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Virtual Collaboration Effectiveness in Multi-Organization Projects: Tool Usability, Task Alignment and Team Connectivity

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Completed Research

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Abstract

As mobile instant messaging (IM) has become the fastest-growing social media (e.g. WeChat, WhatsApp), this study investigates the use of it as a virtual collaboration tool in multi-organization projects. The understanding of the relationships among tool, task and team in technology-facilitated collaboration leads to the integration of technology acceptance model, task-technology fit model and network externality framework into a research model. Tool usability, task fit and team connectivity are hypothesized to have direct and indirect effects on virtual collaboration effectiveness. The results based on survey observations collected from multi-organization project teams using WeChat in China support most of the hypothesized relationships. The theoretical and practical implications of findings are discussed.

Keywords: Mobile instant messaging, technology-facilitated collaboration, multi-organization project, virtual collaboration effectiveness, tool usability, task fit, team connectivity

Introduction

The emergence of social media not only revolutionizes the way how people communicate with each other in their social lives but also brings about profound changes in workplace collaboration (Ou et al., 2013; Davison et al., 2014). Mobile instant messaging (IM) based on smart phone technology further provides a ubiquitous social media environment that enables people to stay connected and keep updated anytime and anywhere (Bingham & Conner, 2015). The diffusion of smart phones enables mobile IM applications to gradually penetrate from personal communications to the exchange of work-related information and knowledge (Cameron & Webster, 2005).

In contemporary business environment, fast changing organizational structure and operational processes impose task requirements that are more cognitively complex, teamwork-based and dependent on social skills (Heerwagen, Kelly & Kampschroer, 2007). The appropriate use of mobile IM for social networking in work is conducive to team building and task collaboration beyond time and space constraints (Baskerville & Nandhakumar, 2007). Some studies suggest that mobile IM may have some negative effects under certain conditions, such as work interruption and disturbance (Ou & Davison, 2011; Gupta, Li & Sharda, 2013) and deception behavior (Zhou, 2005). However, more research suggests that mobile IM plays a positive role in knowledge sharing (Ajjan et al., 2014; Ou, Davison & Wong, 2015), work performance (Quan-Haase et al., 2005; Wong et al., 2014) and employee creativity (Zaman, MAnandarajan & Dai, 2010).

Mobile IM not only supports the communication among the employees within an organization, but also facilitates the interactions across organizational boundaries (Cho, Trier & Kim, 2005). Such technology-mediated collaboration may involve project team members, external partners, customers, suppliers and other stakeholders in different forms, such as global software development projects (Niinimaki & Lassenius, 2008; Dittrich & Giuffrida, 2011), geographically dispersed teams (Hung et al., 2007), and virtual teams (Ehsan et al., 2008).

Existing research focuses on the use of mobile IM within organizations by addressing the factors affecting usage (Shen et al., 2011) as well as team productivity and performance (Ehsan et al., 2008; Bertolotti et al., 2015). However, there are few studies on the application of such an emerging collaboration tool in the context of multi-organization projects. This study investigates the factors that affect the effectiveness of such a new form of virtual collaboration through mobile IM social media beyond organizational boundaries.

Theoretical Background

Virtual collaboration refers to the extensive use of technological channels for team members to communicate with each other for the accomplishment of project tasks (Peters & Manz, 2007). In such technology-facilitated collaboration, project team members are often physically dispersed and need to exchange information through digital means rather than face-to-face meetings (Wainfan & Davis, 2004; van Osch, Steinfield, & Balogh, 2015). The challenge is bigger for multi-organization projects that involve teamwork beyond not only time and space constraints but also organizational boundaries.

Thus the research question that deserves a close look is: what are the factors that affect virtual collaboration effectiveness in the context of mobile IM use in multi-organization projects? Due to the complexity of phenomenon, it is not likely that the investigation can be based on a single theoretical framework. Rather the relationships among the key components of virtual collaboration need to be examined so as to identify all relevant frameworks. In a multi-organization project, team members work on tasks through the mediation of mobile IM as the collaboration tool. Thus the key components of virtual collaboration include team, task and tool. As shown in Figure 1, there are three pairs of relationships among them: tool- team, task-tool, and team-task. How well that these relationships are handled contribute to virtual collaboration effectiveness.

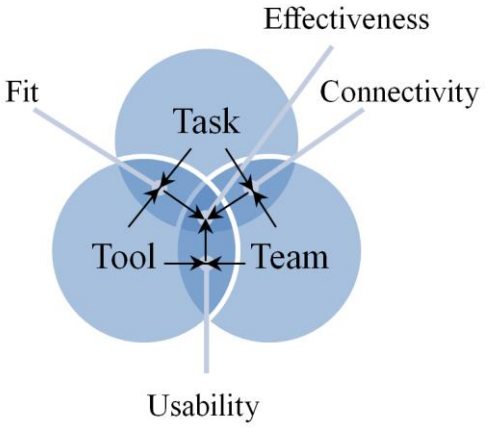

Figure 1. Determinants of Virtual Collaboration Effectiveness

The end users of mobile IM in a multi-organization project are team members. Thus the relationship between project team and collaboration tool can be translated into how team members adopt mobile IM technology. The most well-known framework that deals with user adoption is the technology acceptance model (TAM) developed by Davis et al. (1989), which predicts the behavioral intention to use a technology with perceived usefulness and perceived-ease-of-use. Together, usefulness and ease-of-use comprises the utility function of usability: one that motivates technology adoption in terms of performance expectancy and the other that deters technology adoption in terms of effort expectancy (Calisir & Calisir, 2004; Venkatesh et al., 2003). Therefore, tool-team relationship can be summarized with tool usability, that is: the extent to which mobile IM as a coloration tool is used by team members is largely determined by its usability.

When mobile IM is used multi-organization projects, the main purpose is to facilitate task accomplishment more than social networking. The plethora of information (text, graph, voice etc.) that can be exchanged through mobile IM makes it an ideal tool for project coordination and cooperation. Such an alignment between project task and collaboration tool, or "task fit", captures the task-tool relationship in virtual collaboration. According to the task-technology fit model, task performance and technology utilization are enhanced when technology characteristics match task characteristics (Goodhue & Thompson, 1995).

Finally, a multi-organization team is typically formed on an ad hoc basis for particular project tasks. Such a task-oriented team comprises employees from different organizations, and members have job-related connections at different levels. Working on the assigned tasks together, team members have the closest connections with each other at the project level. As the project tasks in question often concern the decision-makings and operations within each organization, team members have relatively close connections with other colleagues at the organizational level. In addition to employees, multi-organization projects often involve external stakeholders such as customers and suppliers. From the perspective of an individual user, such social connections are pertinent to the concept of network externality, which suggests the value of communication technology depends on the number of others using it (Strader, Ramaswami & Houle, 2007). At the higher project level, such a team-task relationship can be captured with the term "team connectivity" that describes how well members are connected with each other and external stakeholders via technology.

Together, tool usability, task fit and team connectivity shape virtual collaboration effectiveness. Most studies on mobile IM use behavioral intention as the dependent variable, but few address the effectiveness of such social media in organizational settings. The construct of IS effectiveness was developed for more traditional organizational systems like transaction processing systems and decision support systems (Grover, Jeong & Segars, 1996). It is found that the effectiveness of a system depends mainly on user experience and performance contribution (Melone, 1990; Chan et al., 1997). In the virtual collaboration facilitated by mobile IM, both aspects concern how a project team utilizes the collaboration tool to maximize task performance. Compared with individual-level variables like intention and satisfaction, virtual collaboration effectiveness adapted from IS effectiveness at the organization level is able to capture the interactions among team, task and tool.

Research Model

The discussion of virtual collaboration effectiveness and relevant theoretical frameworks leads to the development of a research model shown in Figure 2. In this model, tool ease-of-use and tool usefulness that comprise tool usability are closely associated with the user experience aspect of virtual collaboration effectiveness; whereas task fit and team connectivity mainly pertain to the performance enhancement aspect. In addition to their direct effects on the dependent variable, task fit and team connectivity have indirect effects through the mediations of tool usability. A collaboration tool is not helpful for performance enhancement if project team members do not like it due to poor user experience.

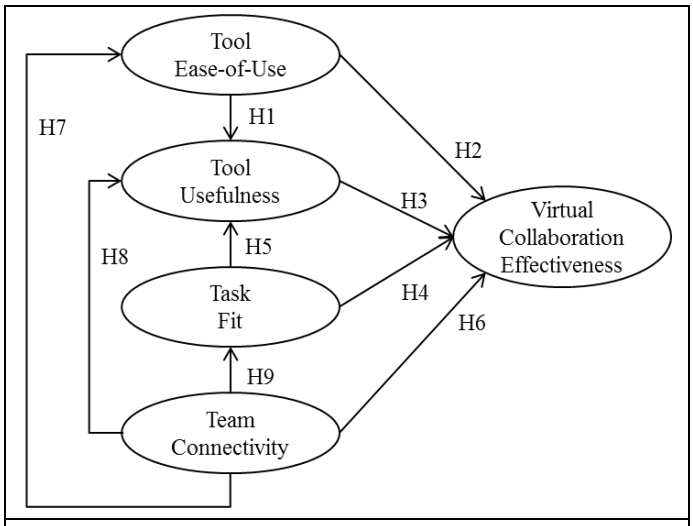

Figure 2. Research Model

As an emerging collaboration tool in organizations and project teams, mobile IM gains popularity mainly with its service and design characteristics. It is a free mobile IM platform with a user-friendly interface that is intuitive and straightforward to learn. For organizations, there is almost no need to invest money, time and other resources on system maintenance and user support. Many mobile IM users simply extend their social networks from personal friends and relatives to workplace colleagues and partners. For organizations, mobile IM represents a great opportunity to enhance the communication and collaboration for project teams anywhere and anytime. According to the TAM, the perception of mobile IM's ease of use will influence the judgment of its usefulness (Davis et al., 1989).

H1: Tool ease-of-use has a positive effect on tool usefulness.

Considerable research in the IS field has confirmed that system usability affects user experience, such as satisfaction and attitude. Deng et al. (2010) study of mobile IM services found that functional value and service quality contribute to customer satisfaction. Zhou & Lu (2011) also found that perceived usefulness significantly affects user attitude towards mobile IM. In addition, Mahmood et al. (2000) found that the ease-of-use of information technology significantly affects end-user satisfaction. Similarly, Rouibah & Hamdy (2009) study on information communication technologies usage suggests that both usefulness and ease of use significantly affect user satisfaction.

Mobile IM enables project team members and stakeholders to communicate and work with each other beyond physical, temporal and organizational barriers (Cho, Trier & Kim, 2005; Ou, Davison & Wong, 2015). This handy and accessible mobile IM platform provides distributed team members a ubiquitous social media environment conducive to their seamless interactions (Dittrich & Giuffrida, 2011). As a result, the usability of mobile IM in terms of usefulness and ease-of-use contributes to virtual collaboration effectiveness by enhancing user experience.

H2: Tool ease-of-use has a positive effect on virtual collaboration effectiveness.

H3: Tool usefulness has a positive effect on virtual collaboration effectiveness.

From the communication point of view, different social media tools have their own advantages and disadvantages suitable under different circumstances (Ramirez et at., 2008; Quan-Haase & Young,

2010). In a multi-organization project, a close system that only allows employees to communicate within an organization is certainly not very helpful. From the perspective of task-technology fit, a technology needs to align with task context so as to enhance user performance (Goodhue & Thompson, 1995; Lin, 2012). In the collaboration among virtual team members, Aiken, Gu and Wang (2013) found that task-technology fit strengthens knowledge sharing. Thus, how mobile IM functionalities align with project tasks is likely to have an impact on virtual collaboration effectiveness in terms of performance contribution.

H4: Task fit has a positive effect on virtual collaboration effectiveness.

In addition to the direct effect of performance contribution, task fit may also have indirect effects on virtual collaboration effectiveness by influencing user experience. When technical characteristics match task requirements, users are likely to perceive a technology useful (Dishaw & Strong, 1999). In a multi-organization project, the functionalities that mobile IM provides allow team members and other stakeholders to share all kinds of information. Therefore, how mobile IM is viewed as aligned with project tasks may affect its usability to team members. Through the mediation of tool usefulness, therefore, task fit is likely to have an indirect effect on virtual collaboration effectiveness as well.

H5: Task fit has a positive effect on tool usefulness.

Mobile IM, as a social media, differs from traditional organizational systems as its value to users mainly comes from network externality associated with the number of connections that they have with each other (Belvaux, 2011; Lin & Lu, 2011). The scale effect is powered by mobile IM functionalities such as one-to-one conversation, group chat and broadcast messaging. They allow project team members to communicate not only with each other but also with colleagues and external stakeholders (e.g. suppliers and customers). The scope and depth of interactions directly associated with such network externality lead to user satisfaction and participation (Luo & Lee, 2015; Wei & Lu, 2014). In a multi-organization project, therefore, team connectivity is conducive to task collaboration via strengthened interactions and relationships.

H6: Team connectivity has a positive effect on virtual collaboration effectiveness.

Like task-technology fit, team connectivity may also have an indirect effect on virtual collaboration effectiveness by influencing user experiences. In particular, the scale effect of network externality is directly associated with people's use of social media for task accomplishment. Empirical studies confirm that the users of mobile instant messaging find it more helpful when the number of contacts increases (Zhou & Lu, 2011; Zhou, Li & Liu, 2015). The more connected team members are, the more resources (e.g., information) are available for them, which may motivate technology usage, reduce usage barriers, and enhance task performance.

H7: Team connectivity has a positive effect on tool ease-of-use.

H8: Team connectivity has a positive effect on tool usefulness.

H9: Team connectivity has a positive effect on task fit.

Methodology

Research Design

First released in January 2011 by Tencent in China, WeChat is a mobile IM product that supports services like texting, group chat, broadcast messaging, moments, voice/video call, photograph/video sharing, location exploration, payment and city service (http://en.wikipedia.org/wiki/WeChat). It runs on almost every operating system on the smart phone (e.g. IPhone, Windows Phone, BlackBerry, and Android) and becomes a platform into itself by continuously adding new features. According to a recent report, the number of active WeChat users reached 650 million in 2015 (Tencent, 2015). In China alone, more than 90 percent of smartphone users have adopted WeChat. In addition, there are over 20 language versions used by people in around 200 countries (Tmtpost, 2015).

WeChat is a fast-growing mobile social media rather than just a chat app. In addition to serving individual users, WeChat offers three types of accounts (service, subscription, enterprise) for organizations and businesses to support enterprise marketing, communication, and after-sales services. These three types of accounts not only facilitate the internal communication among the employees of an organization but also their interactions with external users. Thus WeChat has become a collaboration tool for project team members to work together through multimedia and multimodal communication anywhere and anytime (Cui, 2016).

Due to the popularity of WeChat in China, it is used by the majority of working population for the communication of job-related information and maintenance of professional relationships. The target population comprises the members of multi-organization project teams that use WeChat as the main collaboration tool. Questionnaires were distributed to the employees of organizations in 6 major cities (Shanghai, Guangzhou, Shenzhen, Xi'an, Jinan, and Nanjing) of China based on snowball sampling. The initial contacts were obtained from an executive MBA program and an advanced manager training center. To make sure that each participant has actual experience of using WeChat in multi-organization project, there are two filtering questions on whether each had been a member of at least one multi-organization project team within the last 3 years and whether WeChat was used. If the answer was no to either question, the person should give the questionnaire to someone else who might qualify. A total of 170 questionnaires were distributed and 114 valid responses were collected.

Table 1 reports the profile of participating organizations and multi-organization project teams in the sample. Organization size was largely balanced in terms of small-and-medium enterprises (SMEs) and large ones, with SMEs a little bit more than half. Two thirds of organizations were in business for more than 10 years, whereas the rest were younger. In terms of duration of projects, almost two thirds were short-term projects within a year, and less than one sixth were long-term projects lasting more than two years. Similarly, most of the teams were small or medium in size comprising fewer than 50 members, whereas a little bit over 10% of teams had 50 or more members. The geographic distribution of the multi-organization teams, on the other hand, was more balanced: a little bit more than half of the teams were located in the same region, whereas the others were distributed over different regions or across different countries.

Table 1. Profile of Multi-organizational Projects

Characteristics	Number	%
Organization Size		
Under 100 employees	14	12.3
100-500 employees	37	32.5
500-1,000 employees	12	10.5
More than 1,000 employees	51	44.7
Organization Age		
Under 3 years	10	8.8
3-10 years	27	23.7
More than 10 years	77	67.5
Project Duration		
Less than 1 year	72	63.1
1-2 years	24	21.1
More than 2 years	18	15.8
Project Team Size		
Less than 20	71	62.3
20 but less than 50	28	24.6
More than 50	15	13.1
Geographic Distribution		
Same region	64	56.1
Different regions	22	19.3
Different countries	28	24.6

Measurement

Tool Usefulness and Tool Ease-of-Use were measured with the items adapted from relevant TAM scales (Davis, 1989). The measures of Task Fit were adapted from the perceived task-technology fit scale in Jarupathirun's (2007) and Lin and Huang's (2008) studies. Team Connectivity items were adapted from the measures of network externality by Strader et al. (2007) and Zhou and Lu (2011). Items of Virtual Collaboration Effectiveness were adapted from IS effectiveness scale developed by Chan et al. (1997).

As all variables are psychological constructs measured with Likert scale items, common method bias needs to be addressed as a potential concern. This study conducted Harman's one-factor test (Podsakoff et al., 2003; Podsakoff et al., 2012) with confirmatory factor analysis. The five-factor model (there are five latent variables in the research model) yielded much smaller chi-square statistic to degrees-of-freedom ratio ($\chi 2/df$=2.604) than the one-factor model that captured shared variance

($\chi 2/df$ =5.24). Meanwhile, the six-factor model with the overall factor added only improved model fit marginally ($\chi 2/df$ =2.087). As the variance explained by the common factor did not overwhelm that explained by individual factors, common method bias did not pose a threat in this study.

Results

First, measurement validity was assessed based on the observations collected, and Table 2 reports relevant results. The reliability coefficients Alpha were all above 0.7, indicating acceptable convergent validity. Meanwhile, the square roots of average variance extracted (AVE) were all above 0.8 whereas all correlation coefficients were below 0.8. As the shared variance among the indicators of each construct exceeded that among different constructs, discriminant validity was supported. Finally, the descriptive statistics showed that the responses were generally positive as expected.

Table 2. Measurement Validation

Construct	Alpha	Mean(SD)	1	2	3	4	5
1. Task Fit	.90	3.55 (.89)	**.841**				
2. Tool Ease-of-Use	.92	3.63 (1.16)	.309	**.902**			
3. Tool Usefulness	.95	2.95 (1.16)	.451	.640	**.911**		
4. Team Connectivity	.87	3.81 (1.12)	.350	.768	.578	**.892**	
5. Coll. Effectiveness	.91	3.32 (.93)	.480	.758	.761	.766	**.830**
Note: The bolded diagonals of correlation matrix are the square roots of AVE.							

To test the research model that contains latent constructs and mediating relationships, a partial least square structural equation modeling (PLS-SEM) analysis was conducted. As shown in Table 3, almost all the hypothesized relationships were found significant. In particular, tool usability, task fit and team connectivity variables had significant direct effects on virtual collaboration effectiveness. In addition, task fit had an indirect effect through the mediation of tool usefulness. There were multiple routes through which team connectivity affected virtual collaboration effectiveness via other variables: tool ease-of-use being the strongest mediator, tool usefulness the weakest, with task fit in between. For tool usability, usefulness mediated the effect of ease-of-use on virtual collaboration effectiveness.

Table 3. Estimates of Path Coefficients

Hypothesis & Path	Coefficient (SE)
H1: Tool Ease-of-Use → Tool Usefulness	.455 (.125)***
H2: Tool Ease-of-Use → Collaboration Effectiveness	.220 (.071)***
H3: Tool Usefulness → Collaboration Effectiveness	.369 (.059)***
H4: Task Fit → Collaboration Effectiveness	.128 (.057)**
H5: Task Fit → Tool Usefulness	.264 (.083)***
H6: Team Connectivity → Collaboration Effectiveness	.339 (.075)***
H7: Team Connectivity → Tool Ease-of-Use	.773 (.061)***
H8: Team Connectivity → Tool Usefulness	.130 (.104)*
H9: Team Connectivity → Task Fit	.348 (.101)***
Note: One-tailed test. *-Sig. at 0.1 level; **- Sig. at 0.05 level; ***-Sig. at 0.01 level	

In terms of direct effects, tool usability, team connectivity and task fit contributed comparably to virtual collaboration effectiveness in the order of strong to weak strength. Variables account for the majority of influence in comparison with team connectivity and task fit (i.e. 0.220+0.369 > 0.128+0.339). In addition, tool ease-of-use and tool usefulness also mediated the effects of the other variables. Thus, tool usability is pivotal to virtual collaboration effectiveness. Considering both direct and indirect effects, the total effects of task fit and team connectivity can be calculated and compared. For task fit, its direct effect on virtual collaboration effectiveness was 0.128 and its indirect effect through tool usefulness was 0.097 (i.e. 0.264*0.369), leading to the total effect of 0.225. Team connectivity has three indirect effects on virtual collaboration effectiveness, one through tool usefulness (0.130*0.369=0.048), one through tool ease-of-use (0.773*0.220=0.170), and the other through task fit (0.348*0.128=0.045). Together with the direct effect of 0.339, the total effect of team connectivity was 0.602. Whereas team connectivity has larger total effect, task fit was more independent for the need of mediation through tool usability to influence virtual collaboration effectiveness.

Discussions

Researchers have extended TAM with TTFM (e.g. Dishaw & Strong, 1999) as well as network externality (e.g. Chih-Chien, Hsu & Fang, 2005; Wang, Lo & Fang, 2008), still with behavioral intention as the dependent variable. In technology-facilitated collaboration, however, researchers and practitioners may be more interested in how to make the collaboration more effective rather than whether users intend to use the collaboration tool. This study combines three theoretical frameworks (TAM, TTFM, and network externality) with the use of a different dependent variable based on the understanding of what are involved in virtual collaboration.

The integration of multiple frameworks yielded insights on the relative importance of tool usability, task fit and team connectivity on virtual collaboration effectiveness. Tool usability is the necessary condition for members to participate in technology-facilitated collaboration and mediates the effects of other factors. Task fit has both direct and indirect effects on virtual collaboration effectiveness through the partial mediation of tool usefulness. This is consistent with the premise of task-technology fit model (TTFM; Goodhue and Thompson, 1995) that the alignment between task characteristics and technology characteristics enhances both technology experience and task performance of users. By including both usability and alignment variables and specifying their mediating relationships, it is possible to evaluate such a premise with empirical evidence. Having a strong direct effect on virtual collaboration effectiveness, task connectivity also yielded equally strong indirect effects through the mediation of tool usability and task fit. This not only supports network externality (Katz & Shapiro, 1986) in technology-facilitated collaboration, but also suggests that team connectivity mainly serves as a contextual variable that captures the effect of user environment.

The findings of this study provide some helpful hints on the best practices of virtual collaboration. Though organizations are not able to change design features of a collaboration tool like WeChat, they may still enhance its usability through training. In multi-organization projects, it is important that all team members are well informed of all the functionalities to be used and practice them under different scenarios. This not only strengthens tool usability but also task fit. In addition, team connectivity acts as a catalyst for virtual collaboration effectiveness. Thus project managers need to provide clear guidance on how to establish and maintain connections, both within and beyond teams.

Conclusion

This study investigates the factors that influence the effectiveness of multi-organization project teams using the exemplary mobile IM platform WeChat as a collaboration tool. Based on the relationships among the tool, task and team, it develops a research model that hypothesizes the direct and mediating effects of tool usability, task fit and team connectivity on virtual collaboration effectiveness. A survey study was conducted and the results support most of the hypothesized relationships. In particular, the findings reveal different roles that that tool-, task- and team-related factors play.

This study is limited in the fact that observations were collected from a single country (i.e. China) based on a particular collaboration tool (i.e. WeChat). This raises the question of generalizability on whether findings can be applied to other settings. Future studies may collect observations on the collaborative use of other tools from different countries.

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