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Abstract

Virtual teams (VTs) have emerged as a new form of organizational structure supported by enabling information and communication technologies (ICT) that are able to meet future service innovation challenges of the fast-changing business environment. How effective are these virtual teams in comparison to traditional face-to-face groups? Is the teamwork quality similar and is information exchanged as effectively?

The objective of this research is to investigate these issues by developing a research model that combines the task-technology fit and teamwork quality concepts and by using a laboratory experiment to examine the effect of task complexity, media characteristics, and teamwork quality on service innovation performance and satisfaction. The results will offer holds important implications for research and practice in the areas of both service innovation and IT.

Keywords: Virtual team; Communication media; Media-richness theory; Teamwork quality; Task-technology fit

1 INTRODUCTION

Globalization of the business environment and the rapid and revolutionary changes in technology have led to a marketing shift from a product-centric view to a service-centric paradigm (Gressgard, 2011; Malhotra et al., 2007; Cascio, 2000). These changes have driven corporations to expand the boundaries of teams from traditional co-located settings to geographically disparate (spatial and temporal) and culturally different settings (Kedia & Mukherjee, 2009; Purvanova & Bono, 2009; McDonough et al., 2001).

Consequently, virtual teams (VTs) have emerged as an innovative new form of business organizational structure, supported by information and communication technologies (ICT) that are able to meet future innovation challenges of the fast-changing business environment (Wakefield et al., 2008; Wiesenfeld et al., 2001). A VT, as defined by Ale Ebrahim et al., (2009b), is a "small temporary group of culturally diverse geographically dispersed, organizationally and/or time dispersed knowledge workers who coordinate their tasks, mainly with electronic information and communication technologies to carry out one or more organization projects within the diversity of the global environment."

The original idea for much of the research about work in a virtual environment comes from the information systems area under the general umbrella of computer-mediated communication, or CMC (McGrath, 1991; Sproull & Kiesler, 1986). However, the predominate perspective for research on virtual teams, particularly by IS researchers, has shown the links between advances in information and communication technology (e.g., electronic mail, audio-teleconferencing, video conferencing, group decision support system/GDSS, and group decision support systems/DGSS), and team performance (Maznevski & Chudoba, 2000; McDonough et al., 1999; Ocker, et al., 1998; Warkentin, et al., 1997; Ocker et al., 1996; O'Conaill et al., 1993; Chidambaram & Jones, 1993; Hiltz et al., 1986; Nunamaker et al., 1991). So far, we have seen that technology plays an important role in communication and collaboration as team members conduct their cross-boundaries work on virtual teams. Therefore, the purpose of this study is to explore virtual team performance through the fit concept. The specific aims of this research are (a) to provide a theoretical model by combining the media richness theory and teamwork quality concept to better understand virtual team service innovation performance and (b) to compare teamwork quality influence between co-located teams and virtual teams.

In summary, the purpose of this research is to extend previous literature from the Media Richness Theory (MRT), Task-Technology Fit (TTF) perspective, and teamwork quality concept to examine the virtual team performance. The following questions are considered:

(1) How can virtual teams that manage interactions through information and communication technologies (synchronous vs. asynchronous) be made more effective?

(2) What types of information and communication technologies (synchronous vs. asynchronous) best support service innovation tasks by virtual teams?

(3) Can virtual teams using information and communication technologies (synchronous vs. asynchronous) have superior service innovation performance to co-located teams?

(4) Does different teamwork quality influence service innovation performance of virtual teams and co-located teams?

The rest of the paper is organized as follows. First, we discuss and identify the research gaps from previous research about virtual teams. Then, we aim to fill the research gaps by combining three conceptual paradigms: the Media Richness Theory; the Task-Technology Fit model; and teamwork quality concept into a new conceptual model. Finally, we present a future research plan on how to test this model.

2 BACKGROUND

As described above, when team members of virtual teams or co-located teams work together to complete a task they must communicate through some media (Zmud et al., 1990). The most common medium is face-to-face communication (Panko & Kinney, 1995a), which allows participants to use communication modes (e.g., voice tone, words, gestures, touch) to transmit task and social information. Other media can't fully provide the same functions as face-to-face communication. In other words, the various forms of media have differing degrees of impact on communication and can change the team's work style and influence better or worse team performance. Thus, the medium plays a key role in virtual team performance. Therefore, we try to understand the characteristics of communication technologies by drawing on the Media Richness Theory, as described below.

2.1 Media Richness Theory (MRT)

The Media Richness Theory (MRT), also known as the information richness theory, is one of the most widely applied theories. It is a framework to describe how task performance will be improved when task information needs are matched to a medium's ability to transmit richness of information (Daft & Lengel, 1986; Daft et al., 1987; Trevino et al., 1987; 1990). In other words, MRT argues that media which send "rich" information (e.g., face-to-face meetings) are best suited to equivocal tasks (where there are multiple interpretations for available information) and "less rich" media (e.g., computer-mediated communication) are best suited to non-equivocal tasks (Daft & Lengel 1986; Daft et al. 1987). Richness is defined as the ability of information to change understanding within a time interval (Daft & Lengel, 1984, 1986). MRT theory asserts that four constructs influence the richness of media: the ability of the medium to transmit multiple cues (e.g., vocal inflection, gestures), immediate feedback, personalization, and language variety (Daft & Wiginton, 1979). Table 1 shows the concept of media richness via a simple framework that depicts how communication media vary in the richness of information processed (Daft & Lengel, 1984).

Table 1. Media Characteristics that determine Richness of information

Medium	Feedback	Channel	Source	Language	Information richness
Face-to-face	Immediate	Visual, Audio	Personal	Body, Natural	Highest
Telephone	Fast	Audio	Personal	Natural	High
Electronic (e-mail, EDI)	Fast	Limited visual	Personal	Natural/Numeric	High/Moderate
Written, Personal (letters, memos)	Slow	Limited visual	Personal	Natural	Moderate
Written, Formal (bulletins, documents)	Very slow	Limited visual	Impersonal	Natural	Low
Numeric, Formal (computer output)	Very slow	Limited visual	Impersonal	Numeric	Lowest

Note. Adapted from Daft and Lengel (1984).

Most studies of the media richness theory have examined perceptions of media fit, not actual effects of media use performance (Rice, 1992). On the other hand, others studies that point out that face-to-face meeting work groups surpassed computer-mediated work groups on negotiation and intellective tasks (high uncertainty and high equivocality), but no significant differences existed between two groups with regard to generate and decision-making tasks (Daft et al., 1987; El- Shinnawy & Markus, 1992; Lengel & Daft, 1988; Rice & Shook, 1990; Trevino et al., 1987; 1990).

In summary, the purpose of the media richness theory is to identify which medium will work most effectively in a given situation (Daft & Lengel, 1986; Dennis & Kinney, 1998). In other words, could people really use the richer (leaner) media to improve the performance of equivocal (uncertainty) tasks? Fulk et al. (1987) further identify that prior studies related to this perspective have only partially

supported the MRT. However, the media richness theory provides a framework for explaining which medium is better for a team to meet their requirements and complete tasks, but the task-media fit concept of the MRT is insufficient to explain performance (Dennis et al., 1998). Therefore, one goal of this study is to re-think the task-media fit concept from the task-technology fit theory (Goodhue & Thompson, 1995). This is managed through new variables introduced in this research model.

2.2 Task-Technology Fit theory (TTF)

The concept of fit in the area of Management of Information Systems (MIS) is an interesting issue (Bergeron et al., 2001; Christiaanse & Venkatraman, 2002; Henderson & Venkatraman, 1999; Venkatraman, 1989). The most well known theoretical model in IS research is the Task-Technology Fit (TTF) model (Goodhue, 1988), which is defined as "the degree to which a technology assists an individual in performing his or her portfolio of tasks" (Goodhue & Thompson, 1995, p. 216). IS researchers have tested the TTF model in different contexts (D'Ambra & Wilson, 2004; Gebauer & Shaw, 2004; Karimi et al., 2004; Klaus et al., 2003; Dennis et al., 2001). It can also be applied to the virtual team situation described in this study to measure the effects of task-media technologies fit on virtual team performance.

Previous studies have examined virtual teams performing a variety of tasks, ranging from member support to actual production (McGrath, 1991; Daft & Lengel, 1986; McGrath & Hollingshead, 1993). However, different levels of interdependence and uncertainty are associated with different tasks (McGrath & Hollingshead, 1993; McGrath, 1991; Daft & Lengel, 1986). A virtual team will need different functions of information and communication technologies to support task requirements and to successfully complete their tasks. For example, when teams have tasks requiring real time coordination, they may need to use video-conferencing to support the synchronous group communication to complete their tasks. This indicates that the ability of groups or individuals to successfully complete their tasks is dependent upon using the specific functionalities of certain technologies.

Furthermore, we argue that the TTF model can be applied to organizational level research and we adopt this viewpoint for this study. However, we expand the application scope in two ways: (1) We identify functionalities of the best fitting technologies based on MRT theory for virtual team tasks; and (2) We theorize about the effects of technological adoption on team characteristics. An understanding of team level characteristics is gained by drawing on teamwork quality, as described below.

2.3 Teamwork quality (TWQ)

The complex nature of teamwork is a multifaceted, higher-order concept that includes both task related activities and social interaction within teams (Hoegl & Gemuenden, 2001). Important aspects of teamwork include communication, coordination, balance of member contributions, mutual support, effort, and cohesion. Factors outside of the scope of teamwork quality include concerns for the formation of the team, outside influences, and resources. The model of teamwork quality does not consider specific antecedents, given the plethora of organizational, environmental, and personal traits that can affect the interaction quality of a team (Dietrich et al., 2010). In general, a high level of teamwork quality leads to a high level of team performance (Hoegl & Parboteeah, 2006; Hoegl & Gemuenden, 2004).

The teamwork quality construct and its measures have been examined in empirical studies by Easley et al. (2003) and Hoegl and Gemuenden (2004). In teams exhibiting high teamwork quality, team members openly communicate relevant task information (Katz & Allen, 1988; Hauptman & Hirji, 1996), coordinate their task activities (Adler, 1995; Faraj & Sproull, 2000), and contribute their knowledge (Seers, 1989). They also mutually support each other in team discussions and individual task work (Tjosvold, 1984; Cooke & Szumal, 1994), establish and maintain standards of higher effort (Hackman, 1987; Weingart, 1992), and foster team cohesion (Mullen & Copper, 1994; Gully et al., 1995). Therefore, different levels teamwork quality can have varying impacts on project performance

(Hoegl & Gemuenden, 2001). In this study, we adopt this concept of teamwork quality as a means to affect performance.

3 RESEARCH MODEL

This research adopt the inputs-process-output model (McGrath, 1964) and combine media-richness theory (Daft & Lengel, 1986)、task-technology theory (Goodhue & Thompson, 1995) and teamwork quality (Hoegl & Gemuenden, 2001) and try to propose a comprehensive research model to know how virtual teams engaged in service innovation and what kinds of ICT can facilitate service innovation more efficacies. MRT theorists have proposed links to successful outcomes as well as intermediate factors, but provide little guidance as to the exact path taken. The TTF model has similar considerations of success and intermediate factors but provides incomplete guidance for a model structure involving virtual teams. The teamwork quality model, however, is more specific in identifying several immediate predecessors of project success.

With that in mind, based upon these three conceptual paradigms, we propose the model shown in Figure 1 to identify factors of virtual team context. According to TTF and media richness theory, task and communication media technologies characteristic may impact task-communication media technologies fit and communication media utilization (Daft & Lengel, 1986; Goodhue & Thompson, 1995). However, the structure of the subsequent relationships is not specified. This is then further refined by the relationships stressed by I-P-O model (McGrath, 1964) that says teamwork quality and success are impacted by the information technologies, but again without any structural claims. The third layer is the teamwork quality model that directly links certain factors to project success (Hoegl & Gemuenden, 2001). Collectively, the three theories not only mesh the variables together, but precisely define the complete structure not accomplished by any of the three alone or in pairs. The following research hypotheses are raised.

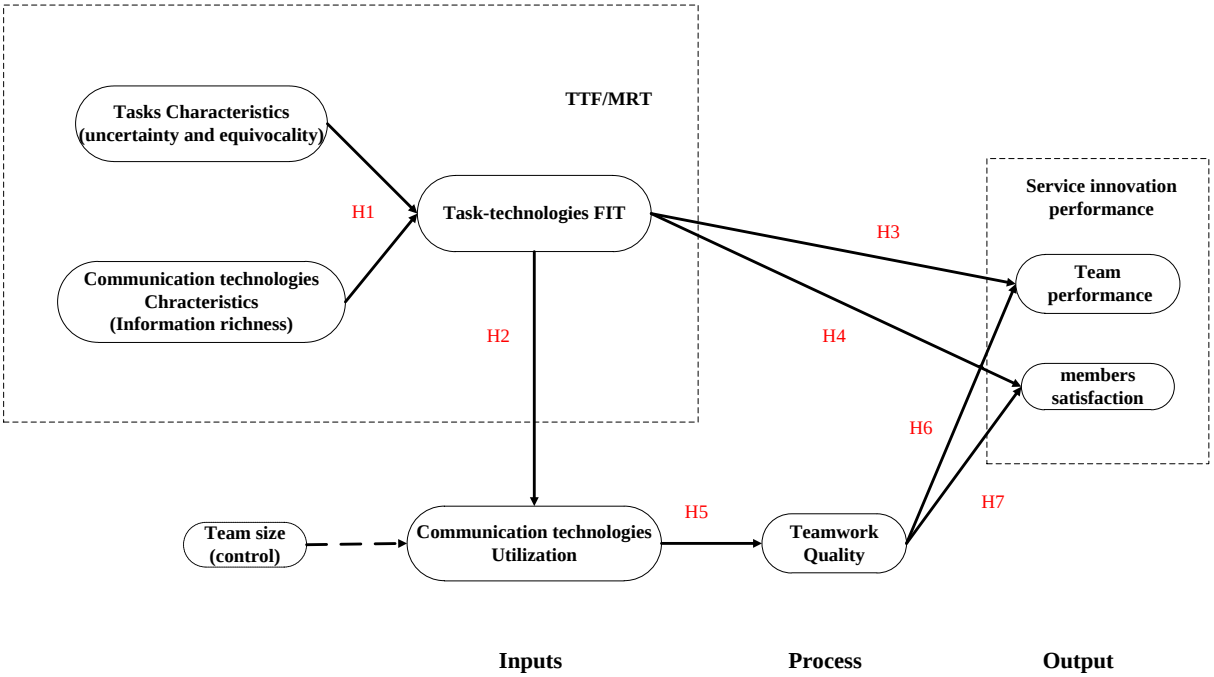

Figure1. Research model

3.1 Hypotheses

Impact of Task-Communication media technologies fit

The object of our study is to test across all the core components of the TTF theory and media richness theory, from task and communication media technology to performance impacts, with a particular emphasis on the role of task-technology fit and direct link to communication media technology utilization. This relationship is based on two important assumptions: first, the TTF will strongly influence user beliefs about consequences of utilization; and second that these user beliefs will have an effect on utilization (Goodhue & Thompson, 1995).
Therefore, TTF should be one important construct that to determine whether systems are believed to be more useful, more important, or give more relative advantage (Davis, 1989; Hartwick & Barki, 1994; Moore and Benbasat, 1991). Furthermore, TTF does not only increase the likelihood of utilization, but it also increases the performance impact of the system regardless of why it is utilized. However, utilization is the behavior to explain team how to complete task by using the communication media technology to satisfy service innovation tasks needs. Therefore, performance will be a function of both utilization and TTF (Goodhue & Thompson 1995). In other words, high performance implies a high level of task-technology fit, and satisfaction with the communication media technologies. High TTF increases the performance impact of the system. Specifically, we tested the following hypothesis：

H1：Member evaluations from virtual team of task-technology fit will be more affected than the ones from real team by both task characteristics and characteristics of the technology.
H2：Member evaluations from virtual team will be more affected than real team in task-technology fit on influencing the communication technologies utilization.
H3：Member evaluations from virtual team will be more affected than real team in task-technology fit on influencing team performance.
H4：Member evaluations from virtual team will be more affected than real team in task-technology fit on influencing personal satisfaction of team members.

Impact of Communication technologies utilization

Previous studies based on inputs-process-output model (McGrath, 1964) to utilize a systems perspective to identify a set of antecedents or inputs which set the team conditions, a set of dynamic processes that affect how teams interaction, and a set of enablers that moderate the effects of the inputs and processes on the outcomes (Powell et al., 2004; Martins et al., 2004; Gladstein, 1984; Klimoski & Mohammed, 1994). However, the teamwork quality construct (Hoegl and Gemuenden, 2001) is as a comprehensive measure of the quality of collaboration in teams. Therefore, these lead us to expect that communication media technologies utilization is detrimental to teamwork quality from team members. Based on empirical evidence and I-P-O models, we propose the following:

H5：Communication technologies utilization from virtual team will be more affected than real team in teamwork quality.

Impact of Teamwork quality

Hoegl and Gemuenden (2001) propose a high level construct to capture the quality of collaboration within teams and empirically validate teamwork quality based on six indicators: communication, coor-dination, balance of member contributions, mutual sup-port, effort, and cohesion. Furthermore, they also point out that the teamwork quality is really positively relative to team effectiveness and efficiency by demonstrating how each of these indicates of teamwork quality provides performance contributions (Hoegl & Gemuenden, 2001). We, therefore, propose the following hypothesis:

H6：Teamwork quality from virtual team will be more affected than real team in team performance.
H7：Teamwork quality from virtual team will be more affected than real team in personal satisfaction of team members.

4 RESEARCH METHODOLOGY

In order to test the hypotheses, this study includes controlled laboratory experiments. A 4 × 2 factorial design will be employed. The three manipulated variables related to task-media fit are media characteristics (face-to-face vs. synchronous and asynchronous), task characteristics (generating vs. intellective vs. judgment). These variables will be used to answer research questions. The research design and subject numbers assigned in each cell are shown in Table 2. All participants will be asked to complete the validated questionnaire in order to evaluate the task-media-teamwork quality fit. Finally, Structural Equation Modeling will be used to evaluate the proposed research model and test the hypotheses.

Table 2. Research design

Task type / Communication technologies	Generating Tasks	Intellective Tasks	Judgment Tasks	Negotanation Tasks
Real team	30 (6 teams)	30 (6 teams)	30 (6 teams)	30 (6 teams)
Virtual team (Face-book/Email/Join-net/Skype)	30 (6 teams)	30 (6 teams)	30 (6 teams)	30 (6 teams)

4.1 Subjects

Study participants are recruited through two sources：1. Physical team members are draw from undergraduate business classes at National Sun Yat-Sen University. 2. Virtual team members are recruited through a number of different methods：(1) to post to the "wall" of five network homepages on Facebook (Two universities, two regional)，(2) to post the news to the famous bulletin board system in Taiwan. They are randomly assigned to the twelve treatments. A $20 prize, based on the decision quality, is promised to the top dyads (for the all tasks) or individuals (for the good performance) who participated under the same experimental conditions. Members of virtual teams do not know one another and work as a group via difference communication technologies with the other participants. A total of 60 subjects participate in this experiment.

4.2 Tasks

Task types are operationalized into generating tasks, intellective tasks, judgment tasks and negotiation tasks. Participants are asked to develop possible solutions among the four type tasks mentioned by McGrath and Hollingshead (1993). From a research perspective, these tasks have a number of desirable characteristics. First, these tasks are relevant to the subjects, which incentive higher involvement and enables participants to contribute their personal knowledge and experiences (Connolly et al. 1990). Second, these tasks have been used extensively in prior research (Hiltz & Johnson, 1991; Straus & Mcgrath, 1984; Watson et al., 1988; Kahai, & Cooper). Finally, these tasks are relative to service innovation issues. Therefore, we choose these tasks to maximize the treatment effect in this study.

4.3 Communication technologies

Communication technologies are regarded as tools used by virtual teams in carrying out their tasks. In the context of information systems research, communication technologies refers to computer communication systems (electronic mail、instant message、video-conference、social network) and user support services (discussion, training, co-creation, etc.) provided to assist users in their tasks. This study employed five communication technologies. Participants in the real-teams mode that

communication through face-to-face discussion; participants in the virtual teams condition are connected via synchronous or asynchronous communication technologies (Join-net、Skype、Facebook、Email).

4.4 Control Variables

Team size is a control variable in this study. We provided the team sizes, and these were confirmed by the team leaders by the laboratories. The size of a project team is an important structural variable with potential influences on the quality of a team's collaborative task process and project success (Campion et al., 1993; Gladstein, 1984; Hackman, 1987). In other words, when team size grows that make the interaction within team become more difficulty. (Steiner, 1966). Therefore, we include team size as a control variable in this study.

4.5 Procedure

The experiment is with-subject design. It is consisted of twelve sessions. Each session was sixty-minute long. Before the laboratory session, participants must complete a background-information questionnaire and are randomly assigned to a team in one of the twelve treatment conditions. Participants using the synchronous and asynchronous communication technologies underwent a ten-minute practice session before the experiment to acquaint themselves with the medium. At the laboratory session, participants assign to the different service innovation tasks and ask to solve the tasks by exchanging the necessary information in one of the communication modes. After solving the all service innovation tasks, they will fill out a debriefing questionnaire for media richness and satisfaction. For these tasks, there is no time limit, but they are encouraged to finish as soon as possible. After resolving the task, participants have to complete a questionnaire containing scales.

5 EXPECTED RESULT

This research adopt the inputs-process-output model (McGrath, 1964) and combine media-richness theory (Daft & Lengel, 1986)、task-technology theory (Goodhue, 1988) and teamwork quality (Hoegl & Gemuenden, 2001) and try to propose a comprehensive research model to know how virtual teams engaged in service innovation and what kinds of ICT can facilitate service innovation more efficacies. We except the results and findings will provide valuable suggestions to practitioners and researchers.

5.1 Implications for research

From our theoretical perspective, we offer a broadened view of service innovation performance based on I-P-O model (McGrath, 1964) and combine task-technology fit theory、media-richness theory and teamwork quality to proposal a theoretical model to explain how virtual teams engage in service innovation and what kinds of ICT can facilitate service innovation more efficacies.

5.2 Implications for practice

The applicability of the finding shown in this study can be extended to real world organizations and the way their creative teams work. Managers and virtual teams can choose fit communication technologies and develop effective team interactions that enable virtual teams to improve implementation-effectiveness of different types of service innovation.

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