Effective Use of Collaborative IT Tools: Nature, Antecedents, and Consequences

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Abstract

A fundamental issue for IS academics and practitioners is how collaborative IT tools can be effectively used to improve group work. Collaborative IT tools are integrated sets of IT functionalities that facilitate communication and information sharing among inter-connected entities. Integrating the literature on group support systems with recent work on IT capabilities, this paper introduces the construct of Collaborative IT Tools Leveraging Capability. It is defined as the ability of groups to effectively use a set of IT functionalities—workspace sharing, conferencing, file sharing, scheduling, chat, email—available in collaborative IT tools to facilitate group work.

Collaborative IT Tools Leveraging Capability is proposed to impact group performance. To enhance the group's effectiveness in leveraging collaborative IT tools, we propose a set of antecedents: customization of collaborative IT tools, the group's habit in using collaborative IT tools, the group's perceived usefulness and ease of use of collaborative IT tools, the group member's trust, and environmental uncertainty.

Data from 365 group managers support the study's structural model with the antecedents and outcomes of Collaborative IT Tools Leveraging Capability at different levels of environmental uncertainty. The paper discusses the study's contributions to understanding the nature of Collaborative IT Tools Leveraging Capability, its impact on group work, and how it can be enhanced to facilitate group work. Implications for enhancing group work with the aid of collaborative IT tools are also discussed.

1. Introduction

Organizations are making large investments in collaborative IT tools with the expectation that these IT investments will facilitate group work and enhance performance. Collaborative IT tools, such as Groove and Oracle Collaboration Suite are integrated sets of IT functionalities that facilitate communication and information sharing among inter-connected entities. Today's collaborative IT tools are sophisticated versions of computer-aided 'Group Communication Support Systems', 'Groupware', 'Group Decision Support Systems', 'Electronic Meeting Systems' (Dennis *et al.* 1988; DeSanctis and Gallupe, 1987; Kraemer and King, 1988; Nunamaker, Dennis, and Valacich, 1991), systems designed to support collaborative work and facilitate a group's information needs. As Dennis *et al.* (1988, p. 592) predicted, these systems overlap in their IT functionalities to support group work. By enabling collaboration in places where it was not feasible before and improving information sharing among group members, collaborative IT tools have transformed the nature of collaborative group work (e.g., Easley, Devaraj, and Crant, 2003). However, despite the large investments in collaborative IT tools (Hansen and Nohria, 2004), we still know little about whether, how, and why collaborative IT tools can be effectively used by work groups to enhance their group performance.

Collaborative IT tools can be viewed as generic information technologies that cannot be largely differentiated (Ray, Barney, and Muhanna, 2005). Following the trend of recent studies that have focused on the actual use of IT (Devaraj and Kohli, 2003), and not merely its existence or technical design, this study focuses on whether and how groups *effectively* use collaborative IT tools. Building upon Pavlou and El Sawy's (2006) focus on the *leveraging* dimension of IT, we introduce the construct of *Collaborative IT Tools Leveraging Capability* (CITTLC). It is defined as the ability of work groups to effectively use their basic set of collaborative IT functionalities—workspace sharing, conferencing, file sharing, scheduling, chat/messaging, and email—to facilitate group work. This construct is conceptualized at the process-level of analysis with the work group as the unit of analysis since this level is the most appropriate for observing the effects of IT (Ray *et al.*, 2005). Whereas most prior research on collaborative IT tools has focused on their individual adoption and simple use, this study focuses on their *effective* use at the group level. The study's basic argument is that for collaborative IT tools to pay off, collaborative IT tools must be collectively adopted by groups and be used effectively.

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To shed light on the nature, antecedents, and outcomes of CITTLC, we undertook three key steps:

First, we reviewed over 30 commercial software packages to identify the generic IT functionalities that are commonly found in today's collaborative IT tools to identify a parsimonious set of IT functionalities, namely *workspace sharing, conferencing, file sharing, scheduling, chat/messaging,* and *email.* Integrating these six IT functionalities, CITTLC is proposed as a formative second-order construct formed by the group's effective use of specific IT functionalities.

Second, to show the consequences of CITTLC, we formally theorize its impact on group performance, which is formed by *project efficiency, project effectiveness,* and *situational awareness*. The proposed impact of CITTLC on group performance is proposed to be positively moderated by the degree of environmental uncertainty where the group operates.

Third, the study identifies and empirically tests the antecedents that enhance a group's CITTLC. Extending the literature on IT capabilities, a set of antecedents is proposed, *technology adoption* variables (the group's perceived usefulness and ease of using collaborative IT tools), *technology design* variables (customization of collaborative IT tools), *social* variables (the group's mutual trust), *post-adoption* variables (the group's habit in using collaborative IT tools), and *environmental* variables (the degree of environmental uncertainty that the group operates).

The proposed research model includes the three elements noted by Dennis *et al.* (1988) to understand group work—*methods* (the specific IT functionalities that comprise the nature of CITTLC), *group outcomes* (represented by group performance), and the *environment* (environmental uncertainty), plus the antecedents of CITTLC—the study's primary focus.

2. Theory Development

Collaborative group work has been considered the foundation for the success of modern organizations (e.g., Huber, 1984). Collaborative work has been enhanced by the infusion of Internet-based collaborative IT tools, which are integrated sets of IT functionalities that enable communication and information sharing among inter-connected entities from virtually any geographical location. Today, Internet-based collaborative IT tools are proliferating (Easley *et al.*, 2003; Wheeler, Dennis, and Press, 1999). We refer to these computer-aided systems as "collaborative IT tools," defined as *an* integrated sets of IT functionalities that facilitate communication and information sharing among inter-connected entities.

2.1. Developing the collaborative IT tools leveraging capability construct

To better understand the nature, antecedents, and consequences of collaborative IT tools, we introduce and conceptualize the construct of 'Collaborative IT Tools Leveraging Capability' (CITTLC) as the ability of work groups to effectively use the basic IT functionalities of collaborative IT tools to facilitate group work.

The development of the CITTLC construct draws upon the IT capability literature (Bharadwaj, 2000; Melville *et al.* 2004) – which is rooted in the resource based view (Barney, 1991). Since collaborative IT tools can be viewed as generic IT technologies (Ray *et al.*, 2005), we focus on *leveraging* or effectively using collaborative IT tools as the primary differentiating means for groups. CITTLC captures the effective use of collaborative IT tools, and not how much is required to acquire or deploy IT functionalities. This is consistent with Tippins and Sohi (2003) who described their notion of 'IT competency' as the extent to which a firm is knowledgeable about and effectively utilizes IT tools to manage information.

Also, while the literature has viewed IT capability at the firm level of analysis (Melville *et al.* 2004), Ray *et al.* (2005) argued that the primary effects of IT should be examined at the process level, stressing the need to look below the firm level of analysis. Also, while the IS literature has predominantly viewed IT capability as arising from the IT unit, Pavlou and El Sawy (2006) noted the need to look outside the IT unit to better understand the IT capability of end users.

Thus, CITTLC is conceptualized at the group level and unit of analysis as the effective use of collaborative IT tools to enhance group performance.

2.1.1. Components of collaborative IT tools leveraging capability

To identify the nature of the CITTLC construct, we examined 30 collaborative packages to identify their IT functionalities. A review of these software packages identified the core IT functionalities that are commonly found in collaborative IT tools, namely *workspace sharing, conferencing, file sharing, scheduling, chat,* and *email* functionalities

2.1.2. Collaborative IT tools leveraging capability as a formative higher-order model

Consistent with the IT capabilities literature, CITTLC is proposed as a multi-dimensional construct. Integrating the functionalities found in collaborative IT tools, CITTLC is conceptualized as a formative second-order construct formed by the group's effective use of these six key IT functionalities. Formative second-order models provide a parsimonious depiction of multi-dimensional constructs by representing the individual role of basic IT functionalities on CITTLC.

Since work groups are likely to use these six IT functionalities with different degrees of effectiveness, the effective leveraging of each IT functionality is proposed to influence CITTLC in a *formative* fashion. Besides, since an improvement in the work group's ability to leverage any single IT functionality does not necessarily imply an *equal* improvement in the ability to use other IT functionalities, a reflective model is deemed less likely. The formative model is consistent with Zigurs et al. (1991) who argue that groups adapt IT functionalities differently based on the structures the group brings to its processes. Therefore, a formative second-order model is proposed to be appropriate for representing the multi-dimensional CITTLC construct.

2.2. Collaborative it tools leveraging capability & group performance

We focus on three aspects of group performance – process efficiency, situational awareness, and project effectiveness. The group's process efficiency refers to time and cost savings (Kusunoki *et al.*, 1998). The group's situational awareness reflects the group's understanding of its surroundings (Endsley, 1996). Third, the group's project effectiveness refers to project quality and innovativeness (Kusunoki *et al.*, 1998). These three performance variables are proposed to be represented with a formative second-order model.

By supporting superior information processing and knowledge sharing through rich, reliable, and rapid communication and information flows, CITTLC is proposed to enhance the three performance dimensions (process efficiency, situational awareness, and project effectiveness) by enabling groups to complete their activities more efficiently, more effectively, and with more responsiveness, as explained in detail below:

2.2.1. Process efficiency

The effective use of collaborative IT tools is proposed to enhance process efficiency. First, the effective use of chat and email functionality enables efficient communication and information flows, helping groups perform their activities efficiently. Collaborative IT tools can store information, allowing group members to refer to them later (Dennis, 1996), thus not wasting time from losing information and having to do extra work. Second, the effective use of scheduling functionality makes it easier for groups to identify and allocate available people and resources to the most appropriate tasks. Third, the effective use of conferencing functionality enables groups to avoid travel and face-to-face meetings, thus reducing costs. Finally, the file and workspace sharing functionality enables groups to synchronize and execute more activities in parallel (Sethi *et al.*, 2001). By reducing the cost, time, and effort needed to perform group activities, CITTLC increases process efficiency.

2.2.2 Situational awareness

The effective leveraging of collaborative IT tools is proposed to enhance group situational awareness. First, the effective use of chat, email, and file sharing functionality helps groups stay aware of their surroundings by obtaining and exchanging up-to-date information. Second, the effective use of scheduling and conferencing functionality enables groups to jointly assess real-time information about their surroundings. Rao and Jarvenpaa (1991) showed that collaborative IT tools facilitate redundancy, thus making it more difficult for important information to get lost. Finally, the effective use of workspace sharing functionality helps groups obtain visibility of real-time data, collectively analyze data, allowing them to have a real-time view of their surroundings (Wade and Hulland, 2004). Thus, CITTLC enhances the group's situational awareness.

2.2.3. Project effectiveness

The effective use of collaborative IT tools is finally proposed to enhance group project effectiveness. First, the effective use of email, chat, and conferencing functionality enables work groups to share project knowledge by viewing, discussing, and editing project documents. Dennis and Garfield (2003) show that collaborative IT tools have a significant impact on the participation of the group's work processes and project deliverables. By allowing the exchange of diverse pieces of unique information, collaborative IT tools enable discussions of broader issues (Dennis and Valacich, 1994). Second, the effective use of file sharing functionality facilitates access to knowledge, enabling groups to acquire and synthesize knowledge. Third, the effective use of scheduling and workspace sharing functionality can enhance the group's problem-solving capacity, help create new thinking, and enable groups to find better solutions through rich communication (McGrath and Iansiti, 1998). Collaborative IT tools have been shown to facilitate a greater number of ideas, which has been linked to superior project quality (Dennis et al., 1996; Valacich et al., 1994). In sum, the effective leveraging of collaborative IT functionalities can enhance the group's project effectiveness.

In sum, we propose the following hypothesis:

H1: Collaborative IT tools leveraging capability positively influences group performance.

2.3. The moderating role of environmental uncertainty

The environment consists of all external entities that are not controlled by a group (Tyran *et al.*, 1992). The role of the environment has long been proposed to shape the nature and role of collaborative IT tools (Dennis *et al.*, 1988). Environmental uncertainty

describes the extent by which the group's surroundings are characterized by frequent changes that are difficult to forecast. In uncertain environments, rapid communication and information flows are needed to adapt to environmental changes and respond to new conditions (Pavlou and El Sawy, 2006).

In uncertain environments, the information processing and knowledge sharing capabilities of collaborative IT tools are likely to be conducive to group performance by enabling work groups to better respond to the environment. First, sharing knowledge, generating new thinking, solving problems, and finding new solutions are critical in uncertain environments. CITTLC is ths expected to be pronounced in shaping *project effectiveness* in uncertain environments. Second, staying current with the environment and having up-to-date information becomes more crucial in uncertain environments. CITTLC becomes more important to enhance a group's *situational awareness*. Third, uncertain environments make it more difficult to allocate people and resources to tasks and synchronize group activities. Thus, CITTLC is likely to have a pronounced effect on a group's *process efficiency*. In sum, we hypothesize that the positive impact of CITTLC on group performance (H1) to be higher in more uncertain environments.

H2: Environmental uncertainty positively moderates the positive impact of collaborative IT tools leveraging capability on group performance.

2.4. Enhancing collaborative IT tools leveraging capability

Having hypothesized that CITTLC enhances group performance we next focus on enhancing a group's CITTLC. The effectiveness in using collaborative tools is shaped by individual factors and social phenomena (Nagasundaram and Dennis, 1993). Following an extensive review of the literature, we identified a set of variables that are proposed to enhance CITTLC, which are grouped into five categories: (1) *adoption* variables (group's perceived usefulness and ease of using collaborative IT tools); (2) *technology design* variables (customization of collaborative IT tools); (3) *social* variables (group's intra-group trust); (4) *post-adoption* variables (group's habit of using collaborative IT tools); and (5) *environmental* variables (environmental uncertainty within which the group operates).

2.4.1. Technology adoption variables: group's perceived usefulness and ease of use

Following the Technology Acceptance Model (TAM) (Davis, 1989), the major determinants of IT adoption are *perceived usefulness*—the extent to which a user believes that using an IT system will enhance her job performance and *perceived ease of use* - the extent to which a user believes that using an IT system will be effortless. While these TAM variables have been described at the individual level (Venkatesh *et al.* 2003), the group's perceived usefulness and ease of using collaborative IT tools are proposed at the group level (consistent with the study's unit of analysis). This follows Dennis and Reinicke (2004) who argue that there is a need for more specific versions of TAM designed to better predict adoption of specific IT systems. Following Dennis and Reinicke, a group's perceived usefulness of collaborative IT tools captures the group's aggregate perception of whether the IT functionalities enable the group to enhance its job performance, and perceived ease of use captures the group's aggregate belief in terms of the group's collective use of collaborative IT tools being effortless.

Extending perceived usefulness and ease of use at the group level, the group's perceived usefulness and ease of using collaborative IT tools are proposed to enhance the group's CITTLC. Extending TAM to the group level, groups are more likely to use IT functionalities if they view them to be useful and easy to use. Also, extending TAM to predict the *effective* use of collaborative IT tools (not merely their use), groups that collectively think that collaborative IT tools would be useful to the group's productivity are more likely to work together to assure that tools are effectively used. Accordingly, collaborative IT tools that are easy to use are proposed to be more effectively used by the group. Therefore, we hypothesize:

H3a: A group's collective *perceived usefulness* of collaborative IT tools positively influences the leveraging capability of collaborative IT tools.

H3b: A group's collective *perceived ease of using* collaborative IT tools positively influences the leveraging capability of collaborative IT tools.

It is important to note that a group's perceived usefulness and ease of use have been shown to be influenced by group factors, such as task performance, the group's well being, member support, and the extent of the difference between the skills needed for the new versus the old technology (Dennis and Reinicke, 2004). Also, Benbasat and Lim (1993) offer many group, task, context, and technology variables that contribute to the perceived usefulness of collaborative IT tools. By viewing the group's perceived usefulness as a direct predictor of CITTLC, it is not necessary to include many variables that would have an *indirect* effect on CITTLC through perceived usefulness.

2.4.2. Technology design variables: customization of collaborative it tools

Despite being general-purpose IT technologies, collaborative IT tools have flexible functionalities that can be customized to better match a group's activities.

This is consistent with Goodhue (1994) and Goodhue and Thompson (1995) who argue that the technology must match the group's task to be effective. For example, workspace sharing functionality can be customized to work with the group's existing computer-aided design software. Also, file sharing functionality can link to the group's design databases, and scheduling functionality to the group's tasks. Thus, if the collaborative IT tools are customized to the group's specific tasks and are adapted to better match the group's idiosyncratic business processes, rules, and practices, they are likely to be more effectively leveraged by the group.

H4: The *customization* of collaborative IT tools positively influences the leveraging capability of collaborative IT tools.

2.4.3. Social variables: intra-group trust

Intra-group trust reflects the extent to which the group members trust each other. Trust among group members captures whether group members are capable to perform their individual activities (competence) whether promises to each other are reliable (integrity), whether group members are honest to each other (honesty), and whether they would go out of their way to help each other (benevolence) (Gefen *et al.*, 2003). Trust is considered to be a key antecedent of successful collaboration by enhancing the willingness among collaborators to share information and knowledge (Piccoli and Ives, 2003). In fact, studies of collaborative IT tools showed that the nature of the group interaction is as important as the technical characteristics of IT (Gopal and Prasad, 2000). Also, by making group members feel less vulnerable, trust enhances the group's comfort with sharing sensitive information. In sum, if groups openly share information, they are more likely to effectively use their collaborative IT tools that primary rely on enhancing rich communication and rapid information flows among groups members.

H5: Intra-group *trust* positively influences the leveraging capability of collaborative IT tools.

2.4.4. Post adoption variables: group's habit in using collaborative it tools

Habit represents the frequency of repeated, routine, or automated performance of using an IT system (Limayem and Hirt, 2003). Habit in using collaborative IT tools reflects the group's willingness to make the IT tools as a part of the group's regular work routine. Since repeated use is one of the primary factors for enhancing the effectiveness of any behavior, the group's habitual use of collaborative IT tools is likely to enhance the effective leveraging capability of IT tools.

H6: Group's *habit* in using collaborative IT tools positively influences the leveraging capability of collaborative IT tools.

2.4.5. Environmental variables: environmental uncertainty

As noted earlier, environmental uncertainty reflects whether the group's surrounding environment is characterized by frequent changes that cannot be easily predicted. Unanticipated changes force groups to seek new information, develop new skills, and build new knowledge, that require rapid information flows. In such environments, groups are forced to enhance their information processing and knowledge sharing capabilities to quickly adapt to environmental changes. Given the need to enhance their information processing capacity, groups will strive to use their collaborative IT tools more effectively.

H7: *Environmental uncertainty* positively influences the leveraging capability of collaborative IT tools.

2.5. Control variables

Several effects are controlled for in terms of their potential impact on the study's dependent variables:

Experience with Collaborative IT Tools: Past experience in using collaborative IT tools helps groups effectively use IT.

Group Experience: The literature has shown that groups with more experience are more likely to have superior group performance and to be more competent on their work practices (Dennis *et al.*, 1988).

Group Size: The number of group members often has an important role on group outcomes (Gallupe *et al.*, 1992). Since group size may have either a positive or a negative role on performance, it is controlled for its potential role on CITTLC and group performance.

3. Research methodology

3.1. Measurement development

Besides the CITTLC construct, all measurement items were adapted from existing scales. For the new CITTLC measure, standard scale development methods were used (Straub, 1989). First, the content domain of each construct was specified. Second, a large pool of items was developed based on the conceptual definition, assuring that these items tap the construct's domain. From this pool, items were chosen based on whether they conveyed different, yet related shades of meaning (Churchill, 1979). The measurement items were refined based on a large-scale pretest of the survey instrument with 17 groups. All measurement items were consistent with the study's unit of analysis at the group level.

Collaborative IT Tools Leveraging Capability: A new measure was developed to capture the extent that groups use collaborative IT tools (Pavlou and El Sawy, 2006). Special care was taken to link the proposed IT functionalities (email, chat, scheduling, file sharing, shared workspace, conferencing) with group activities (Lind and Zmud, 1995). A total of ten items was used.

Group Performance: Project effectiveness and process efficiency were measured with two items each (Kusunoki *et al.*, 1998). Situational awareness was measured with three items (Endsley, 1996).

Antecedents of Collaborative IT Tools Leveraging Capability: The group's perceived usefulness and ease of using collaborative IT tools was measured with three items (Venkatesh 2000). The customization of collaborative IT tools was measured with two items. Intra-group trust was measured with four items (Jap, 1999). Habit was measured with two items (Limayem and Hirt, 2003). Environmental uncertainty was also measured with two items (Pavlou and El Sawy, 2006).

3.2. Survey administration

A survey study was conducted among 400 groups of a large multi-national holding corporation that specializes in product lifecycle management software. This corporation integrates three recently integrated companies that specialize in different types of software applications. These three companies share the same collaborative IT tool suite, which ensures that all work groups use the same collaborative IT functionalities. Since the study's unit of analysis was the group, we employed key informant methodology by asking the group managers to respond on behalf of the group.

Invitation e-mails were then sent to the group managers, explaining the study's purpose and assuring them that the responses will be treated confidentially, and the results would only be reported in aggregate to ensure their anonymity. The respondents were asked to click on a URL link shown in the e-mail message that linked to the survey instrument. The respondents were offered as an incentive a report with the study's results.

To ex ante reduce the potential for mono-method bias, the study's instructions specifically asked the respondents to consult with other group members to collectively respond to the survey items. Follow up communication with several managers confirmed that they consulted with their groups before responding.

In total, out of the 400 invitees, a total of 365 usable responses were obtained (91% response rate). Despite the high response rate, non-response bias was assessed by verifying that early and late respondents were not significantly different in terms of their demographic characteristics (age, gender, education, experience with collaborative tools, and group size) and their survey responses (Armstrong and Overton, 1977). All t-test comparisons between the early and late respondents showed no significant differences, inferring lack of non-response bias.

All respondents indicated their position as a group manager or leader. However, their position in the company varied from top executives (Vice Presidents, Division Managers) to mid and low level managers. In terms of functional areas, groups had diverse activities, such as marketing and sales (20%), engineering and product development (18%), customer training and technical support (15%), account management (8%), or product support (8%). The groups were located and served many countries, with the majority serving the United States, Canada, and Europe. The diversity of these groups increases the study's external validity.

3.3. Data analysis and results

We employed Partial Least Square (PLS) for measurement validation and structural model testing. PLS is best suited for testing complex models (Fornell and Bookstein, 1982). We chose PLS to account for the large number of variables in the research model and the existence of higher-order formative factors and moderating effects.

3.4. Measurement validation

Reliability: Reliability was assessed using internal consistency scores (Werts, Linn, and Joreskog, 1974), which are acceptable since they exceed .70.

Convergent and Discriminant Validity: Convergent and discriminant validity is inferred when the PLS indicators (a) load much higher on their hypothesized factor than on other factors (own-loadings are higher than cross-loadings), and (b) when the square root of each construct's Average Variance Extracted (AVE) is larger than its correlations with other constructs (the average variance shared between the construct and its indicators is larger than the variance shared between the construct and other constructs) (Chin, 1998). The AVEs are all above 0.80, which are larger than all correlations. Also, there was an excellent loading pattern in which all measurement items fall on their own constructs. These two tests suggest that all measures have adequate convergent and discriminant validity.

Common Method Variance: The extent of common method bias was assessed with Harman's one-factor test by entering all constructs into a principal components factor analysis (Podsakoff and Organ, 1986). Evidence for common method bias exists when a general construct accounts for the majority of the covariance among all constructs. In this analysis, each principal construct explained roughly equal variance (range = 6-18%), indicating no common method bias. Second, a partial correlation method was used

(Podsakoff and Organ, 1986). The highest factor from the factor analysis was added to the PLS model as a control variable on all dependent variables. According to Podsakoff and Organ (p. 536), this factor is assumed to "contain the best approximation of the common method variance if is a general factor on which all variables load." This factor did not increase the variance explained in any of the dependent variables, inferring no common method bias. Third, we used Lindell and Whitney's (2001) method, which employs a theoretically unrelated construct (*marker* variable) to adjust the correlations among the principal constructs. *Voluntary use of collaborative IT tools* was used as the marker variable, which captures if the collaborative IT tools are voluntarily used by the group. Irrespective of whether groups are forced to or they voluntarily use collaborative IT tools, the literature suggests that there should not be a major difference in terms of capability and performance. Therefore, any high correlation among any of the items of the study's dependent variables and voluntary use would be an indication of common method bias. Since the average correlation among voluntary use and the principal constructs was r=.11 (average p-value=.1.44), this test shows no evidence of common method bias. Finally, the correlation matrix did not indicate any highly correlated variables, while evidence of common method bias usually results in extremely high correlations (r>.90) (Bagozzi *et al.*, 1991). These tests suggest that common method bias does not account for the study's results.

Multicollinearity was not a serious issue since all tests (eigen analysis, tolerance values, VIFs) did not show evidence of multicollinearity. Also, no evidence of heteroscedasticity wad detected. Finally, outlier analysis did not denote any outliers. The measurement properties of the study's principal constructs are deemed adequate.

3.5. Formative second-order models

To estimate the formative second-order models of CITTLC and performance, we modeled the coefficients (γi) of each first-order factor to the latent second-order factor (Diamantopoulos and Winklhofer, 2001, p. 270).

3.5.1. Formative second-order model of leveraging capability of collaborative it tools

The impact of all first-order constructs that represent the effective use of the six proposed collaborative IT functionalities on CITTLC is significant (p<.01). We also tested the correlations among the first-order constructs since significant correlations suggest that the first-order constructs may belong to the same set, even if formative constructs need not necessarily be correlated (Chin, 1998). The correlations among the first-order factors ranged between .33 - .63 (p<.01). Since a reflective model would render extremely high correlations (often above 0.80), a formative model seems more likely. We also tested whether the second-order CITTLC construct fully mediates the impact of the first-order constructs on group performance, using Baron and Kenny's (1986) mediation test (omitted for brevity). This step ensures that the second-order construct is a more parsimonious representation of the first-order constructs and fully captures their predictive power on the dependent variable it is theorized to predict (Chin, 1998). CITTLC is the only significant predictor when all first-order constructs are included in the model, confirming its full mediating role. In sum, these tests support the proposed second-order formative model of CITTLC.

While all IT functionalities have a statistically significant impact on overall CITTLC, the scheduling, file sharing, conferencing, and shared workspace functionalities have a much higher effect than email and chat/messaging functionalities. T-tests suggest that the each of the regression betas for scheduling, file sharing, conferencing, and shared workspace IT functionalities have a significantly higher impact that the regression betas for email and chat/messaging IT functionalities (p<.001). These findings testify to the higher effect that more sophisticated IT functionalities have on enhancing a group's CITTLC compared to the simpler email and chat/messaging functionalities.

3.5.2. Formative second-order model of group performance

The formative model of group performance was assessed using a similar procedure to CITTLC. All first order performance components had a significant impact (p<.01) on overall group performance. Also, the correlations among the first-order factors ranged from .73 to .76 (p<.01). These results support the proposed second-order formative model.

4. Results

4.1. Testing of research model

The proposed research model was tested with PLS Graph 3.0. The PLS path coefficients and the significance levels were assessed with 200 bootstrap runs. The moderating effect of environmental uncertainty with leveraging capability of collaborative IT tools were tested as part of the structural model with interaction terms formed by cross-multiplying all standardized items of each constructs. We also examined all possible interaction effects among the proposed antecedents of CITTLC, and also their direct effects on group performance. For clearer exposition, the PLS item loadings of each construct are omitted

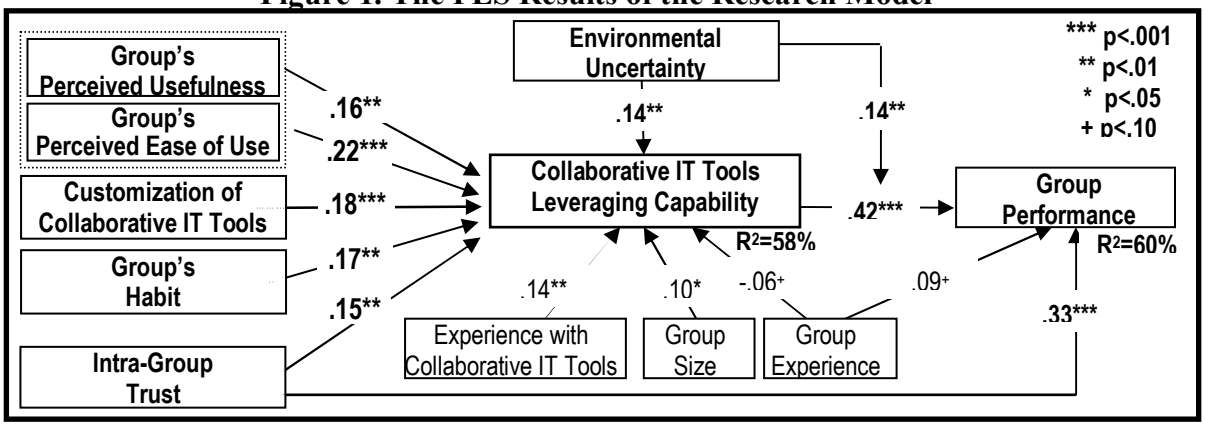
since they are all above 0.80. Also, only significant relationships and control effects are shown (Figure 1).

As shown in Figure 1, the impact of CITTLC on group performance was significant (beta=.42, p<.01), supporting H1. The moderating effect of environmental uncertainty on the relationship between CITTLC and group performance was significant (beta=.14, p<.01), supporting H2. To test the significance of the moderated (interaction) effect, we performed the following tests (Carte and Russell, 2003): First, we calculated the additional variance explained due to the interaction effect, which was substantial (ΔR^2=6.1%). Second, we examined if the variance explained due to the moderated effects is significant beyond the main effects (Carte and Russell, 2003, p. 481). The F-statistic was 1.02, which was statistically significant (p<.05). Third, the variance explained between the main and interaction effects was tested with Cohen's f^2 that was .13, denoting a medium-size effect. Taken together, these tests confirm H2.

In terms of testing the antecedents of CITTLC, the technology adoption variables—group perceived usefulness (beta=.16, p<.01) and perceived ease of using (beta=.22, p<.01) collaborative IT tools—were significant, rendering support for H3a and H3b, respectively. The customization of collaborative IT tools also had a significant effect (beta=.18, p<.01), supporting H4. Group's habit (beta=.17, p<.01) significantly influences CITTLC, supporting H5. The impact of intra-group trust on CITTLC was also significant (beta=.14, p<.01), supporting H6. Finally, environmental uncertainty had a significant impact (beta=.14, p<.01), supporting H7. Interestingly, none of the independent variables had a significantly (p<.05) higher effect on CITTLC over the other variables, implying that all five antecedents of CITTLC have roughly an equal effect on CITTLC.

To examine the mediating role of CITTLC, we tested whether the proposed antecedents of CITTLC had a significant *direct* effect on group performance. Only intra-group trust had a significant direct impact on CITTLC (beta=.33, p<.01), while all other antecedents became insignificant when CITTLC was included in the model. This relationship is explained by the fact that trust has other positive effects on groups beyond merely enhancing their effectiveness in using collaborative IT tools. Despite the direct effect of trust on performance, CITTLC as a key mediator in the structural model.

Figure 1. The PLS Results of the Research Model



Finally, since non-linear (quadratic and interaction) effects for the antecedent variables may confound the proposed independent effects, we included quadratic (X^2) and interaction effects as additional variables in the proposed model (Carte and Russell, 2003). The results showed that none of the quadratic and interaction effects was statistically significant, and none of them explained a high amount of variance in the dependent variable. Thus, fears of non-linear confounds were alleviated.

4.2. Effective leveraging *versus* use of collaborative it tools

A key premise in the development of the CITTLC construct is that the effective use of collaborative IT tools is the key predictor of group performance, not their existence, technical sophistication, or the extent of their use. Since all groups in our sample had access to the firm's collaborative IT tools, the mere presence of IT tools and their functionality did not differ across groups to have an effect on group performance. To contrast the relative impact of CITTLC versus the mere use of collaborative IT tools, we asked the respondents to assess the extent they are using collaborative IT tools in general, and also the extent they are using IT functionalities (email, chat/messaging, scheduling, file sharing, conferencing, shared workspace) on a 7-point Likert-type scale anchored at 1=Not at all - 7=To a large extent with seven items. This construct was operationalized as a first-order formative construct

with the measures of the 6 specific IT functionalities forming the first-order variable of overall use of collaborative IT tools, which was highly correlated with the overall (indicator) measure of the extent to which the group uses collaborative IT tools in general ($r=.83$, $p<.01$).

We then examined the effectiveness of CITTLC over the simple use of collaborative IT tools on group performance. While the use of collaborative IT tools significantly affected group performance ($b=.21$, $p<.05$) when CITTLC was not included in the PLS model, its impact became insignificant when CITTLC was included. This finding suggests that the extent of using of collaborative IT tools is a poor predictor of group performance when CITTLC is present.

We also examined a structural model in which the simple use of collaborative IT tools mediated the impact of the proposed CITTLC antecedents. While the use of collaborative IT tools was significantly correlated to CITTLC ($r=.35$, $p<.01$) and had a significant effect on CITTLC ($b=.19$, $p<.05$), its impact became insignificant when the five proposed antecedents of CITTLC were also included in the model. These findings suggest that the proposed antecedents of CITTLC do not enhance the effective use of collaborative IT tools *indirectly* by facilitating the extent of their use, but they *directly* enhance the group's ability to effectively use collaborative IT tools (as formally hypothesized in H3-H7).

In sum, these findings imply that the extent of using collaborative IT tools does *not* have a role in either predicting group performance or facilitating the effective leveraging of collaborative IT tools.

5. Discussion

The proposed process-level construct of CITTLC with the work group as the unit of analysis focuses on the effective use of collaborative IT tools to improve group performance. By demonstrating the performance effects of effectively using generic IT functionalities, this study aims to entice IS researchers to look beyond the firm level for identifying the strategic effects of collaborative IT tools. Rather than focusing on the existence of collaborative IT tools and their technical design, this study stresses the need to examine the effective use of IT functionalities. Finally, this study aims to entice IS researchers to prescribe how CITTLC and group performance can be further enhanced by identifying additional antecedents.

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