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Mobile Social Media in Inter-organizational Projects:

Aligning Tool, Task and Team for Virtual Collaboration Effectiveness

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Abstract

Inter-organizational projects face unique challenges and opportunities due to team diversities and task complexity. Mobile social media like WhatsApp and WeChat emerge as new-generation collaboration tools in such endeavors. Based on a literature review, this study posits that how well team-tool, task-tool and team-task relationships are handled shape virtual collaboration effectiveness. The conceptual framework, validated with the interviews from inter-organizational project team members in China and the USA, leads to a research model. The results of a larger-scale survey confirm that tool usability, task fit and team connectivity contribute to virtual collaboration effectiveness, which affects project management success and team appreciation. In addition, there are noticeable cross-country differences, especially the opposite moderating effects that degree of use imposes on the relationship between virtual collaboration effectiveness and project management success. Theoretical and practical implications of the findings are discussed.

Keywords: mobile social media, inter-organizational project, virtual collaboration effectiveness, tool usability, task fit, team connectivity, project management success.

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1. Introduction

Social media websites like Facebook not only revolutionize the way how people communicate with each other in their social lives but also bring about profound changes in workplace collaboration (Ou et al., 2013). Based on smartphone technology, mobile social media further provide a ubiquitous communication environment that enables people to stay connected and keep updated anytime and anywhere (Bingham and Conner, 2015). This form of computer-mediated communication undergoes an explosive growth with the success of WeChat and WhatsApp, each of which reached the milestone of one billion active users in 2016 (Sutikno et al., 2016; Tencent, 2016). Such mobile applications allow people to form groups and interact with each other in a real-time manner (e.g., group chat), and boost social coordination and presence awareness (Ling and Lai, 2016; Wang and Reani, 2017).

In today's competitive environment, most business projects are time-sensitive and cognitively demanding, and involve intensive communication among team members (Heerwagen et al., 2016). Through computer-mediated communication, employees are able to work with each other on project tasks beyond time and space constraints. For instance, the use of enterprise social media (ESM) and enterprise instant messaging (EIS) enhances the collaboration among co-workers in terms of job performance and satisfaction (Ajjan et al., 2014; Kwahk and Park, 2016; Robertson and Kee, 2017).

Supporting flexible group formation and coordination, mobile social media facilitates teamwork within as well as across organizational boundaries (Romero and Vernadat, 2016). Also known as multi-organizational, inter-firm or multi-firm projects, inter-organizational projects require team members from different organizations to work together to achieve

project success (Calamel et al., 2012; Jones and Lichtenstein, 2008; Leufkens and Noorderhaven, 2011; Ruuska et al., 2011; Söderlund, 2004; Sydow and Braun, 2018). In addition to formal team members, such projects may involve customers, suppliers and other stakeholders at different places in virtual teams through computer-mediated communication (Bhatti and Ahsan, 2017; Ehsan et al., 2008).

Compared with internal projects, inter-organizational projects encounter bigger challenges in terms of psychological connectedness among team members and knowledge sharing for task accomplishment (Alsharo et al., 2017; Mukherjee et al., 2012). Mobile social media provide unique technological capabilities for users to overcome such social and informational barriers in cross-organization collaboration (Wang et al., 2016). Therefore, people naturally and spontaneously adopted WhatsApp, WeChat and similar platforms (e.g., Skype) in inter-organizational projects.

This phenomenon contrasts the use of organization-sponsored collaboration tools (e.g., ESM and EIS) by employees in internal projects (Hung et al., 2007; Osch et al., 2015). The extant research on how employees use given technologies for workplace coordination is insufficient to comprehend the emergence of mobile social media as new-generation collaboration tools for inter-organizational projects, which feature voluntary tool adoption, diversified team composition and complex task requirement. As an attempt to fill in the research gap, this study addresses the question of how to align tool, team and task in virtual collaboration for optimal project outcomes.

The remainder of this article is organized as follows. First, it reviews the literature on virtual collaboration and the team-tool, team-task and task-tool relationships involved. This

leads to the conceptualization of virtual collaboration effectiveness, which depends on tool usability, team connectivity and task fit. After a qualitative validation of the conceptual framework, hypothesized relationships in a research model are tested with survey observations. The findings are discussed in terms of theoretical and practical implications, followed by the conclusion.

2. Literature Review

Virtual collaboration pertains to the extensive use of technological channels for team members to work with each other for the accomplishment of project tasks (Peters and Manz, 2007). It occurs in a virtual team when face-to-face meetings are largely impossible as part or all of its members are physically dispersed (Wainfan and Davis, 2004). The challenge is even bigger for an inter-organizational project in which the tasks require the joint effort of team members from different organizations (Ahola, 2018). For cross-organizational task coordination, ad hoc team members adopt mobile social media as voluntary collaboration tools (Anders, 2016). In inter-organizational projects, therefore, task, team and tool have relatively large “degrees of freedom”, making their mutual alignment a prominent issue.

The stand-alone examination of three virtual collaboration elements is descriptive in nature (e.g., team composition, task complexity, and tool functionality), and it is the relationships among them that matter in terms of how well an inter-organizational project is carried out. Conceptual and case studies suggest that virtual collaboration outcomes depend on whether an appropriate collaboration tool is used to facilitate task accomplishment (i.e., task-tool relationship), how extensively team members adopt and utilize the collaboration tool (i.e., team-tool relationship), and how well team members coordinate with each other to work

on the tasks (i.e., team-task relationship) (Argote and Fahrenkopf, 2016; Quan-Haase et al., 2005). In different fields, researchers have developed theoretical frameworks that focus on the relationship between two elements at a time.

The task-technology fit model suggests that task performance and technology utilization are enhanced when technology characteristics match task characteristics (Goodhue and Thompson, 1995). Such an alignment between project task and collaboration tool, or *task fit*, captures the task-tool relationship in virtual collaboration. For an inter-organizational project, the main consideration in choosing a collaboration tool is how helpful it is to task accomplishment. Mobile social media are welcome for their capabilities to support multimodal and multimedia communications that facilitate task coordination and knowledge sharing across organizational boundaries (Ling and Lai, 2016).

Project team members are the end users of collaboration tools, and the team-tool relationship can be translated into how they adopt the technologies in working with each other. The well-known framework that deals with user adoption is the technology acceptance model (TAM), which predicts intention to use with perceived usefulness and perceived ease-of-use (Davis et al., 1989). Mobile social media like WhatsApp and WeChat have rich functionalities and intuitive user interfaces, which enhance their usage by team members in inter-organizational projects. Together, usefulness and ease-of-use pair into the utility function of usability: the former represents the benefit side in terms of performance expectancy and the latter represents the cost side in terms of effort expectancy (Abran et al., 2003; Venkatesh et al., 2003). Therefore, the team-tool relationship can be summarized with

tool usability, that is: how team members find a collaboration tool usable largely determines the extent to which they use it.

An inter-organizational project team is temporarily formed for particular project tasks (Bakker et al., 2011). The main managerial issue concerns how to organize employees from different organizations as well as other stakeholders like project sponsors, clients, suppliers and subcontractors into a cohesive virtual team to work on project tasks together (Sonnenwald, 2010; von Danwitz, 2018). Such group connections are pertinent to the concept of network externality, which suggests that the value of a social network depends on the number of participants (Strader et al., 2007). In a virtual team, members establish and maintain mutual connectivity that is essential for role clarity, communication norm and trust (Henderson et al., 2016; Maurer, 2010). Such social network relations are essential for the governance of complex projects when they involve employees from multiple organizations (Adami and Verschoore, 2018). Therefore, the team-task relationship can be captured with *team connectivity* that describes how well virtual team participants are connected for task coordination.

The tool, team and task elements of virtual collaboration correspond to the technology, people and process aspects of collaborative design and construction (Liu et al., 2017). Whereas multiple theoretical lenses suggest that whether any two elements are aligned or misaligned with each other largely draws a line between the success and failure of an endeavor, different frameworks focus on different outcomes, such as technology acceptance, social capital and work performance (Davis, 1989; Keller, 1994; Yuan and Gay, 2006). Similarly, researchers assess workplace social media impacts in terms of technology adoption

(Reychav et al., 2016; Shen et al., 2011), task performance (Bertolotti et al., 2015; Ehsan et al., 2008), and group dynamics (Ajjan et al., 2014; Ou and Davison, 2011; Ou et al., 2015).

To have a comprehensive understanding on how mobile social media affect virtual collaboration in inter-organizational projects, an appropriate dependent variable is needed to capture the effects of tool usability, team connectivity and task fit. The construct of information system effectiveness evaluates how helpful organizational systems (e.g., decision support systems) are to the tasks that they are designed for (Grover et al., 1996). Such technology-related effectiveness mainly concerns user experience and performance contribution (Chan et al., 1997; Melone, 1990). The team-tool, task-tool, and team-task relationships shape both experience and performance aspects of virtual collaboration. Rather than the commonly-used behavioral intention, therefore, the main dependent variable of this study is conceptualized on the basis of information system effectiveness.

3. Conceptual Framework

Virtual collaboration effectiveness refers to how well a project team utilizes a collaboration tool to facilitate task accomplishment. As shown in Figure 1, it indicates the overall alignment among team, task and tool in inter-organizational projects. The three paired relationships, team-tool, task-tool, and team-task, are captured by tool usability, task fit and team connectivity, respectively. Together, how well these relationships are handled shapes virtual collaboration effectiveness.

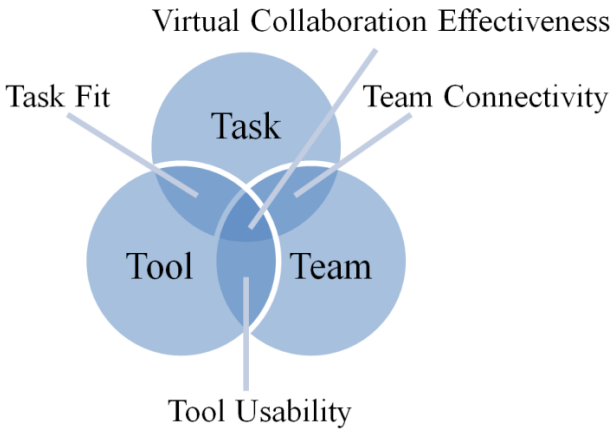


Figure 1. Formation of Virtual Collaboration Effectiveness

This study evaluated the conceptual framework of virtual collaboration effectiveness by interviewing people who had participated in inter-organizational projects. Altogether, 50 employees from various industries in China and the USA (25 each) were asked about their experiences in the most recent inter-organizational projects. Based on the responses, two co-authors categorized each sentence into the closest concept in the framework. Krippendorff's alpha was used to assess inter-rater reliability (Hayes and Krippendorff, 2007). The coefficient was 0.86, indicating that the counts were mostly consistent. This justified the calculation of average counts, as reported in Table 1.

Table 1. Interview Response Categorization

		Sentence Count (Percentage)	
Category	Concept	China	USA
Description	Tool	35 (10.1%)	49 (18.3%)
	Task	37 (10.5%)	48 (18.1%)
	Team	64 (18.4%)	61 (22.9%)
Perception	Tool Usability	73 (20.9%)	35 (13.0%)
	Task Fit	58 (16.7%)	23 (8.5%)
	Team Connectivity	47 (13.3%)	31 (11.3%)
	Virtual Collaboration Effectiveness	35 (10.1%)	21 (7.9%)
Approximate Description-Perception Ratio		**2:3**	**3:2**

Note: The percentage is calculated by dividing each count with the total number of sentences in the interviews from each country: 349 (description: 136 vs. perception: 213) for the China sample and 268 (description: 158 vs. perception: 110) for the USA sample.

There were two general categories of responses: description and perception. Participants described inter-organizational projects in terms of tool, task and team, such as "We used WhatsApp for our project", "the project lasted for three months", and "the team comprised seven members from four organizations". As for perceptive comments, they covered tool usability, task fit, team connectivity and virtual collaboration effectiveness, such as "I found WhatsApp extremely helpful for group communication", "WeChat facilitated project progress through multimodal communication, such as text, voice, photo, and video", "We all worked together towards the project and helped each other when needed", and "Together, we planned tasks, assigned jobs, solved problems, and evaluated results through WeChat".

There was a consistency in the concept frequency rankings between two countries. Within the description category, team was mentioned more than tool and task (which had similar percentages), reflecting the collaborative nature of inter-organizational projects. Within the perception category, tool usability and virtual collaboration effectiveness, at the two ends of experience directness, had the most and least counts. Such a hierarchy underscores how tool usability, task fit and team connectivity contribute to virtual collaboration effectiveness. Thus the interview results corroborate the conceptualization of virtual collaboration effectiveness based on the interplay among tool, task, and team.

Meanwhile, the participants in China gave more perceptive statements whereas those in the USA provided more descriptive accounts (as shown in Table 1, the description-perception ratios were about 2:3 and 3:2 respectively). A close look at the responses showed that all the 25 Chinese participants mentioned WeChat as the primary tool

used in inter-organizational projects supplemented by traditional telephone (11) and email (5), but there were more mentioned by the 25 American participants, including WhatsApp (15), Skype (9) and online meeting (e.g., GoToMeeting and Zoom) (8), supplemented by email (9), texting (8), and teleconference (3). The difference in the tools used is probably due to the fact that virtual collaboration has a longer history of development in the USA than in China, calling for a cross-country comparison in further empirical analyses.

4. Research Model and Hypotheses

The conceptual framework lays a foundation for the examination of the causal relationships associated with virtual collaboration effectiveness. Figure 2 shows a research model depicting how tool usability, task fit and team connectivity affect virtual collaboration effectiveness, which eventually impacts the success of inter-organizational projects. The two sides of tool usability, tool ease-of-use and tool usefulness, are closely associated with the user experience aspect of virtual collaboration effectiveness, whereas task fit and team connectivity mainly concern the performance contribution 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 does not contribute to performance if team members stay away from it. Virtual collaboration effectiveness leads to the final outcomes in terms of project management success on the performance side and team appreciation on the experience side. Meanwhile, how strong each of the two relationships is depends on the degree of use as a moderator.

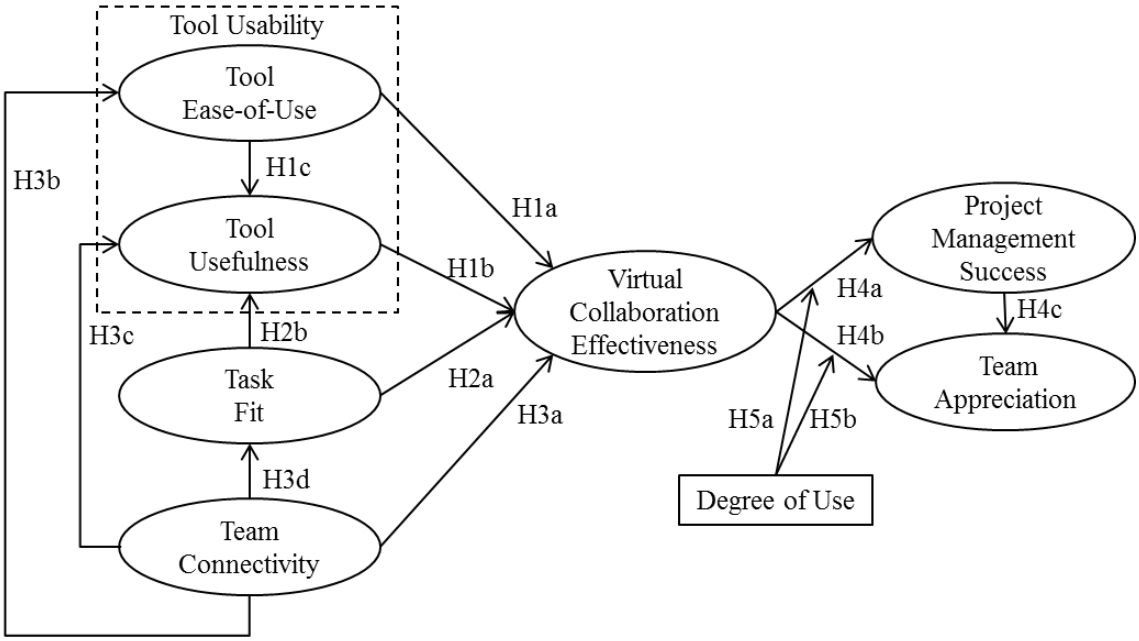


Figure 2. Research Model

Studies on user adoption of communication technologies suggest that their usability in terms of usefulness and ease-of-use affects user experience, such as satisfaction and attitude (Deng et al., 2010; Rouibah and Hamdy, 2009; Zhou and Lu, 2011). Mobile social media applications are handy to use, and they provide an accessible, seamless and ubiquitous environment for distributed team members to communicate with each other over physical, temporal and organizational obstacles (Ou et al., 2015; Reed and Knight, 2010). In the original technology acceptance model, perceived ease-of-use affects perceived usefulness (Davis et al., 1989). Therefore, tool ease-of-use is likely to have an additional indirect effect on virtual collaboration effectiveness through the mediation of tool usefulness.

H1a: Tool ease-of-use has a positive effect on virtual collaboration effectiveness.

H1b: Tool usefulness has a positive effect on virtual collaboration effectiveness.

H1c: Tool ease-of-use has a positive effect on tool usefulness.

In work-related communication, the same collaboration tool may have advantages and disadvantages under different circumstances (Quan-Haase and Young, 2010; Ramirez et

al., 2008). In an inter-organizational project, a proprietary system (e.g., ESM or EIS) is not as helpful as an open mobile application like WhatsApp or WeChat. From the perspective of task-technology fit, a technology needs to match a task so as to enhance user performance (Goodhue and Thompson, 1995; Lin, 2012). In the collaboration among virtual team members, such an alignment strengthens knowledge sharing (Aiken et al., 2013). Thus, task fit is likely to have a direct impact on virtual collaboration effectiveness from the performance contribution aspect. In addition, task fit may influence virtual collaboration effectiveness from the user experience aspect. In an inter-organizational project, the rich functionalities of mobile social media allow team members to share all kinds of information. When technical characteristics match task requirements, users are likely to perceive a technology useful (Dishaw and Strong, 1999). Through the mediation of tool usefulness, therefore, task fit is likely to have an indirect effect on virtual collaboration effectiveness as well.

H2a: Task fit has a positive effect on virtual collaboration effectiveness.

H2b: Task fit has a positive effect on tool usefulness.

Collaboration tools differ from other organizational systems as their value to users mainly comes from network externality associated with the number of connections that they have with each other (Belvaux, 2011; Lin and Lu, 2011). Mobile social media enable one-to-one, one-to-many and many-to-many communication and the exchange of all sorts of information, greatly strengthening the scope and depth of interactions in an inter-organizational project. Team members' connectivity with each other through such interactions directly affect their satisfaction and participation (Luo and Lee, 2015; Wei and Lu, 2014). Therefore, team connectivity is conducive to the performance contribution aspect

of virtual collaboration effectiveness. Through tool usability and task fit, team connectivity may also yield indirect influences. People's use of social media for inter-organizational processes is associated with the scale effect of network externality (Leonardi and Vaast, 2017). Users find a communication technology more helpful when the number of contacts increases (Zhou et al., 2015; Zhou and Lu, 2011). The more connected team members are, the more opportunities and resources are available for them to utilize tool functionalities and accomplish project tasks.

H3a: Team connectivity has a positive effect on virtual collaboration effectiveness.

H3b: Team connectivity has a positive effect on tool ease-of-use.

H3c: Team connectivity has a positive effect on tool usefulness.

H3d: Team connectivity has a positive effect on task fit.

The bottom-line question regarding virtual collaboration effectiveness is: does it matter to the outcomes of inter-organizational projects? On the performance side, researchers focus on the evaluation of project management success in terms of time, cost and scope/quality (De Wit, 1988; Nath et al., 2008). With effective virtual collaboration, an inter-organizational project is likely to be completed on schedule, within budget and according to specification. On the experience side, stakeholder gratification is another important criterion: a project is not a complete success if relevant people are unsatisfied (Müller and Turner, 2007; Westerveld, 2003). Among them, project managers and team members are in the right position to give their opinions as they have first-hand experiences from project execution (Davis, 2014). Therefore, team appreciation is the other direct consequence of virtual collaboration effectiveness. Together, project management success and

team appreciation provide objective and subjective evaluations of project outcomes (Westerveld, 2003). How well a project is accomplished in terms of time, cost and scope is likely to have an impact on team appreciation (Atkinson, 1999; Ko et al., 2011). For an inter-organizational project, in particular, team members are even happier if they meet major benchmarks despite all the challenges of virtual collaboration.

H4a: Virtual collaboration effectiveness has a positive effect on project management success.

H4b: Virtual collaboration effectiveness has a positive effect on team appreciation.

H4c: Project management success has a positive effect on team appreciation.

The strengths of aforementioned relationships largely rely on the intensity of virtual collaboration, which can be captured with degree of use: team members have more interactions with each other when they use a collaboration tool more frequently. Yet degree of use does not necessarily have a direct impact on team performance, which depends more on how a collaboration tool is used than the extent of usage (Malhotra and Majchrzak, 2014). Instead, it may moderate the relationships between virtual collaboration effectiveness and its consequences. The relationships are likely to become stronger at a higher degree of use, as active interactions are essential for virtual team functioning (Levi, 2015).

H5a: Degree of use moderates the relationship between virtual collaboration effectiveness and project management success.

H5b: Degree of use moderates the relationship between virtual collaboration effectiveness and team appreciation.

5. Methodology

5.1 Research Design

Survey observations were collected from the members of inter-organizational project teams in the USA and China to test the research model and make comparisons. Questionnaires were distributed to the enrollees of from two executive MBA programs and one manager training center in China, and one online MBA program in the USA. Each participant was asked to answer the questions based on the experiences in the most recent inter-organizational project. To make sure that the individual recalled actual experiences, there were questions on project duration, team size and the primary collaboration tool used. If any answers were blank, the response was discarded. As project duration and team size are often used as the covariates of collaboration performances (Aga et al., 2016; Liu et al., 2011), they are controlled for the explanation of virtual collaboration effectiveness in this study.

5.2 Subjects

In total, there were 462 valid responses, 273 in China and 189 in the USA. Among the participants, 269 were males (58.2%) and 193 were females (41.8%). Most of them held operational positions (287, 62.1%), whereas the rest were managers (91, 19.7%), executives (35, 7.6%) and others (49, 10.6%). Non-response bias was assessed by comparing early and late responses, as late respondents are more similar to non-respondents than early ones (Armstrong and Overton, 1977). The *t*-test on each variable between the first 50 responses and last 50 responses in both samples did not find any significant differences at the 0.05 level, suggesting that non-response bias is not a big concern.

Table 2. Profiles of Inter-organizational Projects in the Samples

	Frequency (Percentage)	
Characteristics	China	USA
Project Duration		
Less than 0.5 year	120 (44.0%)	119 (63.0%)

0.5 but less than 1 year	70 (25.6%)	56 (29.6%)
1 but less than 2 years	49 (17.9%)	11 (5.8%)
2 but less than 3 years	16 (5.9%)	1 (0.5%)
More than 3 years	18 (6.6%)	2 (1.1%)
Team Size		
Less than 20	185 (67.8%)	29 (15.3%)
20 but less than 50	47 (17.2%)	145 (76.7%)
50 but less than 100	15 (5.5%)	14 (7.4%)
More than 100	26 (9.5%)	1 (0.5%)
Geographic Distribution		
Same city	146 (53.5%)	29 (15.3%)
Different cities in the same country	60 (22.0%)	78 (41.3%)
Different countries	67 (24.5%)	82 (43.4%)
Degree of Use		
Occasionally	58 (21.2%)	17 (9.0%)
Sometimes	76 (27.8%)	23 (12.2%)
Frequently	43 (15.8%)	66 (34.9%)
Usually	43 (15.8%)	34 (18.0%)
Always	53 (19.4%)	49 (25.9%)

As shown in Table 2, most projects were short-term within a year, and there were not many large teams of 50 or more members. In the China sample, small teams of fewer than 20 (67.8%) were the majority, but the USA sample had more medium-size teams between 20 and 50 (76.7%). The geographic distribution also exhibited different patterns: more than half of the teams in the China sample were intra-civic, whereas most teams in the USA sample spread over different cities or regions. This may be attributed to the fact that many organizations in China are located in megacities that outnumber those in the USA[1]. More distributed, virtual teams in the USA used collaboration tools more frequently than those in China.

5.3 Measurement

[1] China has 15 megacities over 10 million people, whereas the USA has two. Source: https://en.wikipedia.org/wiki/Megacity

As listed in the Appendix, most questionnaire items were adapted from the existing instruments. Tool usefulness and tool ease-of-use were measured with the instruments adapted from the technology acceptance model (Davis, 1989). Task fit items were adapted from the perceived task-technology fit measures (Jarupathirun and Zahedi, 2007; Lin and Huang, 2008). The scale of team connectivity was based on the measurement of network externality (Strader et al., 2007; Zhou and Lu, 2011). Virtual collaboration effectiveness measures were adapted from information system effectiveness scale (Chan et al., 1997). Measures of project management success pertained to time, cost and scope criteria (Lim and Mohamed, 1999; Westerveld, 2003). Team appreciation items were adapted from the measures of teamwork outcome satisfaction (Paul et al., 2004; Reinig, 2003). Degree of use was captured in terms of how often the primary collaboration tool was used in the project.

Common method bias was assessed using Harman's one-factor test with both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) (Podsakoff et al., 2012). In EFA, the variance explained by the first overall principal component accounted for less than half of total variance (China sample: 39.15%; USA sample: 42.26%), whereas the major ones (Eigen values > 1) accounted for over two thirds of it (China sample: 74.51%; USA sample: 69.54%). In CFA, the measurement model yielded a smaller chi-square to degrees-of-freedom ratio (χ^2/df) than the one-factor model that captured the method variance (China sample: 3.23 vs. 9.25; USA sample: 2.53 vs. 5.25). Meanwhile, incorporating the overall factor with the measurement model brought little improvement (China sample: χ^2/df =3.17; USA sample: χ^2/df =2.60). The results indicated that the method variance did not overwhelm the trait variance.

6. Results

Table 3 reports the descriptive statistics, reliability coefficient and correlation matrix for reflective constructs in this study. The responses were reasonable as most mean scores were above the neutral point of three in the five-level Likert scale. Coefficient Alpha values were 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. As the shared variance among the indicators of each construct exceeded that among different constructs, discriminant validity was supported.

Table 3. Measurement Validation for Reflective Constructs

Sample	Construct	Mean (SD)	Alpha	1	2	3	4	5	6
China	1. Task Fit	3.55 (.89)	.90	**.85**					
	2. Tool Ease-of-Use	3.63 (1.16)	.91	.34**	**.89**				
	3. Tool Usefulness	2.95 (1.16)	.95	.42**	.64**	**.91**			
	4. Team Connectivity	3.81 (1.12)	.87	.35**	.77**	.59**	**.89**		
	5. Virt. Coll. Effectiveness	3.38 (.92)	.90	.56**	.66**	.69**	.69**	**.82**	
	6. Team Appreciation	3.62 (.74)	.87	.27**	.14*	.21**	.10	.26**	**.85**
USA	1. Task Fit	4.22 (.56)	.92	**.87**					
	2. Tool Ease-of-Use	4.21 (.60)	.90	.63**	**.88**				
	3. Tool Usefulness	4.22 (.66)	.94	.64**	.79**	**.90**			
	4. Team Connectivity	4.13 (.63)	.80	.64**	.51**	.52**	**.84**		
	5. Virt. Coll. Effectiveness	4.24 (.64)	.94	.78**	.55**	.65**	.68**	**.87**	
	6. Team Appreciation	4.22 (.65)	.94	.73**	.54**	.69**	.66**	.79**	**.92**

Note: * - Sig. at 0.05 level; ** - Sig. at 0.01 level. The bolded values on the diagonal of the correlation matrix are the square roots of average variance extracted (AVE).

Project management success is a formative construct of which the indicators (i.e., scope, time and cost) are not supposed to covary. Table 4 reports their variance inflation factors (VIFs): all the values were well below 5, indicating that they were distinct from each other (Hair et al., 2013). In addition, none of the indicators can be trivial in terms of explanatory power. Outer weights tell the relative importance of formative indicators in their

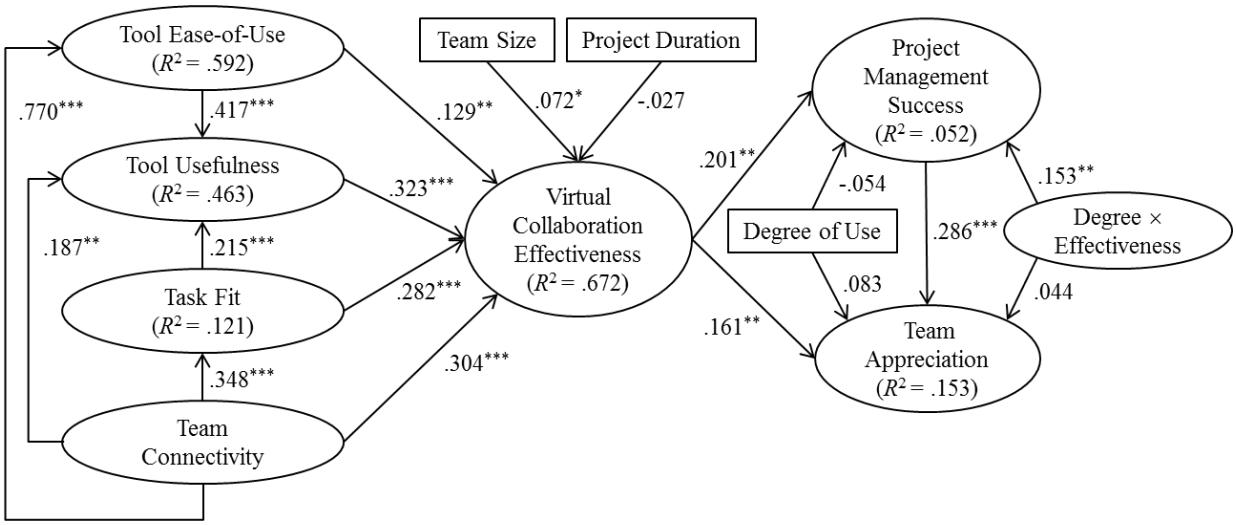
predictions of the outcome variable (i.e., team appreciation). Only the time indicator was not significant in the China sample (but highly significant in the USA sample), yet its absolute importance as shown by the outer loading (equivalent to the bivariate correlation using only time to predict team appreciation) was highly significant. An indicator should be retained if its outer weight is not significant but outer loading is, as it is still absolutely important (Hair et al., 2013).

Table 4. Measurement Validation for the Formative Construct of Project Management Success

Sample	Indicator	VIF	Outer Weights	Outer Loadings
China	Scope	1.456	0.427*	0.808**
	Time	1.516	0.171	0.690**
	Cost	1.580	0.596**	0.902**
USA	Scope	3.063	0.331**	0.912**
	Time	3.219	0.508**	0.952**
	Cost	1.929	0.263**	0.818**

Note: * - Sig. at 0.05 level; ** - Sig. at 0.01 level.

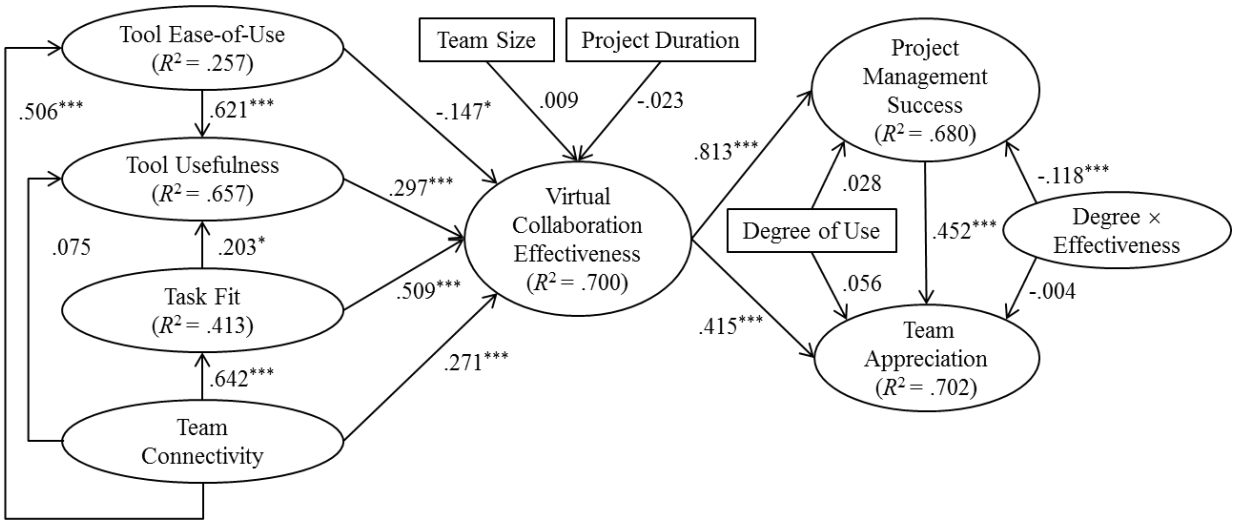
Partial least squares structural equation modeling (PLS-SEM) is capable of testing the hypothesized direct and mediating relationships involving both reflective and formative latent variables (Hair et al., 2013). Figure 3 and Figure 4 show the estimates of statistical models, including standardized path coefficients and the *R*-squared values of endogenous variables, from both samples. Together, tool usability, task fit and team connectivity explained more than two-thirds (China sample: 67.2%; USA sample: 70.0%) of variation in virtual collaboration effectiveness. Its explanatory power on project management success and team appreciation, however, was much stronger for the USA sample than the China sample in terms of *R*-squared (68.0% and 70.2% vs. 5.2% and 15.3%, respectively).



Note: * - Sig. at 0.1 level; ** - Sig. at 0.05 level; *** - Sig. at 0.01 level.

Figure 3. Estimated Model based on the China Sample

In the model, each of the hypothesized relationships involves two latent variables (oval). The only relationship found insignificant was the moderating relationships concerning team appreciation. Among the relationships involving observed variables (rectangular), two concern the control variables (i.e. team size and project duration) and two pertain to the direct effects of the moderator (i.e., degree of use) controlled for its interaction term with virtual collaboration effectiveness (i.e., degree × effectiveness). Degree of use did not have a significant direct impact on either project management success or team appreciation. Between two control variables, team size had a moderately positive relationship with virtual collaboration effectiveness for the China sample but not for the USA sample, whereas project duration was a negative (though insignificant) covariate for both. In China, larger teams seem to benefit from the scale effect associated with network externality. In both countries, longer projects may encounter some challenges to maintain virtual collaboration effectiveness.



Note: * - Sig. at 0.1 level; ** - Sig. at 0.05 level; *** - Sig. at 0.01 level.

Figure 4. Estimated Model based on the USA Sample

Table 5 reports the direct, indirect and total effects of the predictors of virtual collaboration effectiveness. In terms of direct effects, tool usefulness, team connectivity and task fit had stronger impacts on virtual collaboration effectiveness than tool ease-of-use. In the China sample, tool ease-of-use still had a strong total impact as its direct effect (i.e. 0.129) was supplemented with its indirect effect through tool usefulness (i.e. 0.135). In the USA sample, however, its direct effect was negative, canceling out its indirect effect, leading to a negligible total effect. In the USA, virtual collaboration has a longer history through which working professionals get familiar with collaboration tools. This may explain the less importance of tool ease-of-use to them as compared with tool usability. The two tool usability variables mediated the effects of task fit and team connectivity, with the former also being a mediator for the later. Whereas tool usability was necessary to virtual collaboration effectiveness by playing the mediating role, task fit and team connectivity were what made it sufficient with their much larger total effects (China sample: 0.351+0.690=1.041 vs. 0.323+0.264=0.587; USA sample: 0.569+0.677=1.246 vs. 0.297+0.037=0.334). Meanwhile, team connectivity had a larger total effect than task fit (China sample: 0.690 vs. 0.351; USA

sample: 0.677 vs. 0.569), but the latter was relatively independent for the need of mediation through tool usability to influence virtual collaboration effectiveness.

Table 5. Prediction of Virtual Collaboration Effectiveness

Sample	Predictor	Direct	Indirect	Total
China	Tool Usefulness	0.323**	-	0.323**
	Tool Ease-of-Use	0.129*	0.135**	0.264**
	Task Fit	0.282**	0.069**	0.351**
	Team Connectivity	0.304**	0.386**	0.690**
USA	Tool Usefulness	0.297**	-	0.297**
	Tool Ease-of-Use	-0.147	0.185*	0.037
	Task Fit	0.509**	0.06	0.569**
	Team Connectivity	0.271**	0.407**	0.677**

Note: * - Sig. at 0.05 level; ** - Sig. at 0.01 level.

Regarding the consequences of virtual collaboration effectiveness, both project management success and team appreciation were under its direct influence. Meanwhile, project management success had a strong impact on team appreciation. The partial mediation between virtual collaboration effectiveness and team appreciation through project management success confirms that team appreciation is subject to outcome satisfaction as well as process satisfaction (Paul et al., 2004; Reinig, 2003). In the USA sample, both project management success and team appreciation had *R*-squared values around 0.7, indicating their close relationships with virtual collaboration effectiveness. In the China sample, however, the had lower and distinct *R*-squared values (0.052 and 0.153, respectively), which may be due to the fact that many projects still rely on traditional telephone and email in supplement to mobile social media.

Degree of use moderated virtual collaboration effectiveness's relationship with project management success but not team appreciation. As shown in Figure 5, when degree of use increased, the slope between virtual collaboration effectiveness and project management

success increased for the China sample but decreased for the USA sample. This may be due to the fact that people in the USA have more collaboration tool choices and spend more time on them than those in China. Within a certain extent, it is beneficial to increase tool usage in inter-organizational projects, but spending too much time and/or using too many may be counter-productive. By contrast, degree of use made little difference in the relationship between virtual collaboration effectiveness and team appreciation that also relies on social interactions.

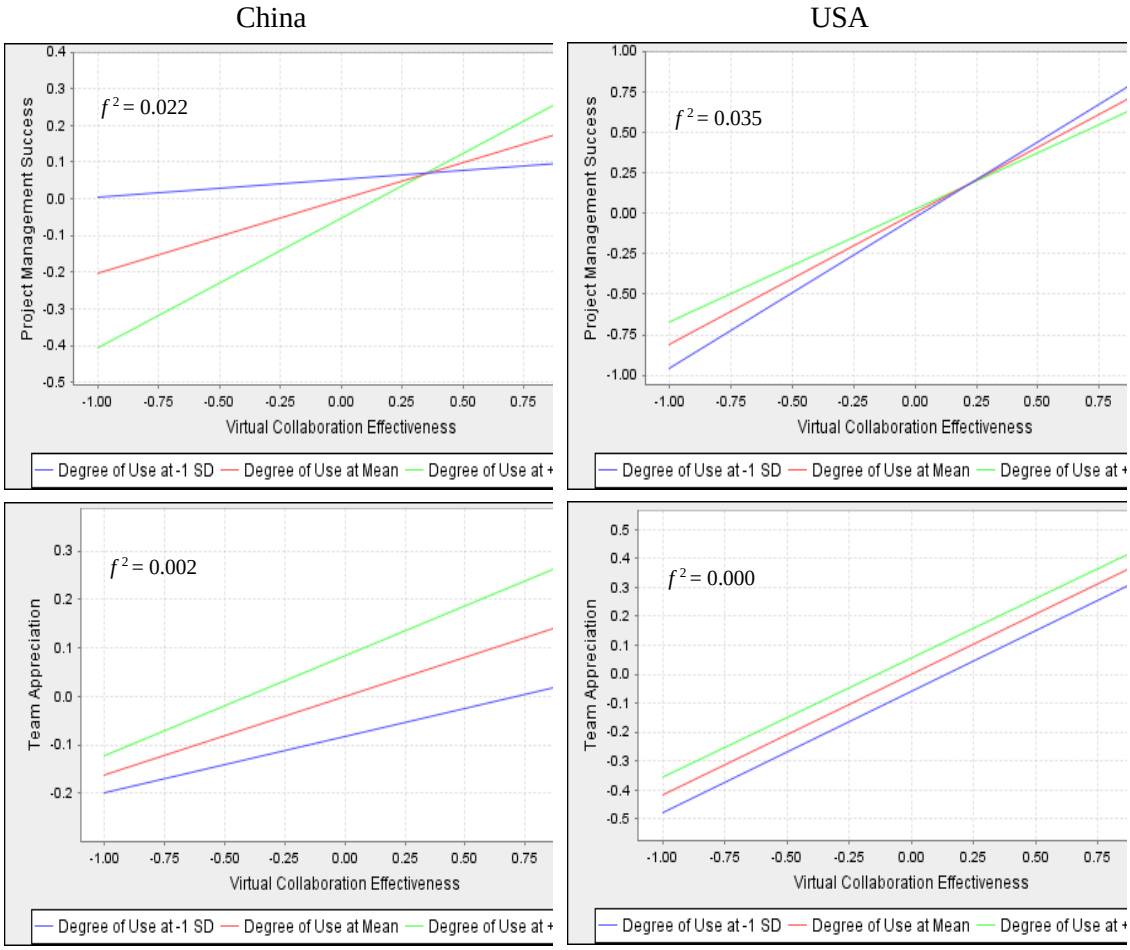


Figure 5. Comparison of Moderating Effects

The effect size of moderation was assessed with *f*-square, the ratio between the variation explained by the interaction term and the total variation of the dependent variable in question (Aiken and West, 1991). A meta-analysis found that the average effect size of

moderation is 0.9%, much lower than that of small direct effects of around 2% (Aguinis et al., 2005). In this study, the significant moderating effect on project management success was well above the average: 2.2% for the China sample, and 3.5% for the USA sample.

Table 6. Multi-group Analysis

Relationship	China	USA	Difference
Control: Team Size→Virtual Collaboration Effectiveness	0.072	0.009	0.063
Control: Project Duration→Virtual Collaboration Effectiveness	-0.027	-0.023	-0.004
H1a: Tool Ease-of-Use→Virtual Collaboration Effectiveness	0.129*	-0.147	0.276**
H1b: Tool Usefulness→Virtual Collaboration Effectiveness	0.323*	0.297**	0.026
H1c: Tool Ease-of-Use→Tool Usefulness	0.417**	0.621**	-0.204
H2a: Task Fit→Virtual Collaboration Effectiveness	0.282**	0.509**	-0.227*
H2b: Task Fit→Tool Usefulness	0.215**	0.203	0.012
H3a: Team Connectivity→Virtual Collaboration Effectiveness	0.304**	0.271**	0.033
H3b: Team Connectivity→Tool Ease-of-Use	0.770**	0.506**	0.264**
H3c:Team Connectivity→Tool Usefulness	0.187*	0.075	0.112
H3d: Team Connectivity→Task Fit	0.348**	0.642**	-0.294*
H4a: Virtual Collaboration Effectiveness→Project Management Success	0.201*	0.813**	-0.612**
H4b: Virtual Collaboration Effectiveness→Team Appreciation	0.161*	0.415**	-0.254*
H4c: Project Management Success→Team Appreciation	0.286**	0.452**	-0.166
H5a: Degree of Use×Virtual Collaboration Effectiveness→Project Management Success	0.153*	-0.118**	0.271**
H5b: Degree of Use×Virtual Collaboration Effectiveness→Team Appreciation	0.044	-0.004	0.048
Direct effect of moderator: Degree of Use→Project Management Success	-0.054	0.028	-0.082
Direct effect of moderator: Degree of Use→Team Appreciation	0.083	0.056	0.027

Note: * - Sig. at 0.05 level; ** - Sig. at 0.01 level.

Table 6 summarizes the results of hypothesis testing with each country sample and multi-group analysis that assessed the differences in model estimates across two samples. There was supporting evidence for all the research hypotheses from at least one sample, except for the moderating effect of degree of use on the relationship between project management success and team appreciation (H5b). Seven out of the fourteen hypothesized relationships were found significantly different across two samples: three more positive for the China sample, and four more positive for the USA sample.

7. Conclusion and Implications

This study investigates the virtual collaboration effectiveness of inter-organizational projects using mobile social media as primary collaboration tools. An examination of the relationships among team, tool and task grounded in interviews leads to a research model that hypothesizes the direct and indirect effects of tool usability, task fit and team connectivity on virtual collaboration effectiveness and its consequences. Survey observations were collected from China and the USA, and the results support most of the hypothesized relationships. The findings suggest that virtual collaboration effectiveness is maximized when tool usability, task fit and team connectivity synergize from both user experience and performance contribution aspects. Virtual collaboration effectiveness does matter to project outcomes in terms of performance-based project management success and experience-based team appreciation. There are cross-country differences, especially the opposite moderating roles that degree of use plays, due to distinct histories of virtual collaboration development (e.g., tool availability and usage).

The findings shed light on the structural, dynamic and contextual aspects of inter-organizational projects (von Danwitz, 2018). The conceptualization and operationalization of virtual collaboration effectiveness help capture the overall alignment among technology, people and process in collaborative design and construction (Liu et al., 2017). Using the construct as the main dependent variable, the research model integrates three theoretical frameworks: technology acceptance model, task-technology fit model and network externality. Rather than just putting them together, such a combination is based on a systematic understanding of virtual collaboration effectiveness formation and ramification. Previously, researchers extended technology acceptance model by including task-technology

fit (Dishaw and Strong, 1999) and network externality (Wang et al., 2008), still using behavioral intention as the dependent variable. For virtual collaboration, researchers and practitioners are more interested in how to optimize its effectiveness than tool adoption. Virtual collaboration effectiveness is connected with its antecedents and consequences into a model of experience and performance routes that interact with each other. In this way, the findings of yield helpful insights on the critical success factors in inter-organizational projects.

Tool usability is the necessary condition for members to participate in virtual collaboration, as tool usefulness and tool ease-of-use mediate the effects of task fit and team connectivity. Task fit has both direct and indirect effects on virtual collaboration effectiveness through the partial mediation of tool usability. This is consistent with the premise of task-technology fit model that such an alignment enhances task performance as well as technology usage (Goodhue and Thompson, 1995). By specifying the mediating relationships involving both tool usefulness and task fit, it is possible to evaluate such a synergistic effect. Meanwhile, team connectivity taps the influence of collective user environment with its direct relationship with virtual collaboration effectiveness as well as indirect ones through both tool usability and task fit (Katz and Shapiro, 1986).

Together, tool usability, task fit and team connectivity explained most variation in virtual collaboration effectiveness (*R*-squared around 70% for both samples). Considering measurement errors, the result implies that all major factors are included. This corroborates the conceptualization of virtual collaboration effectiveness as the result of interactions among tool, task and team. To different extents across China and the USA, virtual collaboration

effectiveness was able to explain project outcomes, which are subject to other factors specific to each sample, such as task requirements, tool experiences and team resources. At a higher level, the competitiveness of business environment makes a difference in how people evaluate the performance outcome of project management success, which largely shapes the experience outcome of team appreciation. Such contextual factors may explain the differences in the predictive power of virtual collaboration effectiveness on its consequences across two countries.

The effects of tool usability, task fit and team connectivity are not static but rather dependent on the intensity of virtual collaboration. This study captures such group dynamics with degree of use, which moderates the relationships between virtual collaboration effectiveness and project management success (but not team appreciation). The positive and negative moderating effects from two country samples suggest an inverse U-shape relationship between group dynamics and performance outcome (which then affects experience outcome). This helps clear the mystery of why computer-mediated communication can be sometimes perceived interruptive rather than interactive by virtual team members (Ou and Davison, 2011). It is recommended that an inter-organizational project team focus on one primary tool (a mobile social media application like WhatsApp or WeChat is preferred for its versatility) and make good use of it rather than spending too much time on too many.

The findings of this study provide some helpful hints on the best practices of virtual collaboration in inter-organizational projects. In terms of tool usability, mobile social media applications like WhatsApp and WeChat gain popularity as they are accessible to everyone and user-friendly. Compared with proprietary systems, there is almost no need for

organizations to invest money, time and other resources on system maintenance and user support. Team members simply include each other in their contact lists, and create a chat group to communicate with each other on project activities. The emergence of this new-generation collaboration tools represents a great opportunity to enhance inter-organizational project management. The findings of this study suggest that developing countries may have a second-mover advantage as there is less distraction from other tools that people have been using in developed countries.

Though organizations are not able to change the design features of mobile social media, they may provide user guidance through training. In inter-organizational projects, it is important that all team members be well informed of relevant functionalities and how to use them under different scenarios. Strengthening tool usability as well as task fit, such formal/informal training eases employees' transition to cross-organization teamwork (van Marrewijk, 2018). In addition, team connectivity acts as a catalyst for virtual collaboration effectiveness, as the configuration of inter-organizational networks is critical for project success (Braun, 2018). Project managers need to provide clear guidance on how to establish and maintain connections, both within and beyond teams (Oliveira and Lumineau, 2017). To maximize project success, they need to moderate conversations and control the degree of use within an ideal range.

This study has limitations that point to the directions of future studies. One limitation is that it does not consider the influence of cultures and customs on virtual collaboration effectiveness. For instance, the line between personal and professional social connections in China (both are "guanxi") is not as clear as those in the USA. This may explain the faster

workplace diffusion of WeChat in China than WhatsApp in the USA. In addition, the two countries are very different along Hofstede's cultural dimensions such as power distance, individualism, and uncertainty avoidance. The differences impose challenges on international virtual collaboration that is becoming more and more common. One interviewee mentioned that team members in China used WeChat but communicated with those overseas with email. Another limitation is in the lack of more detailed information about team and project characteristics that can be used as the covariates to explain cross-project differences. For instance, the average age and education level of each team are likely to impact virtual collaboration effectiveness, and top management support may make a difference as well. Future studies can take such macro- and micro-level factors into account for a better understanding of the phenomenon.

Appendix: Measurement Items

Tool Ease-of-use

Learning to operate the collaboration tool for teamwork was easy.
Using the collaboration tool for teamwork was quite intuitive.
It was easy to become skillful at using the collaboration tool for teamwork.
The collaboration tool was easy to use for teamwork.

Tool Usefulness

Using the collaboration tool made teamwork smoother.
Using the collaboration tool increased teamwork efficiency.
Using the collaboration tool improved teamwork quality.
Using the collaboration tool enhanced teamwork outcome.
In general, the collaboration tool was useful for teamwork.

Task fit

For project tasks, the functionalities of the collaboration tool
…were appropriate.
…were adequate.
…were compatible.
…were helpful.
…provided a good fit.

Team Connectivity

In the process of project coordination,
…regular team members stayed in the loop.
…relevant organizational associates were kept posted.
…external stakeholders (e.g., customers) got involved.

Virtual Collaboration Effectiveness

For the facilitation of teamwork, the collaboration tool
…was reliable.
…provided needed services.
…promoted member participation.
…improved group decision-making.
…enhanced task performance.
…increased job productivity.

Project Management Success

The project was accomplished
…on time.
…within budget.
…according to specifications.

Team Appreciation

To the team,

…task collaboration was fulfilling.

…task completion was satisfactory.

…project results were pleasing.

…project deliverables met expectations.

Degree of Use

How often did your team use the collaboration tool for the project (please check one of the following)?

□ Occasionally

□ Sometimes

□ Frequently

□ Usually

□ Always

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