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Contextualizing the Adoption of Electric Collaboration Tools: System and Team Considerations

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ABSTRACT

This study suggests that individuals' technology adoption decisions in the context of online collaboration tools are based on individual-level assessments of the technology, as well as on group-level attributes of the team with which one needs to work. Thus, a multilevel model of online collaboration technology adoption is proposed and tested, using hierarchical linear modeling techniques applied to a sample of 96 individuals who were nested in 34 virtual teams. Our findings suggest that a team member's perceptions regarding the usefulness of an online collaboration tool positively affect his or her behavioral intentions to use this tool in a similar context in the future. Furthermore, after controlling for individual level perceived usefulness, group potency, as a team-level concept, incrementally and positively affected team members' intentions to use the online collaboration technology with a similar team in the future. Some implications and future research directions are discussed.

Keywords

Online collaboration, virtual teams, technology adoption, multilevel analysis, hierarchical linear modeling, group potency

INTRODUCTION

The study of teams has always been a focus of organizational research as teams become increasingly important and global in modern organizations. Furthermore, modern organizations increasingly rely on technologies for their daily operations and communications. The underlying organizational technologies are often readily available and are becoming increasingly affordable. The combination of the abovementioned trends has led to the creation of a new concept termed virtual teams or technology-mediated teams. This type of team is comprised of several individuals who are not necessarily collocated and who rely on technology for much of their communication. Furthermore, in these teams individuals work on interdependent tasks, and share responsibility for outcomes (Webster and Staples, 2006).

Virtual teams may offer many potential benefits, such as enhanced performance and stronger team-member participation, for organizations (Townsend, DeMarie and Hendrickson, 1998). As a result, virtual teams have become increasingly popular, especially in global organizations. In fact, exclusive face-to-face teams are becoming rare and most professional teams now a day's employ certain degrees of "virtualness" (Bell and Kozlowski, 2002, Martins, Gilson and Maynard, 2004). Thus, it is very important to understand factors pertaining to virtual teams, such that organizations can help improve their usage and performances.

Virtual teams heavily rely on electronic collaboration tools for communication, and these tools are frequently readily available for team members in many organizations (e.g., Net-Meeting tools). Nevertheless, in many instances individuals may choose to work solely face-to-face and avoid using online collaboration tools. In such cases, their organization will not harvest the potential benefits of using virtual teams. As such, it is desirable that we better understand the factors that drive the decision to use online collaboration means, such that organizations can increase their usage. In other words, the adoption of e-collaboration tools is an investigation worthy research. Although this is a very important issue, little research has been done on the acceptance of electronic collaboration tools in a virtual team context.

Technology acceptance in general, on the other hand, has been studied extensively in IS research. The Technology Acceptance Model (Davis, Bagozzi and Warshaw, 1989) and its extensions (e.g. Venkatesh, Morris, Davis and Davis, 2003) have been used repeatedly to explain factors that drive the adoption of information technologies by individual users. Nevertheless, such models often consider attitudinal and perceptual predictors at the individual level only. That is, they take into account the ways individuals perceive or assess the technology (e.g., trust, Gefen, Karahanna and Straub, 2003), and sometimes the way the environment is being perceived by individuals (e.g., facilitating conditions, Lu, Yu and Liu, 2005). Nevertheless, such models rarely take into account macro-level factors that surround the adopters (e.g., organizational climate), which may be relevant, and even crucial, in some cases (Johns, 2006).

In the context of online collaboration the team with which one needs to work is a relevant macro-level factor. It has been well established that potential users of a technology consider individual-level perceptions, such as usefulness and ease of use, when developing adoption decisions. Nevertheless, little is known about team characteristics that affect this decision. In this study, it is argued that individuals may consider their team and its attributes when developing a rational decision to adopt an online collaboration means. That is, even when a collaboration technology seems generally useful, having to use it with an incompetent team may deter one's intention to use it. Such team assessments can be considered task-technology fit considerations (Goodhue, 1995) as well as media richness considerations (Daft, Lengel and Trevino, 1987). Simply put, while an electronic collaboration tool may be perceived as generally effective, its use with less competent team members may seem less appropriate due to the anticipated equivocality and task difficulties.

The use of purely individual-level models of technology acceptance, which is common in the MIS literature, may be problematic conceptually and statistically when dealing with virtual teams. Conceptually, it has been demonstrated across many studies that group level factors play a very important role in individual decisions (Bliese, Halverson and Schriesheim, 2002, Liden, Erdogan, Wayne and Sparrowe, 2006). Studying technology acceptance only at one level can lead to incomplete and disjoint views of how technology is used by individuals in macro-level environments such as teams, departments, and organizations (Burton-Jones and Gallivan, 2007). Statistically, ignoring intra-group dependencies in group research, such as virtual teams, may bias the results (Kenny, 1995). That is, by violating the assumption of independence taken by most statistical techniques (i.e., all members of the same group have the same group attribute, which make their scores interdependent) the obtained coefficients may be biased and misleading.

Given the need for considering macro (team) -level factors in the context of online collaboration, this paper takes a multilevel view on technology adoption. Not only does this study include individual level factors (perceived usefulness), but it also takes into account cross-level effects from group-level factors (group potency) which may influence the adoption decision of individual members. The contribution of this study is two-fold. First, this study is among the first attempts to understand the development of behavioral intentions in a team context. Thus, it extends the technology acceptance and virtual team research by applying multilevel modeling and analysis. Second, it demonstrates the use of a relatively unused methodology in MIS research, namely Hierarchical Linear Modeling. That is, it paves the way for future multi-level MIS investigations in the context of online collaboration, and many others.

This article is organized as follows: The next section provides theoretical background and the hypotheses development. Then, the methods used in this study are presented, followed by a section on data analysis and results. The article concludes with the summary of findings and discussion.

THEORETICAL BACKGROUND

Over the past two decades, Management Information Systems (MIS) researchers have attempted to better understand what drives the adoption and use of information technologies (see review in King and He, 2006). Such issues received strong attention from the research community because of their practical implications; technology will not improve organizational efficiency if people refuse to use it, even though organizations may invest substantial amount of labor and money in the technology. Given the importance of the topic many models for explaining technology adoption behaviors were developed and tested. The prominent model that ignited this line of research is the Technology Acceptance Model (TAM) (Davis, 1989).

TAM is an information-systems specific adaptation of the Theory of Reasoned Action (Fishbein and Ajzen, 1975). According to TAM, a user's behavioral intentions to use a technology are determined directly and indirectly by his or perceptions of usefulness and ease of use. Perceived usefulness is a potential user assessment of whether using an information technology artifact will increase his or her job performance (Davis et al., 1989). Ease is of use is an assessment of the effort required for using the technology. TAM and its extensions (e.g., Venkatesh et al., 2003) have been used widely in IS research in explaining technology usage across systems and contexts (see Sun and Zhang, 2006). Thus, the model's validity and generalizability have been well established. Accordingly, this research project does not attempt to replicate the model in a different context, but rather builds on some of the established TAM relationships.

While user decision to adopt electronic collaboration means can be modeled following the well-generalized TAM pattern, it has at least two complexities to it that do not exist in a typical adoption scenario. First, while individuals may develop behavioral intentions to use an electronic means for collaboration, the final adoption and use of the tool depends on the inputs from other team members, the social structure of the team, the task at hand, and many other factors. That is, the consent of all team members is needed for using an electronic collaboration means. This sort of group decision making and technology appropriation processes may follow the logic of theories such as the adaptive structuration theory (Majchrzak, Rice, Malhotra, King and Ba, 2000). According to the latter theory technology features, task and organizational environment, and

group structure, together with dynamic sources of structures, affect appropriation moves and decision processes. In other words, contextual factors, such as team and task, evolve over time and affect decision processes, such as collaboration tool selection and use, in teams. While this is an interesting area to investigate, it is not the focus of the extant study. Accordingly, we examine the development of behavioral intentions by individuals, and do not extend our model for examining the following appropriation and group decision processes. It is important to understand the development of such individual level intentions because they are an input to the group decision process (which may or may not result in an adoption decision supporting the original individual intentions).

Second, individual-level adoption decisions pertaining to online collaboration tools typically require considerations beyond the system itself. These considerations may include, for example, the team with which one needs to interact and the task a team needs to work on. While task considerations are applicable for adoption decisions regarding any technology (e.g., task-technology fit considerations, Goodhue, 1995), team characteristics are a unique contextual factor which may be taken into account by potential users of electronic collaboration tools. That is, individuals may use team characteristics as the basis upon which they develop behavioral intentions. As such, team considerations are the focus of this study, and are discussed in detail in the next paragraphs.

Note that the abovementioned view of technology adoption in the online collaboration context does not just apply to the individual level, it spans across levels of measurement. Adoption decisions according to this view are developed by individuals; using individual-level assessments (e.g., assessments of ease of use and perceived usefulness) as well as attributes of the groups to which they belong (e.g., team cohesiveness and collective efficacy). In other words, an individual adoption decision has two sources of variation – one at the individual-level and one at the group-level (Bryk and Raudenbush, 1992). The fact that the second source of variance is identical for members of the same group violates the assumption of independence taken by conventional statistical techniques; thus requiring special treatment which will be discussed in the methods section.

Individual Level Hypothesis

On the individual level, we suggest a replication of the relationship between perceived usefulness and behavioral intention in TAM model. In a virtual team context, we expect a typical effect of perceived usefulness on behavioral intentions. That is, individuals who perceive the online collaboration tool to be useful and improve their performance are likely to develop stronger behavioral intentions to use the online collaboration tool. Thus, the following hypothesis is suggested:

H1: Perceived usefulness will positively affect behavioral intention to use the communication technology at the individual level.

Cross- Level Hypothesis

In this study we focus on one group-level attribute, namely group potency. Group potency is a belief of a group about its general effectiveness across tasks and contexts (Gibson, Randel and Earley, 2000). It is an important group attribute to investigate, because it has been linked to many group level outcomes, such as team-satisfaction and team-performance, across many team contexts (Gully, Incalcaterra, Joshi and Beaubien, 2002). Accordingly, recent IS studies tap into this realm and examine, for example, the antecedents of group potency in software teams (Akgun, Keskin, Byrne and Imamoglu, 2007), Nevertheless, this shared, team-level concept has not yet been incorporated in an individual-level technology adoption model.

In this study, the cross-level focus is on the relationship between group potency and behavioral intention to use the online collaboration technology. It has been found that effective virtual teams appear to be able to adapt the technology and match it to communication requirements of the task and attributes of the team (Maznevski and Chudoba, 2001). That is, members of competent virtual teams will better appropriate the technology, and thus may develop stronger intentions to re-use it in future. Furthermore, following media richness theory (Daft and Lengel, 1986), competent teams may better know what needs to be done and thus may use less ambiguous communications, which are more suitable for lean media. Thus, competent teams will be able to communicate and coordinate effectively even when using lean media, such as asynchronous collaboration space. Given more ambiguous communications in less competent teams, team members may find the lean communication means less suitable for accomplishing their needs Thus, they will try to avoid using the same technology in the future, and may prefer face-to-face meetings instead. Thus, the following hypothesis is suggested:

H2: After controlling for individual level perceived usefulness, group potency at the group level will incrementally and positively affect team members' intentions to use the online collaboration technology with a similar team in the future.

The research model is depicted in Figure 1.

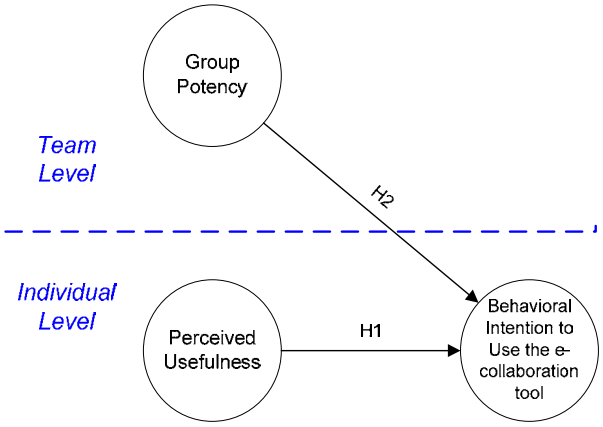

Figure 1: The Multi-level Research Model

METHODS

Participants

Students in an introductory Management Information Systems course held at a North American university were used for this study. They were asked to complete a mandatory online collaboration assignment before completing the survey, which was voluntary. Survey completion was encouraged with small grade incentives.

The assignment involved 103 individuals who were divided into 33 groups of 3 members and one group with 4 members. Out of them, 96 individuals completed the post-exercise survey (93% response rate). The data pertained to all 34 groups, and included 26 groups for which there were 3 responses, 7 groups for which there were 2 responses, and one group that had 4 responses. The sample was comprised of 51 men (53%) and 45 women (47%), with ages ranging from 18 to 56 (average age of 23.4). These individuals had some part-time work experience as well as full-time work experience. The ranges were none to 11 years and none to 30 years respectively, with corresponding means of about 3 years.

Procedures

Individuals were randomly pre-assigned to groups, and were asked to collaborate online using a virtual collaboration space for producing a report. The e-collaboration space was an asynchronous bulletin board through which individuals could exchange ideas and drafts, and develop their final submission by posting messages and files. The assignment asked teams to produce a short report on a case study, building on materials covered in class and using personal interpretations and opinions. In order for team members to develop stable assessments of the online collaboration space they were explicitly asked to collaborate only via the assigned e-collaboration space. Students were given two weeks for completing the assignment, after which they were asked to voluntarily complete a paper-based questionnaire. The teams had a second assignment which was similar to the one described above, in which they could choose between using the e-collaboration space or other means of collaboration (e.g., face-to-face meetings). The second assignment was the subject of their behavioral intentions

Measures

The survey instrument included two sections. In the first section demographic information, such as age, gender, and work experience was solicited. The second part included items pertaining to the research model's constructs. Perceived usefulness and behavioral intentions were measured using the scales by Venkatesh and Davis (2000), and group potency was measured using the scale by Guzzo et al. (1993). The items used a one to seven Likert scale, and were anchored with "strongly disagree" (1) and "strongly agree" (7). A sample of the measures included in the survey and their sources are outlined in **Error! Reference source not found.**.

Construct	Measure Source	# of Items	Items
Group Potency (GP)	Guzzo et al. (1993)	7	Our team has confidence in itself
Perceived Usefulness (PU)	Venkatesh and Davis (2000)	4	Using this e-collaboration tool improves group members' ability to satisfactorily complete the group project
Behavioral Usage Intentions (BI)	Venkatesh and Davis (2000)	2	Assuming I have access to this e-collaboration tool, and I can choose to use this tool or not, I intend to use it for the second group project

Table 1: Sample Items of Measurement Instrument

DATA ANALYSIS & RESULTS

Recall that hypothesis H1 pertains to individual level constructs, whereas H2 captures a cross-level effect (i.e., an effect of a team level construct on individual level behaviors). Several analytical steps were taken for examining these hypotheses. First, construct reliabilities and convergent validities were assessed using loadings and Cronbach's alphas. A composite score was then created for each construct using the measurement items pertaining to the construct. In addition, composite group-level scores were created using individual-level scores after proper examination of intra-class correlations. The individual and group level composite scores were used for model estimation, following the Hierarchical Linear Modeling (HLM) approach (Bryk and Raudenbush, 1992) with HLM6.04. The HLM approach, as opposed to conventional linear modeling techniques, was chosen because it allows partitioning the observed variance into between and within-group components. This partitioning is necessary because according to our theory, two sources of variance exist in an individual's intention- the individual and the team to which he or she belongs. Below we provide more detail on the analysis.

Creating Individual Level Construct Scores

As a preliminary step, all construct reliabilities and item loadings and cross-loadings were assessed. Cronbach's Alphas were 0.97, 0.94, and 0.97 for group potency, perceived usefulness, and behavioral intentions respectively. In addition, all factor loadings were over 0.85, with relatively low cross-loadings. Thus, it was concluded that the measurement scales are reasonably valid and reliable, and composite scores can be created for individual-level constructs as an input for the HLM process. The average of all items pertaining to the same scale was used for creating such composite scores. The average levels of an individual's perceived usefulness and behavioral intentions were 4.30 and 4.39 respectively, with corresponding standard deviations of 1.45 and 1.68.

Creating Group - Level Construct Scores

Recall that group potency items asked individuals to assess (rate) certain attributes of the groups to which they belonged. That is, this construct was measured at the individual level and an aggregation for capturing the group-level concept is needed. This aggregation is based on Chan's (1998) classification of composition models. In the case of group potency, the group-level unit is represented by individual ratings pertaining to the same attribute. That is, a direct consensus conceptualization in which the meaning of a team-level construct is captured by a consensus among team-members is appropriate. In such instances, the average score for a team, using individual scores, may be appropriate, given an acceptable level of within-group agreement (i.e., consensus) (Chan, 1998). This means that individual ratings of items pertaining to group potency should be fairly consistent across individuals within-groups (and may vary across groups). In other words, individuals who belong to the same group should have similar responses to the group potency items.

Within-group interrater agreement (r_{wg}) is often used for assessing consensus, and as the basis upon which aggregation decisions are made. r_{wg} captures the extent to which ratings from different team members are interchangeable (James, Demaree and Wolf, 1993). While there are other measures of reliability (e.g., ICC), the strengths of r_{wg} are that it can deal with multi-item scales, and it is not based on between-group variance (Dixon and Cunningham, 2006). In the current study, r_{wg} was calculated for the group potency scale following the James et al. procedure (James, Demaree and Wolf, 1984). An r_{wg} score of 0.87 exceeds the suggested cutoff of 0.7, thus indicating that individuals who belong to the same group provided reasonably similar assessments of group potency.

Furthermore, the group potency scale was highly reliable at the individual level, with Cronabach's alpha of 0.97. Thus, scale items are highly interchangeable, and their aggregation (averaging) is reasonable. Given the high within-scale reliability and the acceptable within-group reliability, perceptions of group potency, as reported by individual group members, were aggregated into group level concepts by taking the mean across scales and team-members (e.g., the group potency of group 1 was calculated as the average of all group potency scale items as reported by all members of group 1). Overall, a dataset with

34 group level observations of group potency was created. The mean group potency score was 4.96 with a standard deviation of 1.07.

Model Estimation

Recall that H2 argues that group potency positively affects individuals' behavioral intentions to use the e-collaboration tool. Because the dependent variable is at the individual level, and the predictor is at the group level, HLM 6 (Bryk and Raudenbush, 1992) was utilized, following the procedures outlined by Hofmann, Griffin and Gavin (2000). First, a null model which had no predictors at either level was estimated. This model was used for assessing the within-group and between-group variance components, and testing whether there is sufficient between-group variation for further analysis. The results demonstrate that 78% of the variance in behavioral intentions resides within teams (individual level), and the rest (ICC = 22%) resides between-teams (group level). A chi-square test for the between-groups variance component ($p < 0.05$) indicates that there is sufficient variation (different from zero), and a multilevel analysis is plausible.

Second, given the results of the null-model, a model that includes only individual level effects (Perceived Usefulness in our case) was constructed and estimated. Centering was performed around group means for individual-level variables, because group-mean centering is less biased, and leads to less ambiguous interpretations than other centering approaches (e.g., grand-mean centering, which produces regression slopes that are ambiguous mixtures of individual and group level effects) (Enders and Tofighi, 2007). The results demonstrated that perceived usefulness (centered on group means) has a significant effect on behavioral intentions (β=0.87, $p < 0.001$).

Finally, a two-level model was specified and tested. In this model, perceived usefulness predicted behavioral intentions at the individual level, and group potency, at the group level, predicted the intercept of the behavioral intentions regression equation at the individual level. The results provide support for H2; group potency at the group level, affects individual level behavioral intentions ($\gamma = 0.69$, $p < 0.001$), after controlling for perceived usefulness at the individual level ($\beta = 0.87$, $p < 0.001$).

The HLM procedure allows us to decompose the variance explained in behavioral intention into within-group and between-group parts. Following the Snijders and Bosker procedure (1994), perceived usefulness explains 56% of the within-group variance in behavioral intentions, whereas group potency explains 33% of the between-group variance. These components were combined using the formula provided by Bryk and Raudenbush (1992). The total R^2 shows that the full model explains 51% of the total variance in behavioral intentions. The research model, including individual and cross-level effects is depicted in Figure 2 (both effects significant at the $p < 0.001$ level).

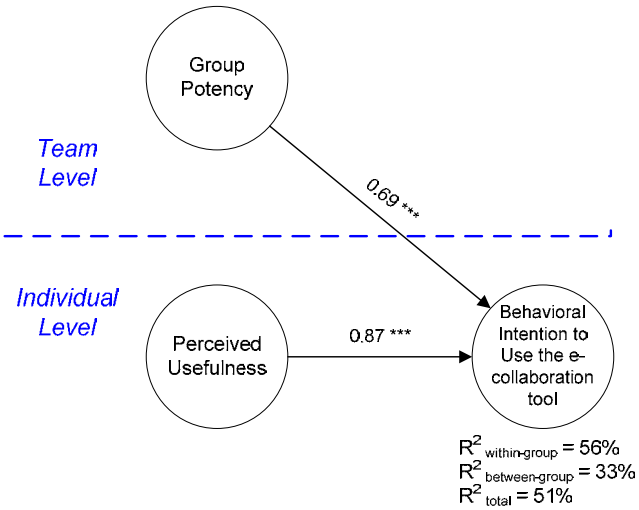

Figure 2: The Multi-level Structural Model

DISCUSSION & CONCLUSION

A growing body of literature deals with factors that affect the adoption of virtual teaming tools and virtual team performance. Given the fact that online collaboration (whether fully virtual or not) has many potential benefits to organizations, it is imperative for us to understand how managers can help diffuse online collaboration technologies, and how they can help teams to better perform in online environments. This study addressed these issues, and extended past research by examining

multilevel effects. The findings suggest that (1) after controlling for assessments of usefulness at the individual-level, group potency strongly affects one's decision to employ an online collocation tool for working with a similar team, and (2) behavioral intentions in a team context have fairly large within and between-group variance components (56% and 33% respectively). That is, users consider both system attributes and team characteristics when developing a rational decision to use an online collaboration tool. More research in this realm is certainly needed.

Several limitations may be acknowledged. First of all, the use of student subjects may limit the generalizability of the findings to actual work teams. Future studies may consider field studies with real work groups to generalize the findings in this study. Secondly, this is a cross sectional study, thus we did not measure changes in behavior and assessment over time. Thus, longitudinal studies in the future can further improve our understanding of the effects of group potency on technology adoption intentions.

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