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ABSTRACT

Developing an effective IT use strategy to achieve its potential is a central concern in organizations. As teams are essential in accomplishing projects and tasks, it becomes relevant to understand the nature of IT use by teams. In this study, we propose a new term, IT capabilities adaptation (ITCA), which represents an emergent view with regard to patterns of successful IT use in teams. By incorporating the construct shared mental models (SMM) as the dependent variable, we develop and pilot test a theoretical model to examine the impact of ITCA on SMM similarity. The model is constructed and examined at the team level. Based on findings in previous studies, we specify four salient properties of IT capabilities adaptation. The findings suggest that the SMM similarity index is significantly associated with IT usage experience and change of perceived complexity.

Keywords

IT capabilities, adaptation, shared mental models, team, cognition.

INTRODUCTION

Advances in both hardware and software are enabling information technologies (IT) to pervade many aspects of conventional business at an unprecedented speed. Developing an effective IT use strategy to achieve its potential is a central concern in organizations (Ives, Hamilton, Davis 1980). To contradict the "productivity paradox", significant progress has been made within IS literature in understanding the nature and the use of IT (Benbasat, Dexter 1985; Davis, Bagozzi, Warshaw 1989; Goodhue and Thompson 1995). The perspective of IT capabilities, defined as a "feature or faculty capable of being developed (Merriam Webster Dictionary)" offers one useful approach to conceptualizing the IT artifact. Adaptation here describes the complex interplay between IT, social structures, and human interaction (DeScanctis and Poole 1994). Combining the two concepts, in this paper, we propose a new term, IT capabilities adaptation, which represents an **emergent view** with regard to patterns of successful IT use in organizations.

In this paper, we also take the first step to examine the interplay between IT use and team cognition. Prior studies in IS have used individualistic cognitive constructs to explain user's behaviors toward IT (Agarwal, Karahanna 2000). However, as IT becomes widely utilized in teams, it would be more relevant to examine the IT artifact at the team level of analysis (Sarker, Valacich, Sarker 2005). We choose to investigate the impact of IT use on team cognition. The team cognitive construct we chose is "shared mental models." SMM or shared mental models represents one form of team cognition and are identified as "arguably the best developed in terms of conceptualization, measurement, and demonstrated effects as compared to other forms of team cognition" (Kozlowski, Bell 2003, p. 366). The SMM theory states that team effectiveness is influenced by team members possessing a congruent mental model with regard to aspects such as task and team operation (Cannon-Bowers, Salas 1993). Research in SMM also suggests that communication is a necessary condition for having a SMM in team (Mohammed, Ferzandi, Hamilton 2010). This naturally leads us to postulate the potential role of IT in the development of SMM. Specifically, we anticipate that assessment of IT capabilities' adaptation would help predict the degree of overlap existing among team members' mental models. Furthermore, we believe that examining the patterns of IT capabilities adaptation, and consequently, their effects on the outcome of SMM will inform the design of organizational interventions to increase the effectiveness of IT use.

Though theoretical exploration of the IT artifact and its capabilities is proliferative, substantive empirical studies examining the effect of IT capabilities adaptation are lacking. This paper presents an exploratory study examining the impact of IT capabilities' adaptation on SMM. The findings will inform future empirical research and help refine our proposed model.

THEORY AND HYPOTHESES

Figure 1 shows the proposed model, referred to as ITCA. By drawing on findings cumulated from IS and organizational literature, ITCA examines relationships between two theoretical constructs, IT capabilities adaptation and shared mental

models (SMM). The model is constructed at the team level of analysis. The goal of ITCA is to provide an explanation of the patterns of using IT for the development of team SMM. Specifically ITCA possesses four salient components—*IT usage experience, change of perceived complexity, change of perceived utility and perceived fit*. SMM is assessed through examining the similarity of taskwork mental models and teamwork mental models. Below we define each of these concepts and develop the arguments for the hypothesized relationship in the proposed model.

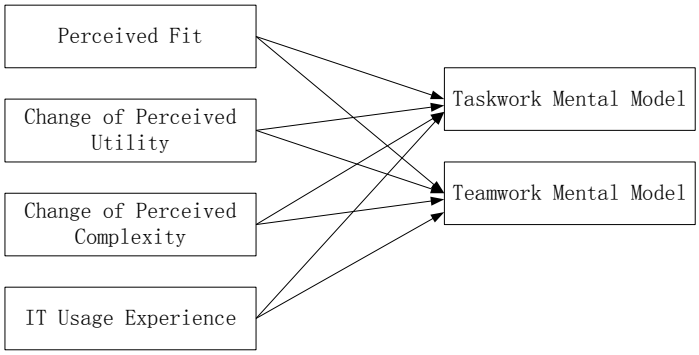

Figure 1. Model of ITCA

IT Capabilities Adaptation

The term IT capabilities adaptation shows our understanding of two central questions in the IS discipline. What is the nature of the IT artifact? How is it used? These two questions are closely related. Answers to the former provide the boundary for examining the latter. Findings of the latter will help deepen our understanding of the former.

Due to the development of advanced information technologies such as cloud computing, the form of IT is, and will continuously become more diverse and complex. In a review of the publications in two major IS journals, 13 distinct forms of IT artifacts (e.g. management support systems; communications and collaboration tools; infrastructure services et al.) were identified (Nevo, Nevo, Ein-Dor 2009). In a response to such evolution of IT artifacts, researchers began to re-conceptualize IT (Carte et al. 2004; Davis et al. 2009; Dennis et al. 2008). Of the many ways of understanding IT, it is argued that describing IT from the capabilities perspective provides a more flexible view with regard to understanding what a particular technology or a bundle of technologies can do or can be exploited to do (Davis, Murphy, Owens, Khazanchi, Zigurs 2009). Following Davis et al. (2009), we define IT capabilities as a "feature or faculty capable of being developed". David et al. (2009) also specified IT capabilities for metaverse technology capabilities in terms of four dimensions -- communication, team processing, interaction and rendering. We use and extend their notion of capabilities in this paper.

For the question of how IT is used in organizations, one emergent view is centered on the concept of adaptation. Socio-technical systems (STS) theory (Bostrom, Heinen 1977) holds the view that IT is neutral; therefore whether or not an implementation of IT succeeds will depend upon how IT will be used. Adaptive Structuration Theory (AST) (DeScanctis and Poole 1994) emphasizes the significant impact of social structures on the IT's structures. AST proposes that the use of technology varies across context. How the technologies are used depends on the "task, the environment, and other contingencies that offer alternative sources of social structures (DeScanctis and Poole 1994, p. 128)." Sun and Zhang (2008, p. 5) proposed the term "adaptive system use", which is defined as "user modifications of the content of his/her features in use (what features are used) and/or the way of using these features (how these features are used)".

Combing the two streams of research discussed above, we propose the term IT capabilities adaptation, which we argue is an emergent characteristic of the human-technology interaction. Sun and Zhang's study (2008) examines triggers of the adaptive system use, while we are interested in identifying patterns of adaptive IT capabilities use. Furthermore, we argue that these patterns can be studied by examining the following salient properties of "IT capabilities adaptation" - IT usage experience, change of perceived complexity, change of perceived utility, and perceived fit.

Prior studies mostly view usage experience with IT as an external factor, or a determinant to individual's or group's attitudes and utilization of technology. For example, actual technology use was found to have positive effects on the state of the flow, a construct describing the degree to which people involve themselves in an activity (Webster and Martocchio 1993). Following Webster' study, cognitive absorption (CA) (Agarwal et al. 2000) theory states that both the enjoyment and flow, which was referred to as the "holistic experience" with technology, positively link to user's beliefs about technology use—perceived usefulness and perceived ease of use. AST suggests that people's familiarity with the usage of technologies will

help users be more faithful in appropriating technologies. AST proposes that technology structures are appropriated based on group's usage of technologies. In this paper, we argue that it is more relevant to know usage experience as a property of IT capabilities adaptation, rather than as an exogenous variable. As a consequence of technologies becoming more ubiquitous and easy to adopt, individual differences with regard to the capability to master IT use given same amount of time has significantly decreased. Therefore, we anticipate that usage experience becomes relevant for describing the notion of IT capabilities adaptation. Considering the context of group, we specifically define *IT usage experience as the total amount of time and the frequency with the IT capabilities use aggregated from all members in the group*. Technology adoption by groups (TAG) (Sarker et al. 2005) states "majority valence toward a technology will have a significant effect on the group's valence toward the technology", similarly; we assume that the sum of the individual experience with IT use would positively correlate to the team's IT capabilities adaptation. Thus we assert the following hypothesis.

$H1_0$: IT capabilities adaptation by virtual teams varies in terms of the IT usage experience.

Another two properties of ITCA are centered on change. AST states that groups appropriate technology structures by making one or more "appropriation moves". A higher number of appropriation moves is favored. At the end of each appropriation move, groups should reach a conclusive judgment toward a specific technology structure through communication and discussion. Such a judgment may stray from the original perceptions of the technology structure held by individuals. We think the coalition of deviations with regard to individual's perception of IT capabilities offers the potential to assess IT capabilities adaptation. Further, among the five characteristics of IT stated by TAG, we anticipate such deviations will be most salient in terms of perceived complexity and perceived utility. Prior studies have found complexity was a function of the "number, novelty, and technological sophistication of new features and concepts" (Aiman-Smith and Green 2002, p. 423) and of "the interpretive flexibility" (Orlikowski 1992). At the end of an appropriation move, after exchanging knowledge, interpretations, and feelings toward a certain IT capability, individual's perceived complexity would presumably decrease. Extending on TAG, we define *change of perceived complexity as the change occurs at the perceived degree of difficulty that group members collectively anticipate in using and adapting to it*. We also assert the following hypothesis.

$H2_0$: IT capabilities adaptation by virtual teams varies in terms of the change of perceived complexity.

TAG (Sarker et al. 2005, p. 51) defines utility as " the relative advantage of adopting technology as collectively perceived by the group". Through communication and discussion, we assume perceived utility of the IT capabilities would be enhanced.

$H3_0$: IT capabilities adaptation by virtual teams varies in terms of the change of perceived utility.

Finally, perceived fit is the fourth characteristic of IT capabilities adaptation. Task-technology fit theory (TTF) (Goodhue and Thompson 1995; Zigurs and Buckland 1998) holds that the individual technology performance is determined by the degree to which task characteristics match the technology used. Similarly, AST states that an ideal appropriation of technology requires positive attitude and faithful to the system's spirit, which is defined as "the general intent with regard to values and goals underlying a given set of structural features (DeScanctis and Poole 1994, p. 126)". Drawing on both of the two theories, we anticipate perceived fit is a useful dimension for defining IT capabilities adaptation. Following the TAG's majority influence proposition, we define *perceived fit as the aggregation of the individual's perceived fit over a certain IT capabilities with regard to the task.*

$H4_0$: IT capabilities adaptation by virtual teams varies in terms of the perceived fit.

Shared Mental Models

A shared mental model (SMM) is the "shared, organized understanding and mental representation of knowledge about key elements of the team's relevant environment" among team members (Mohammed et al. 2010, p. 2). SMM is an important form of team cognition. SMM provides explanation to the implicit mechanism though which a team operates in accomplishing complex projects or tasks. The central assertion is that enhanced and improved SMMs will yield improved team performance by enabling team members to anticipate such as the other's information needs (Salas, Dickson, Converse, Tannenbaum 1992). Specifically, SMM includes taskwork mental models and teamwork mental models. Taskwork mental models refers to mental models about performing the task in a team (e.g. the goals, challenges, procedures). Teamwork mental models are the necessary components important to team interaction and coordination (e.g. member' strengths, team coordination and communication patterns) (Mathieu, Heffner, Goodwin, Salas, Cannon-Bowers 2000). Effective communication is one of the most important factors influencing building SMM. Further, accurate transformation of information is also necessary for building a SMM with high accuracy. Consequently, we propose the following hypotheses.

$H5_0$: IT usage experience is positively associated with taskwork mental models similarity.

$H6_0$: IT usage experience is positively associated with teamwork mental models similarity.

$H7_0$: Change of perceived complexity is positively associated with taskwork mental models similarity.

$H8_0$: Change of perceived complexity is positively associated with teamwork mental models similarity.

$H9_0$: Change of perceived utility is positively associated with taskwork mental models similarity.

$H10_0$: Change of perceived utility is positively associated with teamwork mental models similarity.

$H11_0$: Perceived fit is positively associated with teamwork mental models similarity.

$H12_0$: Perceived fit is positively associated with teamwork mental models similarity.

METHOD

Since this was an initial pilot test of the overall instrument, the sample size was kept quite small. Questionnaires were distributed to a convenient sample of 15 students, who took an introduction course to MIS in a Midwest university with one of the authors. Extra credits were given to participants. The primary aim of this test was to make an initial reliability assessment of the scales and to test the correlations among the constructs.

The 15 students were randomly assigned into five groups. The entire task was to complete a virtual project, which aims to develop a partial business plan for an e-commerce business and to deliver the plan on google site. Students need to decide on the specific business they plan to initialize, and to apply knowledge they learned in class to analyzing the business and IT components of the business. Groups were asked to use google site and other communication technologies to coordinate and communicate. Only two in-class group discussions were taken to facilitate the progress of the project. Questionnaire was given in the end of the project.

Measurement items were developed based on the the four capabilities of IT (Davis et al. 2009) and the theoretical model we proposed. All items were measured on a 1-7 scale. Summated scales were used for measuring each construct.

RESULTS

We evaluated the reliability of the scale by computing the Cronbach's Alpha score. All measurement scales showed high reliability, with $\alpha > .80$. We drop items that can further boost the internal consistency of the instrument so that highest possible α were kept. The final Cronbach's Alpha score ranges from .85 to .95.

Kruskal-Wallis test was used to test $H1_0$ to $H4_0$. Kruskal-Wallis test is a non-parametric method of comparing means among multiple groups. It applies to scale variables with equal interval. It doesn't require large sample size and the normality assumption. Given the test was a pilot study, we evaluated Kruskal-Wallis test at the 0.2 significance level using two-tailed tests. No significant difference between groups in terms of perceived change of utility was revealed. No significant difference between groups in terms of perceived fit was found. However, significant difference between groups in terms of change of perceived complexity was found ($\chi^2=7.28$, $p<.2$). Significant difference between groups in terms of usage experience was also identified ($\chi^2=6.522$, $p<.2$).

Spearman's ranked correlation coefficient was computed to analyze the correlations between each construct. Spearman correlation test doesn't require the normal distribution of the variables. Results indicate that there is evidence to suggests a high correlation ($r=.70$) between usage experience and taskwork mental model similarity ($p<.05$). High correlation ($r=.89$, $p<.05$) was also found between usage experience and teamwork mental models similarity. Change of perceived complexity was found to have high correlation with taskwork mental model similarity ($r=.60$, $p<.05$) and teamwork mental model similarity ($r=.79$, $p<.05$) respectively. The results failed to reveal association between change of perceived utility and taskwork mental model similarity, and teamwork mental model similarity respectively. No significant association between perceived fit and taskwork mental model similarity was found. No significant association between perceived fit and teamwork mental model similarity was identified.

DISCUSSION AND CONCLUSIONS

This study is in general guided by two questions: How do we assess the IT capabilities adaptation? What are the relationships between IT capabilities adaptation and the similarity of SMM in team? Drawing on prior studies about IT conceptualization and utilization by individuals and groups, we proposed four properties of IT capabilities' adaptation—usage experience, change of perceived complexity, change of perceived utility, and perceived fit. Our findings suggest that there are significant differences between groups in terms of both usage experience and change of perceived complexity. Further, there was significant association between usage experience and SMM similarity. High association between change of perceived complexity and SMM similarity was also identified.

In conclusion, the goal in this paper was to enrich our understanding of IT use in enhancing the SMM development in teams. The future study should test the validity of the instrument for each construct, and then conduct a field study to empirically test the proposed theoretical model of ITCA.

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