a model for assessing project success under community source development. In this paper, we present a case of community source project called Kualu to understand the research questions, propose a unique research model for a survey study, outline the related hypotheses, and discuss our data collection methodology. We believe that our study is unique and will have significant impact on the successful introduction of the community source approach to enterprise application development.

Keywords: Community source, open source, Kualu, success factors, system development

Résumé

L'objectif de cette étude est de développer un modèle pour évaluer le succès d'un projet communautaire de développement de logiciels libres. Dans cet article, nous présentons un projet communautaire de développement de logiciels libres appelé Kualu, nous proposons un modèle original de recherche, nous énonçons les hypothèses de recherche et nous discutons notre méthodologie de collecte de données.

Introduction

A community source project is “an open source project that requires significant investments from institutional partners in both human resources and cash contributions” (Liu, Wang and Zhao, 2007). The community source is a unique form of open source while the community source also has some features of the commercial software. Eric S. Raymond, a prevailing authority on open-source and the author of the book, *The Cathedral and the Bazaar*, describes commercial vendors as developing administrative software in a similar way as builders construct cathedrals; and open-source efforts as developing administrative software is illustrated as a bazaar, harnessing a range of approaches and agenda, taking input from diverse people scattered across the world, and being open (Raymond, 2001). The community source development effort can be described as a shopping mall since the community source management follows the instruction from the community source foundation and at the same time takes the input from multiple institutions.

Since the community source is becoming a new approach of system development, understanding the factors affecting the success of the community source becomes increasingly important. However, such issues have not been well studied in the literature. Several key research questions motivate our work: (1) What framework can be used as a theoretical basis for studying the likelihood of the community source success? (2) What factors can be identified within the theoretical framework? (3) How do these factors affect the likelihood of the community source success?

To better understand these issues, a research model is developed for the community source success. The research model is based on the technology – organization – environment framework from the technology innovation and information systems (IS) literature. To make the community project success, it requires efforts not only from the community source foundation but also from the institutional partners. Therefore, the factors are examined from both the community source foundation’s perspective and the institutional partners’ perspective.

The main contribution of this research is to extend previous studies on successful IT project development by providing new insights on project development and deployment under a new software development approach called community source. The result of our investigation will help the IT industry better understand the significant differences among the development of community source, open source, and commercial software.

The structure of the paper is as follows: The first section reviews the relevant literature. The Kuali case is presented in the second section. A research model and research hypotheses are then presented in the third section. In the fourth section, the research methodology is outlined. Finally, the paper concludes with expected findings, limitations, the implications of this study and future research directions.

Literature Review

The Technology-Organization-Environment Framework

Tornatzky and Fleischer (1990) developed the technology-organization-environment (TOE) framework that consists of three aspects, under which a firm adopts and implements technological innovation. These aspects are described as organizational context, technological context, and environmental context.

The TOE framework has been examined by a number of studies on various IS domains. For instance, the adoption of electronic data interchange (EDI) has been extensively studied in the last decade (Mukhopadhyay et al. 1995). An EDI adoption model including three aspects (technological factors, organizational factors and environmental factors) was developed by Iacovou et al. (1995) based on seven case studies. Further, Kuan and Chau (2001) developed a perception-based technology-organization-environment framework with six factors as EDI adoption predictors and confirmed that this framework was useful for understanding the adoption of technological innovation. This TOE framework has been extended to the e-business domain and open source domain. For example, Chau et al. (1997) developed an adoption model for open systems, which tied seven factors together representing three major contexts of open systems adoption: (1) external environment, (2) characteristics of the open systems technology innovation, and (3) organizational technology. In addition, Zhu et al. (2002) built a conceptual model for electronic business adoption incorporating six adoption facilitators and inhibitors.

In summary, the TOE framework has been well studied and shown to be a promising modeling technique. Thus, we

adopt this theoretical framework and extend it to the community source domain, which has not been done in the literature.

Open Source/Community Source

Open source software (OSS) has become the subject of much commercial interest in recent years. OSS seems to hold much promise in addressing the core issues of the software crisis. Recent research in OSS was conducted in several ways. Feller et al. (2000) studied the OSS development paradigm and derived a framework for OSS. Hann et al. (2004) strived to understand what motivates participation in OSS development.

Community source becomes the most recent trend in the development of scalable and flexible information systems collaborated by multiple organizations (Liu, Wang and Zhao, 2007; Liu, Zeng and Zhao, 2008). Community source is a type of open source because it tends to make the source code of the resulting information systems available to the public. Three examples of existing and successful community source projects include (a) Java Architectures, (b) the Sakai Foundation, and (c) the Moodle Community (Hansen-Shinnerl, 2008).

Application software for higher education appears to be the next arena for open source efforts (Wheeler, 2004). Wheeler (2007) argued that developing a collaborative capability is not an option; it is a necessity for effective college and university IT organizations. In this paper, we present a higher education community source case – Kualii.

The Kualii Case

The Kualii Project was established in late 2004. The University of Hawaii, the rSmart group, NACUBO, and Indiana University were the original founders of the Kualii Project. The project's original mission was to create a financial services system specifically for colleges and universities, based on the overall design of the Indiana University's Financial Information System. There are currently twenty-three development partners in the Kualii project. Kualii Financial System (KFS) 2.0 was announced for release in November, 2007.

Although the Kualii project got an award of \$2.5M from the Andrew W. Mellon Foundation, it is mainly funded by partner institutions. There are two types of partners in Kualii: development partners and deployment partners. A development partner is the one that has decided to pay a partnership fee to join in the development stage of the community source project. A Kualii development partner must pay from half million to one million dollar consisting of 25% cash and 75% personnel costs.

The development partners work in the project organization. The Kualii board is the final decision maker during the development of Kualii. The Kualii functional council and the Kualii technical council take care of the functional issues and technical issues of Kualii, respectively. The Extended board, Kualii investors, Kualii functional council, Kualii technical council and the project manager report to the Kualii board. The project manager supervises the project staff and the development staff.

Currently, the Kualii administration extended KFS to two new Kualii systems: Kualii Research Administration (KRA) and Kualii Student Services System (KS). KRA and KS development are in progress.

As a community-based approach to enterprise application development, Kualii is unique in contrast to both open source and commercial software; on one hand, Kualii is an institution-based open source, and on the other hand, it develops large-scale enterprise systems that have thus far been the output of major software vendors. An in-depth analysis of Kualii projects will be helpful with understanding the complex process in software development as well as the key factors that affect the economics of information technology (Varian 2003).

The Research Model and Hypotheses

Although the technology-organization-environment framework was developed to understand the adoption of general technological innovation, the contexts in this framework can be used to explain the success of the community source projects. The community source project success mainly relies on the success of two stages – development and deployment. In the commercial software and the traditional open source project, the developers and the users are different groups. However, in community source, the institutions that participated in the project development are very likely to adopt the software as future users. So the development and the deployment are closely related in community source.

Based on the TOE framework, a research model tailored for community source is developed and depicted in Figure 1, which is called as “Community Source Success Model” (or simply the CSS model). This research model posited 10 factors for the likelihood of success in community source within the four-context framework. In project development, the financial issue plays very important role. The main limitation of the existing TOE framework is that the financial context is not explicitly modeled. Therefore, we extend the TOE framework by adding the financial context. In community source financial context is one of the important issues to make the project success. The model is controlled for industry and phase effects.

Dependent variable

The dependent variable in the research model is *likelihood of success in community source*. The success in community source is evaluated by the development success and the deployment success in community source. To make the community source project success in the development stage, the community source foundation needs to attract right institutions to become the development partners. However in the deployment stage, the community source foundation needs to bring as many institutions as possible to become the deployment partners to make the community source success.

Environmental context

Environment context is the arena in which community source is developed and deployed. Two factors are examined under this context.

Competitiveness of the new system

Competitiveness was recognized by many studies as an adoption driver (Crook et al. 1998; Grover 1993). In the community source project, we define competitiveness as the advantage of the new system which is developed by multiple development partners. A system that is lack of competitive may end up with no incentive to be developed and deployed. This factor is conceptualized to be a second-order construct, encapsulates the following three sub-constructs:

- (1) Fitness of old system to business. If the old system fits the business well, the institutions will have less incentive to develop and deploy the community source system.
- (2) Ease of use in the old systems. If the old system is user friendly, the institutions will be less likely to replace the old system even though the new system can provide more functionality.
- (3) Costs of migration to other systems. If the costs of migration to community source system are too high, the institutions will be hesitate to deploy the new system.

These viewpoints suggest the following hypothesis:

H1: *Higher levels of competitiveness of the community source system will positively affect the likelihood of the community source project success.*

Urgency of partners’ needs

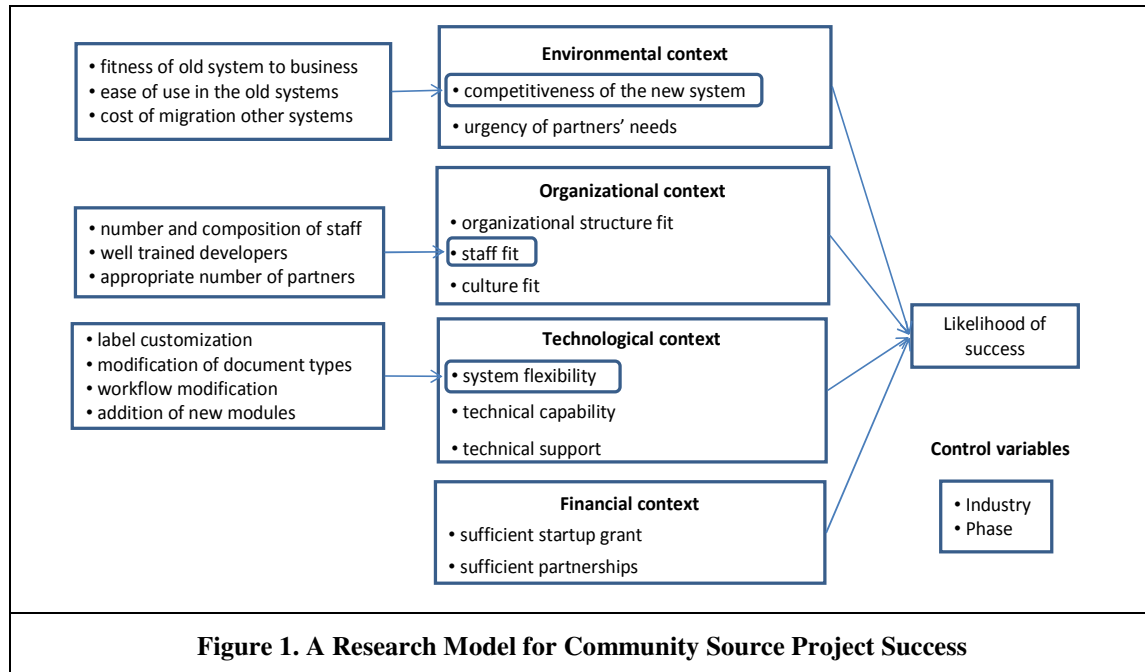
Institutions that want to deploy the community source software earlier are more likely to become partners because the impact of time is great to the institution (Liu and Zhao, 2007). Development partners gain an advantage by being able to deploy successfully sooner. This observation became known to us while we interacted with some Kuali developers. In fact, this advantage makes a big difference when institutions decide on whether or not to become a development partner. The above viewpoints lead to the following hypothesis:

H2: *Higher levels of urgent needs from the partners will positively affect the likelihood of the community source project success.*

Organizational context

In the Tornatzky and Fleischer framework, the organization context describes the characteristics of an organization. Common organization characteristics include firm size, degree of centralization, formalization, complexity of its managerial structure, the quality of its human resource and the amount of slack resources available internally. In

community source, the multiple institutions collaborate closely to develop the project in an organization consists of the community source foundation and the development partners. The management issues of this organization are critical to make the project success. The community source foundation needs to provide an environment to make the development partners to be easy to communicate, to collaborate in this organization. Efficiency is expected to be achieved eventually. The following factors are contributed to build this environment.



Organizational structure fit

In community source, multiple institutions are actually working in a virtual organization. Even if institutions trust each other, problems will arise in the course of collaboration. Hierarchy is certainly one of solutions for settling disputes (Williamson, 1975). Ostrom (1990) pointed out the importance of reciprocity norms and Kogut (2000) stressed the importance of rules of behavior. The Kuali organizational structure is a form of hierarchy which enables the work coordination among development partners in a virtual organization. The Kuali Board is the final decision maker during the development of Kuali. The Kuali functional council and Kuali technical council take care of the functional issues and technical issues of Kuali, respectively. The Extended board, Kuali investors, Kuali functional council, Kuali technical council and the project manager report to the Kuali board. The project manager supervises the project staff and development staff. The monitoring system makes sure that problems can be solved in a right way. The partner institutions are willing to cooperate further when they see social controls arising from norms and monitoring governed this collaboration. Thus, the following hypothesis is generated:

H3: Higher levels of organizational structure fit will positively affect the likelihood of the community source project success.

Staff fit

There are several types of staff in community source: managerial staff, functional staff, and technical staff. They play different roles in the project. To make the community source development successful, it is important for the community source foundation getting the right combination of staff, which we refer as "staff fit". Staff fit is defined as a second-order construct with three sub-constructs:

- (1) *Number and composition of staff.* With the appropriate number and composition of staff, the community source project is relatively easy to manage.
- (2) *Well-trained developers.* The developers in community source have the right skill to develop the system.

(3) *Appropriate number of partners.* If there are not enough development partners, the community source development will not have sufficient resources. However, it is difficult to manage the community source organization if there are too many development partners. The appropriate number of partners can have positive impact on the staff fit since the staff are from the development partners.

The following hypothesis is proposed:

H5: *Higher levels of staff fit will positively affect the likelihood of the community source project success.*

Culture fit

Researchers have argued that globally distributed information systems development is situated within a complex and multileveled socio-cultural context, which may range from national (societal), regional, organizational, or professional (functional) levels, to team level (Dafoulas and Macaulay 2001; Karahanna et al., 2005). In general, there are two different conceptualizations of culture: the dimensional view and the emergent view. The dimensional view of culture depicts culture as shared value, attitudes, and norms by a group of people, which are relatively stable and influence how people behave (Avison and Myers, 1995). The emergent view of culture depicts culture as historically situated, emergent and contested, which is negotiated and constantly interpreted and re-interpreted in social relations and interactions (Myers and Tan, 2002). In this study, we define culture more in dimensional view. Culture fit in community source means that multiple institutions share the same attitude and norms when they get together to develop the project. Based on this, the following hypothesis is posited:

H4: *Higher levels of culture fit among the development partners will positively affect the likelihood of the community source project success.*

Technological context

The technological context relates to the technologies available in community source. Its main focus is on how technology characteristics themselves can influence the community source development and deployment. Three factors are proposed under this context.

System flexibility

In a community source, institutional partners influence the future of the community and its projects through voting rights to determine the software development priorities. Therefore, community source has more stringent requirements in system flexibility in order to deal with very diverse user requirements from its partners. By adopting more flexible technologies, the overall value of Kuali is increased since more institutions would be able to adopt the resulting product of community source due to improved system feasibility to more institutions. That is, in the case of community source, technology flexibility becomes more important than in-house development. The reason that community source becomes a new trend because the availability of service-oriented architectures and other flexibility enhancing techniques. System flexibility is defined as a second-order construct with four sub-constructs:

- (1) Label customization. The system allows its adopters to rename any label on all forms without rewriting code.
- (2) Modification of document types. Modifying and adding new document type are allowed via XML files.
- (3) Workflow modification. The workflow is document-based and allows the modification of document routing without having to write any system code.
- (4) Addition of new modules. The system can be extended to incorporate new applications by providing a common architecture, which is referred as “develop once and use anywhere and on any platform”.

These viewpoints suggest the following hypothesis:

H6: *Higher levels of system flexibility will positively affect the likelihood of the community source project success.*

Technical capability

In community source, there are multiple institutions participating in developing the system. The institution with strong technical capability can make more contribution in the development. In the deployment stage, the institution with strong technical capability can deploy sooner. These arguments lead to the following hypothesis:

H7: *Higher levels of technical capability will positively affect the likelihood of the community source project success.*

Technical support

Since community source is one type of open source, technical support is always important in the deployment stage. In Kualu, the rSmart group, which is an organization providing support to open-source in academia, is one of the members who found Kualu project. The support from the rSmart group will attract more institutions to deploy Kualu. The following hypothesis is proposed:

H8: *Higher levels of technical support will positively affect the likelihood of the community source project success.*

Financial context

Financial context is not shown specifically in the Tornatzky and Fleischer framework since the resource issues were mentioned under the organizational context. In community source project, the resource issues are so critical to the project success that it is well deserved to add an additional context to examine the detail factors. There are two factors under this context:

Sufficient start up grant

It is important for the community source foundation to have sufficient start up grant to initial the project. The Kualu project received a \$2.5 million matching grant from the Mellon Foundation to support the advancement of its community-source software for financials. Without this grant, the Kualu project might have difficulty to grow from the starting point. Therefore, it is reasonable to hypothesize:

H9: *Sufficient start up grant will positively affect the likelihood of the community source project success.*

Sufficient partnership fee

The community source project requires significant investments from institutions that decide to become a partner. The critical decision for each institution is whether or not it should pay a significant amount of partnership fee in order to join the development community. Since the result of the development community will become open source in the end, the institutions who do not participate in the community source development can deploy the system for free later on. The partnership fee needs to be set up in the right level to achieve sufficient fee. It will be difficult to get enough development partners if the partnership fee is too high while it will be hard to get sufficient funding from the institutions if the partnership fee is too low. With lacking of cash and human recourses, the project cannot survive any way. Based on this, the following hypothesis is posited:

H10: *Sufficient partnership fee will positively affect the likelihood of the community source project success.*

Research Methodology

An exploratory study is underway to identify factors affecting project success in community source. The initial result generated from this study will be used to adjust the CSS model shown in Figure 1, as needed. The exploratory study consists of a pilot survey and around twenty interviews. After the exploratory study, the formal survey will be conducted to empirically develop measurement items for validated factors of the adjusted CSS model in the context of community source. In this study, the empirical data will be collected about KFS that has just been completed.

Survey

The survey will be conducted in one of the Kualu Days. The Kualu Days is the Kualu regular conference that is held twice per year starting from 2005. The attendees of the Kualu Days consist of development partners, deployment partners and Observers of Kualu.

Since a formal survey will be done after this pilot survey, we plan to randomly select 1/3 of the attendees to receive the questionnaires and keep the rest of the attendees for the formal survey to avoid surveying the same people twice. With the help of the Kualu management team, we will be able to get the attendance list and attended the conference

to distribute the questionnaires. The list of attendees who received the questionnaires will be recorded. For the formal survey, the revised questionnaires will be sent to the rest of attendees online.

The questionnaire consists of three parts. In the first part, respondents will be asked about the background information, such as the university size, the university status with Kualiti (development partner, deployment partner or observer) and his or her main role in Kualiti. In the second part, we will ask respondents to rank the top three factors in each context (environmental context, organizational context, technological context and financial context). The data generated from the second part can help us check if the current model misses any factors that have strong impact on the success of the community source project. In the third part, respondents will be requested to evaluate the significance of each factor in the KFS project. A five Likert-scale will be used where one denotes “Strongly disagree” and five “Strongly agree”, respectively. For example, respondents will be asked to pick a number from 1-5 for the statement “the KFS system is a competitive alternative to commercial ERP systems.”

Interviews

Around twenty in-depth interviews will be conducted during the conference to test the CSS model, the factors affecting the project success in community source, and the measurement of these factors. We would like to interview people who have extensive involvement with Kualiti and play important roles in KFS development. The interviewees will consist of various roles, such as executives, functional staff, and technical staff. Insights from these interviews will help further validate the hypotheses mentioned above.

Validation

Content validity will be conducted to check whether instrument measurements are drawn in a representative manner from all possible ways that could be used to measure the content of a construct under investigation (Straub et al. 2004; Straub 1989). Following the instrument validating steps, the next question to be considered is construct validity. Factor analysis will be conducted to assess both convergent and discriminant validity (Straub et al. 2004). After the above validation of the instrument, internal validity will be checked to see whether there are unmeasured rival variables for the observed effects on the dependent variable (Jenkins 1985; Straub 1989). External validity will be tested in a future study by applying the research model to other projects other than the KFS project in Kualiti and those outside Kualiti (Garson 2002b).

Concluding Remarks

In the exploratory study, we will validate the CSS model by means of correlation analysis aforementioned. The analytical result will demonstrate how project success is affected by the various independent factors such as competitiveness of the KFS system, urgency of partner needs, sufficient start up grant, and sufficient partnerships. We will weed out those independent factors that exhibit weak correlation, and the results might point to the need for adding certain independent factors to the CSS model. A formal survey will be done following the pilot study to further validate the CSS model.

This study has two limitations. First, our study focuses on the factors affecting project success in development and deployment. To gain a better picture of the success of community source projects, technology diffusion should also be examined as a long-term study. Second, the dataset will be generated from the higher education sector. However, universities are quite different from commercial companies, and therefore, the research result may not be entirely applicable to other industries. Accordingly, one future research direction is to design a longitudinal study to examine the diffusion of the community source approach, and another direction is to study community source projects outside the higher education sector as they become available.

Nevertheless, this research has several potential implications. First, this study should help the Kualiti management understand KFS in more depth, and the insights gained will help Kualiti better manage the ongoing KRA and KS projects. Second, this study will shed new light on the distinctive features of community source as compared with commercial software and open source.

References

- Avison, D. E., and Myers, M. D. "Information systems and anthropology: an anthropological perspective on IT and organizational culture," *Information Technology & People* (8:3), 1995, pp. 43-56.
- Chau, P.Y.K., and Tam, K.Y. "Factors Affecting the Adoption of Open Systems: An Exploratory Study," *MIS Quarterly*, March 1997.
- Crook, C. W., and Kumar, R. L. "Electronic Data Interchange: A Multi-Industry Investigation Using Grounded Theory," *Information & Management* (34), 1998, pp. 219-232.
- Dafoulas, G. and Macaulay, L. "Investigating Cultural Differences in Virtual Software Teams," *The Electronic Journal on Information Systems in Developing Countries* (7:4), 2001, pp. 1-14.
- Feller, J., and Fitzgerald, B. "A Framework Analysis of the Open Source Software Development Paradigm," *Proceedings of the Twenty First International Conference on Information Systems*, 2000
- Garson, G.D. "Fallacies, Reliability, Validity, Significance, and Association," *Guide to Writing Empirical Papers, Theses, and Dissertations*, Marcel Dekker, Inc., New York, 2002b, pp. 189-204.
- Grover, V. "An Empirically Derived Model for the Adoption of Customer-Based Interorganizational Systems," *Decision Science* (24:3), 1993, pp. 603-640.
- Hann, I., Roberts, J. and Slaughter, S. "Why Developers Participate in Open Source Software Projects: An Empirical Investigation," *Proceedings of the International Conference on Information Systems*, December 12-15, 2004, pp 821-830
- Hansen-Shinnerl, C. "What Institutional Conditions are Indicators of Migration to the Quali Foundation's Community Source Software Partnership?" *The Doctoral Dissertation*, The University of Pennsylvania, 2008.
- Iacovou, C. L., Benbasat, I., and Dexter, A. S. "Electronic Data Interchange and Small Organizations: Adoption and Impact of Technology," *MIS Quarterly* (19:4), 1995, pp. 465-485.
- Jenkins, A.M. "Research Methodologies and MIS Research," *Research Methods in Information Systems*, E. Mumford, R. Hirschheim, G. Fitzgerald and T. Wood-Harper (eds.), North-Holland, Amsterdam, Netherlands, 1985, pp. 103-117.
- Karahanna, E., Evaristo, J. R., and Srite, M. "Levels of culture and individual behavior: an integrative perspective," *Journal of Global Information Management* (13:2), 2005, pp. 1-20.
- Kogut, B. "The Network as Knowledge: Generative Rules and the Emergence of Structure," *Strategic Management Journal* (21), 2000, pp. 405-425.
- Kuan, K. K. Y., and Chau, P. Y. K. "A Perception-Based Model for EDI Adoption in Small Business Using a Technology-Organization-Environment Framework," *Information and Management* (38), 2001, pp. 507-512.
- Liu, M., Wang, H. J., Zhao, J. L., "Achieving Flexibility via Service-Centric Community Source: the Case of Quali", *Proceedings of the Americas Conference on Information Systems*, August 9-12, 2007, Keystone, CO, USA.
- Liu, M., Zeng, D. D., Zhao, J. L. "A Cooperative Analysis Framework for Investment Decisions in Community Source Partnerships," *Proceedings of the Americas Conference on Information Systems*, August 14-17, 2008, Toronto, Canada.
- Liu, M., Zhao, J. L., "Real Options Analysis of the Community Source Approach: Why Should Institutions Pay for Open Source?" *Proceedings of the First China Workshop on Information Management*, July 22-23, 2007, Shanghai, China.
- Mukhopadhyay, T., Kekre, S., and Kalathur, S. "Business Value of Information Technology: A Study of Electronic Data Interchange," *MIS Quarterly* (19:2), 1995, pp. 137-156.
- Myers M.D. and Tan, F. "Beyond Models of National Culture in Information Systems Research," *Journal of Global Information Management* (10), 2002, pp. 24-32.
- Ostrom, E. "Governing the Commons: The Evolution of Institutions for Collective Action," New York, Cambridge University Press, 1990
- Raymond, E. "The Cathedral and the Bazaar," Sebastopol, CA: O'Reilly Media., Inc., 2001.
- Straub, D., Boudreau, M.-C., and Gefen, D. "Validation Guidelines for IS Positivist Research," *Communications of the Association for Information Systems* (13) 2004, pp 380-427.
- Straub, D.W. "Validating Instruments in MIS research," *MIS Quarterly* (13:2), June 1989, pp 147-166.
- Tornatzky, L. G., and Fleischer, M. "The Process of Technology Innovation," Lexington Books, 1990.
- Varian, Hal R.. "Economics of Information Technology." Unpublished manuscript, University of California, Berkeley. July 2001. Revised: March 23, 2003.
- Wheeler, B. "Open Source 2010: Reflections on 2007," *EDUCAUSE Review*, Jan-Feb 2007, p49-52.
- Wheeler, B. "The Open Source Parade," *EDUCAUSE Review*, Sep-Oct 2004, p68-69.

- Williamson, O. "Markets and Hierarchies: Analysis and Antitrust Implications," New York, Free Press, 1975.
- Zhu, K., Kraemer, K.L., and Xu, S. "A Cross-country Study of Electronic Business Adoption Using the Technology-Organization-Environment Framework," Proceedings of the Twenty-third International Conference on Information Systems, 2002.