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EXPLORING THE ROLE OF ICT IN THE FORMATION OF TRANSACTIVE MEMORY SYSTEMS IN VIRTUAL TEAMS

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Abstract

This paper is a research in progress. Virtual teams (VTs) are increasingly common in organizations, yet explicit research on VTs' performance is relatively rare. One of the key challenges faced by individuals in VTs is the awareness of 'who knows what' and 'who does what' in the team. One of the solutions offered by past research in overcoming these key challenges is for teams to form Transactive Memory Systems (TMS). However, previous research on TMS has been limited and focused primarily on face-to-face teams yielding inconsistent results with respect to TMS formation in VTs. Therefore, the goal of this research is to explore and describe the formation of TMS in VTs. Our focus will be on the role of ICT as a communication tool to foster TMS formation. We intend to empirically examine this role, using a model derived from Brandon and Hollingshead (2004) as basis. We propose to use a large-scale survey to test our augmentation of this model. It is hoped that this study will provide a deeper understanding of the use of ICT as a communication tool during the formation of TMS in VTs.

Keywords: Transactive memory system, virtual team, ICT usage.

1 INTRODUCTION

Modern organizations have become more reliant on Virtual Teams (VTs) as a mechanism to conduct work traditionally accomplished by face to face teams(Griffith et al. 2001). This can be attributed to advancements in ICT allowing greater collaboration and networking between people in the virtual space. In general teams are formed with the aim of utilizing individual team member's skills, experience, and knowledge, aiming for wiser decisions, higher quality of solutions, and better performance. Virtual teams are different in the sense that: 1) team members are geographically and/or temporally dispersed (Gibson and Cohen 2003) i.e. separated across time and space (Kirkman et al. 2004), and 2) team members are heavily reliant on ICT for communication or execution of interdependent tasks (Jarvenpaa et al. 1999). Teams are often formed in response to growing demands for efficiency in accomplishing interdependent tasks while many organizations believe that decisions made by a group of people with diversified expertise will be of higher quality than those made by a single employee (Griffith and Neale 2001). Among different theoretical perspectives addressing the issue of utilizing diversified expertise in teams, Transactive Memory System (TMS) has received much attention during the past decade. The TMS literature focuses mostly on the sharing of team knowledge in terms of who knows what and findings suggest that the existence of TMS has positive effects on team performance (e.g.: Austin 2003; Moreland and Myaskovsky 2000; Wegner et al. 1991). TMS is defined as a team's shared understanding of who knows what (Wegner 1987; Wegner 1995; Wegner et al. 1991) and who does what in the team (Brandon and Hollingshead 2004). Ultimately, a team member's expertise is only valuable to the team when other members are aware of its existence (Littlepage et al. 2008; Oshri et al. 2008).

Most of the prior studies on TMS mainly addressed traditional face to face teams with the exception of the studies by Kanawattanachai and Yoo (2007). We believe that an investigation of ICT as a communication medium to form TMS in virtual teams is crucial for two reasons. First, virtual teams are becoming more common in organizations (Griffith et al. 2001; Griffith et al. 2003). Second, the focus on global cooperating across the globe and absence of face to face communication, *TMS* may be more valuable in virtual teams. This is supported by Griffith et al. (2003) and Yoo and Kanawattanachai (2001) who state that it is not easy for members to fully utilize the diverse expertise in a virtual environment without being aware of who knows what. Furthermore, prior research on *TMS* appears to be inconsistent. First, a few authors report that it is difficult to form TMS in virtual teams (Gavidia et al. 2005; Lewis 2004). Second, the study conducted by Kanawattanachai and Yoo (2007) who states that the use of ICT such as email can help the formation of TMS in virtual teams. Third, in contrast to the study conducted by Kanawattanachai and Yoo (2007), Kayworth and Leidner (2000) found that it is difficult for virtual team members to communicate using email because it delays communication. In relating to these three different contrasting research findings, it is our intent to explore how ICT as a communication medium can facilitate the formation of TMS in virtual teams. There appears to be a gap in empirical research on what other types of ICT can be used and how ICT as a communication medium can facilitate the formation of TMS in virtual teams. According to Choi et al. (2010), organizations need to consider how ICT tools can support the formation of TMS, so that it can "effectively enhance TMS in teams" (p. 866) . Gibson and Cohen (2003) further confirm that, due to the lack of research in this area, virtual team project managers may find it difficult to understand how and what type of ICT can help virtual team members to communicate in forming TMS. Hence, this research seeks to contribute to the virtual team literature by exploring and finding answers to the following question:

What is the role of ICT in the formation of Transactive Memory Systems in virtual teams?

This research in progress paper starts with a discussion of prior research in Section 2. In Section 3, we propose the research model following by a set of hypotheses formed by drawing on prior research. In Section 4, we describe our proposed research design and concludes in Section 5 concludes with expected contributions of this research.

2 PRIOR RESEARCH

The idea of Tansactive Memory (TM) was first introduced by Wegner et al. (1985) in an attempt to understand how individuals in close relationships, such as married or dating couples, utilize each other's memory to perform a memorizing task. They found that frequent communication between couples increases the shared awareness of who knows what. Wegner (1987) then extended the concept of TM into group settings where there is a system of TM's , i.e. Transactive Memory System (TMS). According to him a TMS in groups is seen as 'a set of individual memory systems' and is frequently drawn on communication among team members using their individual memory systems. In TMS, an individual connects his/her memory system with those of others' by treating others' memory as an external storage and using it during processes of transactive encoding and retrieval. Specifically, transactive encoding involves discussing and determining for incoming information 'where and in what form it is to be stored in the group'. Transactive retrieval "requires determining the location of information and sometimes entails the combination or interplay of items coming from multiple locations". (p. 190). Wegner (1995) further described the process of TMS using a metaphor of computer networks with shared-directories: directory updating, (learning who has what knowledge in the group), information allocation (passing the information to the individual with the relevant expertise for storage) and retrieval coordination (searching information in an organized way so that the needed information can be located from the right person and most quickly). Subsequent empirical studies on TMS have increased significantly in the past few years. Faraj and Sproull (2000) were among the earliest who conducted a field study on TMS. Framing TMS as an expertise coordination process, they found that teams' expertise coordination was associated with team effectiveness, and its effects were above and beyond the effects of team characteristics such as presence of expertise, professional experience and software development methods. Austin (2003) examined the relationship between TMS and team performance with continuing work teams. They concluded that TMS was positively associated with the teams overall goal performance.

In the study by Brandon and Hollingshead (2004) they extended the concept of TMS by stating that team members "must attend not only to who knows what but also to who does what" (p. 635). They suggest that TMS is built with the development of task-expertise-person (TEP) units. A TEP unit is an individual mental model that mentally represents the association between Tasks (T), Expertise (E) and Persons (P) within a team. A TEP unit is a shared understanding between team members, with a specific task (T) and an area of expertise (E) and also with a person (P). They mention that frequent communication among team members can help facilitate the development of the TEP unit leading to the formation the TMS which then increases the overall team performance. The TEP development process goes through a series of three iterative communication cycles. Each of this cycle will be explored in section 3.3. Empirical studies have also explored and confirmed that communication feedback, learning and frequent communication among individual contribute to the development of TMS (Hollingshead 1998; Moreland and Levine 1999; Moreland and Myaskovsky 2000) and this has benefited the organizations team's performance over time (Kanawattanachai and Yoo 2007; Lewis 2004). Taken together, past studies have highlighted that frequent communication is an important antecedent in the development of TMS leading to an overall team performance. However with the advancement and support of ICT, contemporary organizations are now moving into the virtual teams. Base of the advantages TMS has on the team's performance and the advancement and support of ICT, we have reason to believe that ICT can help facilitate TMS in virtual team. Thus there is a need to investigate how the use of ICT facilitates the development of TMS in a virtual team.

3 EXPLORING THE RESEARCH MODEL

In this research we are exploring the role of ICT in the formation of TMS in virtual teams, using the proposed model by Brandon and Hollingshead (2004) (see Figure 1). They argue that TMS is built with many TEP units through a series of communication process cycles, leading to high levels of accuracy, sharedness and validation that indicate an optimal state of TMS. This model offers an important extension in the TMS studies by articulating the processes involved in achieving TMS. This model suggests that the extent to which team members forms TMS depends on the characteristics of

its prerequisite stage (cognitive interdependence) and the communication that takes place in TEP development. In a virtual team the use of ICT as a communication medium is also able to help the formation of the TEP unit. Specifically in this research we investigate the use of ICT as a communication medium in facilitating TEP development in virtual teams, which then leads to the formation of TMS.

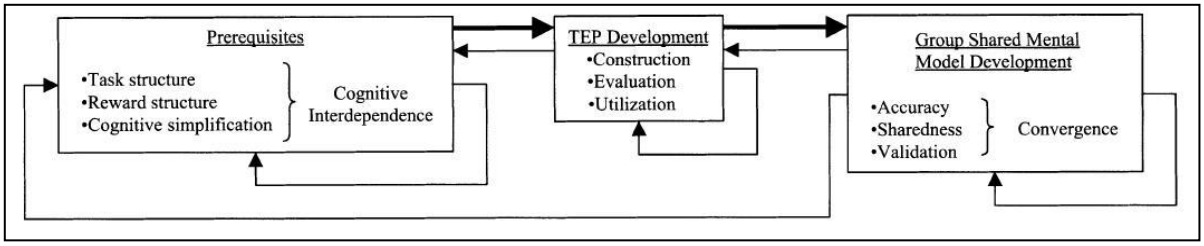

Figure 1. The processes involved in the formation of TMS

Source: Brandon and Hollingshead (2004, p.634)

3.1 ICT Facilitates the Formation of *TMS* in Virtual Teams

ICT is seen as a powerful infrastructure required to ensure connectivity among team members who are in dispersed locations (Chudoba et al. 2005; Hertel 2005; Majchrzak et al. 2005). Organizations are now increasingly relying on ICT in supporting individuals to work in teams with geographically dispersed co-workers (virtual team). Furthermore, Alavi and Tiwana (2002), Chudoba et al. (2005), Griffith and Neale (2001) and Griffith et al. (2003) state that, typically in virtual teams, ICT is useful in two ways, as a medium for: (1) communication and (2) collaboration. With the help of ICT, virtual team members are able to collaborate and communicate their interdependent tasks across dispersed locations (Bell and Kozlowski 2002; Bjorn and Ngwenyama 2008) and it is also possible for members to work remotely from any part of the world at relatively low cost (Saunders 2000; Saunders and Ahuja 2006). For the purpose of this research, we are only focusing on the use of ICT as a communication medium because, previous study by Alavi and Leidner (2001), strongly suggest that ICT can be used to support frequent communication among virtual team members. In addition, past research on TMS has also acknowledge that frequent communication influences the formation of TMS (Choi et al. 2010; Hollingshead 1998; Kanawattanachai and Yoo 2007; Yoo and Kanawattanachai 2001). Altogether we have reason to believe that, in a virtual team where there is an absence of face to face communication, ICT can be used successfully as a communication medium to support the frequent communication required for the formation of TMS. Thus, we would also like to explore the importance of ICT as a communication medium in the formation of TMS. Figure 2 presents our proposed research model to be used in this study

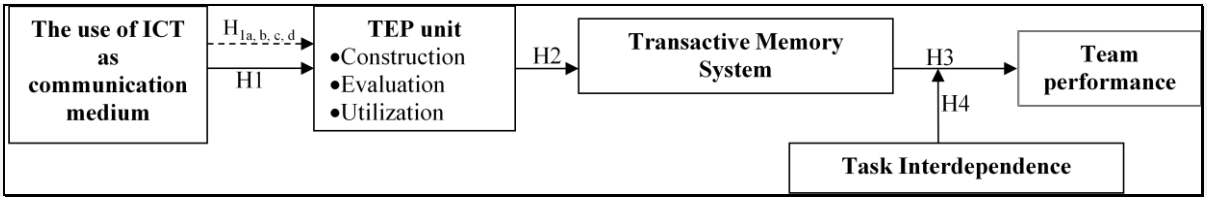

Figure 2. The proposed research model

3.2 The use of ICT as a communication medium

The use of ICT tools such as email, telephone and instant messaging system are useful since these technologies enable virtual team members to communicate despite not being in a close proximity. These types of ICT tools enable members to share information and knowledge to accomplish their interdependent tasks. Furthermore, Dennis and Valacich (1999) and Murthy and Kerr (2003) state that these type of ICT tools can facilitate two kinds of communication occurring in virtual teams namely

asynchronous communication and synchronous communication. Murthy and Kerr (2003) state that, for asynchronous communication, virtual team members often draw on ICT tools such as email. On the other hand, when synchronous communication (e.g. Skype) in virtual teams is required team members need to be present at the time when the exchange of communication is taking place. This is typically because, the objectives of this type communication medium is to: (1) negotiate and reach an agreement and (2) get immediate feedback from members. Murthy and Kerr (2003) further confirm that synchronous communication is often useful in virtual teams especially when members are working on an interdependent task that requires mutual agreement among members. Following this, in the next section, we explore the use of ICT as a communication medium that facilitate the initial formation of a TEP unit thus forming TMS.

3.3 How ICT facilitate TEP unit development in the formation of TMS

TEP unit development proceeds through a series of three iterative communication cycles, (1) construction, (2) evaluation and (3) utilization. Brandon and Hollingshead (2004) mentions that once a team develops a TEP unit, "TMS is most effective"(p. 638). In the following sections, we explore contents being communicated in the TEP development process (based on each cycle). Considering the content communicated during each cycle, this study argues that communication can be facilitated by ICT in achieving a TEP unit. Based on the literature, we have reason to believe ICT can facilitate the communication of content, because communication content can be: (1) expressed in verbal and written forms (Carte and Chidambaram 2004), (2) discussed at any time and any place without requiring members to actually meet (Chidambaram and Jones 1993), and (3) understood by just reading or listening to the content as there is no need for team members to see facial expressions of other member's when communicating (Anderson et al. 2007; Chidambaram and Jones 1993).

3.3.1 *How ICT can facilitate communication in the TEP unit Construction cycle*

The construction cycle begins during the early stages of a team formation or the early stages of a project lifecycle (Brandon and Hollingshead 2004). When constructing the TEP unit, team members will communicate by either, conveying and/or exchanging information with other members about the Persons (P) in the team, their Expertise (E) and their relevant Tasks (T). During this cycle, each team member will mentally associate Tasks (T) with Expertise (E) and Persons (P). According to Carte and Chidambaram (2004), team members will more likely to "focus on written messages" (p.453) during the formative stages of a project lifecycle, to avoid any interpersonal conflict in expressing their expertise, information, and skills. They also suggest that the use of asynchronous ICT tools can have a positive effect during the team's early discussion stage. They go on to state that, the use of asynchronous ICT can improve interactions by reducing the "salience of surface-level diversity" and forcing team members to "articulate their ideas in writing" (p.455). This indicates that the use of ICT tools may be useful during the construction cycle in helping team members to communicate to create their TEP units. Hollingshead and McGrath (1995) and Furst et al. (1999), also state that the use of asynchronous ICT tools frequently also effects the successfulness of a virtual team. Since ICT tools act as a medium for communication it helps team members to actively participate in getting to know each other's knowledge and expertise, especially in the early stages of the project lifecycle. The use of ICT tools in a virtual team is also supported by Anderson et al. (2007). They state that ICT tools such as email, may be useful tool since it can facilitate the exchange of information between members in a team to confirm 'who knows what' and 'who does what' especially during the early stages of forming a virtual team. Therefore, we hypothesize that:

H_{1a}: The use of asynchronous ICT for communication medium leads to an effective TEP unit construction cycle.

3.3.2 *How ICT can facilitate communication in the TEP unit Utilization cycle*

Brandon and Hollingshead (2004) state that when a TEP unit is to be utilized, team members will communicate with each other to obtain information to complete particular Tasks (T) assigned to each member. To complete Tasks (T), it is often crucial to get immediate feedback from other members.

According to Kanawattanachai and Yoo (2007), immediate communication feedback among members are important in making sure they are able to utilize other member's skills in solving difficult or any interdependent tasks. The use of ICT tools may help team members provide immediate yet constructive feedback (Furst et al. 1999; Kotlarsky et al. 2005; Yoo et al. 2001). Anderson et al. (2007) also state that when an individual requires immediate feedback, synchronous ICT tools may be useful. They further confirm that these types of ICT tool allow virtual team members to negotiate, ask questions or obtain immediate feedback. Therefore, we hypothesize that:

H_{1b}: The use of synchronous ICT as a communication medium is leads to an effective TEP unit utilization cycle.

3.3.3 *How ICT can facilitate communication in the TEP unit Evaluation cycle*

According to Brandon and Hollingshead (2004), when a TEP unit is evaluated, team members will communicate to inform others whenever they feel that a TEP unit is of low credibility or there is a lack of confidence with another team member's Expertise (E). Credibility in this research refers to the degree in which team members feel that they can rely upon the knowledge and expertise of other team members (Lewis 2003). A TEP unit maybe considered of a low credibility because a task (T) might be assigned to the (1) wrong Person (P), or (2) Person with the wrong Expertise (E) thus affecting the overall performance of the team. Jarvenpaa et al. (1998) also examined how team members' credibility affect the productivity of a team. Their finding indicates that a team member's knowledge and expertise credibility is vital towards overall task and project completion. They also suggest that appropriate ICT tools may help overcome any credibility issues among virtual team members. Kanawattanachai and Yoo (2007) suggests that frequent communication between team members is needed to overcome any low credibility issue among its members. Constant discussion and negotiation are necessary in overcoming these issues. DeSanctis and Monge (1999) also supports this by asserting that there is a need for frequent updated communication between virtual team members , thus using appropriate ICT tools may help this process. Anderson et al. (2007) also state that ICT tools may facilitate the constant need for communication in the evaluation cycle. Therefore, we hypothesize:

$H_{1c/d}$: The use of asynchronous/ synchronous ICT as a communication medium leads to an effective TEP unit evaluation cycle.

The development of a TEP unit is an ongoing process in a virtual team based on frequent communication between its team members. TEP units are best viewed as "a hypotheses of varying strengths rather than certainties" (Brandon and Hollingshead 2004, p.637), because it often takes time and effort to figure out who is good at what and who knows what. Based on the preceding discussions, we have hypothesized that ICT plays an important role in facilitating communication during the TEP development. It enables the exchange and sharing of information, thoughts and ideas which may contribute to a TEP unit. Therefore, based on the literature, we argue that, the use of ICT can compensate for the lack of face to face communication and thus enabling the formation of TEP units in virtual teams. Furthermore, it is our intent to find evidence and rich accounts of how ICT can facilitate the communication that occur during TEP development. Further, a virtual team's overall success is highly dependent on the effectiveness of communication and appropriate use of ICT tools (Townsend et al. 1998). If the communications among virtual team members are not fully utilized then this may impend the development of the TEP unit. Based on the discussion above, we have reason to believe that in a virtual team the development of a TEP unit is mainly due to the amount of communication that takes place between team members. The more information or knowledge communicated between team members, the more they will begin to make connections between the Persons (P), their Expertise (E) and Tasks (T), and based on the preceding discussion above this communication may take place using the appropriate ICT tools. Thus we also hypothesize:

H1: The degree of use of ICT as a communication medium is positivity associated in developing a well developed TEP unit.

Studies have also shown that there is a positive relationship between individual TEP units and the effectiveness of TMS. Moreland et al. (1998), found that the combined knowledge and expertise from

each team member in assembling a specific task was found to have a significant positive association with the TMS. Kanawattanachai and Yoo (2007) also suggest that there is a need to form a network link of trust between team members in a virtual team so that each team member understands the specialized knowledge of others. By doing so, this will lead to a better overall team performance and more effective TMS. Alavi and Tiwana (2002) also indirectly highlighted the importance TEP units and asserted that a team's TMS is most effective when team members are able to recognize who in their team has the required knowledge and expertise in completing a given task. According to Brandon and Hollingshead (2004) a TMS is achieved when all the team members have similar TEP units. Similar TEP units is "the extent to which individual team members' TEP units overlap, allowing them to share the same understanding of the task and the team" (Blickensderfer et al. 2000, p.252). Thus based on this, we hypothesize:

H2: An overlapping TEP unit leads to a well developed TMS.

3.4 Team performance

Wegner et al. (1991) first tested the effects of TMS among dyads in a memory experiment among intimate couples. They concluded that couples with long-term relationships could recall more items than other couples due to the presence of TMS among the long-term relationship couples. Following this, Liang et al. (1995) conducted a radio assembly experiment with work groups and explored the mediating role of TMS in group training and team performance. They concluded that team training is more effective than individual training because team members trained together are more likely to form TMS, which in turn have provided a positive effect on the team's task performance. Kanawattanachai and Yoo (2007) conducted a web-based business simulation game in testing how TMS in a virtual environment relates to team performance. They found that TMS has a positive impact on team performance as shown by profit, stock price, and market share (the outcomes of the web-base business simulation game). Akgun et al. (2006), also explored how TMS relates to new product development teams, through its effects on the team learning, and the speed in which new products are available to the market. They concluded that TMS is able to enhance the team's ability to detect and resolve any product problems and facilitate collective team learning among its team members. In summary based on the previous evidences we hypothesize:

H3: A well developed TMS leads to better team performance.

3.5 Task interdependence

Studies have shown how TMS is beneficial to teams with task interdependence, for example studies by Akgun et al. (2005; 2006) have shown how members in a production and R&D team with different functions need to rely on each other in performing or completing their tasks. In teams with a high task interdependence, team members are actively sharing and acquiring additional information and knowledge in to complete the overall task (Wegner 1987; Wegner et al. 1991). TMS will also help team members to utilize knowledge and expertise from every member, to make higher quality decisions and to coordinate their task efficiently thus leading to a better overall team performance (Kanawattanachai and Yoo 2007; Sharma and Yetton 2007). Base on the summary above, we have shown that the direct effect of TMS on the team's performance is moderated by task interdependence. Thus we hypothesize:

H4: The effect of TMS and team performance is moderated by task interdependence.

4 RESEACRH DESIGN

Based on the characteristics of this research, an explorative cross sectional design will be appropriate for this study. This design is chosen because we are interested in (1) exploring and describing how virtual team members use ICT as a communication medium in getting to know other team members' expertise towards developing their TEP units, (2) exploring how virtual team members use their previous created TEP unit towards forming a TMS, and (3) exploring how TMS leads to a better team performance, which is moderated by the team's task interdependence. The data collection in this study

would be base on historical information. Although the TEP unit is achieved over a period of time obtaining data from a longitudinal study is time consuming and complex. De Vaus (2001) and Neuman (2006) however suggested a cross sectional design may also be use in an exploratory and descriptive research, since we can also obtain data base on historical information (what has been done). We will employ a quantitative method using a large-scale survey. The survey will use existing measures from previous studies. To decide on the most suitable measurement for each of the constructs, a deeper analysis of each existing measurement scales is currently conducted. The suitability of existing measures is to be evaluated against the scope of this research, and its constructs. For the constructs, using ICT as communication medium, TEP unit, TMS, team performance and task interdependence existing measurement scales from Burton-Jones and Gallivan (2007), Rabbiosi et al. (2009), Faraj and Sproull (2000) , Wu and Wang (2006), Lewis (2004) and Janz et al.(1997) will be adapted respectively. In order to control the validity threat of the common method variance we adopt the suggestion by Sharma et al. (2009) by employing the "behavioral continuous measures with open-ended numerical scales" (p. 485). They refer behavioral continuous method as "specific behaviours or actions that people have carried out" (p. 479). For the TEP unit construct, it is difficult to measure as each virtual team member would have different TEP units. However according to Peter et al. (2007), in constructs that are difficult to measure, "they may focus on outcomes" (p.625), or what is known as reflective constructs. Taking this into consideration the TEP unit construct would be measured as a reflective construct. To ensure the validity of the instrument, further literature and the opinions of fellow researchers will be used to ensure that the survey questions are related to each construct. In addition, the questionnaire will be pilot tested in order to verify its reliability. Based on these reviews, only then an existing validated measurement is selected. The sample population for this study would be virtual team members namely: (1) virtual team members who are working at sites that are located in different buildings, cities, states, nations, or even continents (Chudoba et al. 2005), (2) virtual team members who are who separated across time (Kirkman et al. 2004) and (3) virtual team members that use a variety ICT tool as a communication medium, to accomplish their interdependent tasks (Alavi and Tiwana 2002; Anderson et al. 2007; Jarvenpaa et al. 1999). The sample population for this research would concentrate either in Malaysia or Australia. The choice of industry in this study would be base on previous studies that found most of the organizations that utilizes virtual teams are the knowledge base type industry (e.g. Majchrzak et al. (2000), Chudoba et al. (2005), Oshri et al. (2008) and Maznevski and Chudoba (2000). Examples of knowledge base industry are software development firms, manufacturing organizations, and consultancy services companies. Therefore, based on these literatures this research will focus at virtual teams in the knowledge base type industry. We intend to analyse our data in three steps, (1) examine the psychometric properties of the measurement using exploratory and confirmatory factory analysis (e.g. Choi et al. (2010)), (2) perform statistical tests in examining the appropriateness of individual response to the team level responses and (3) testing the stated hypotheses using statistical methods such as correlation, simple and multiple regression and frequency statistics. Measured data will be further analysed using the structural equation modelling tool of SPSS and partial least square (PLS).

5 CONCLUSION

This paper has discussed the research which is in progress in exploring the formation of TMS in virtual teams. There will be significant contributions to both academia and practitioners. The contributions to academia are as follows: (1) to better understand the role ICT as a communication medium in facilitating the TEP development and TMS formation in virtual teams and (2) to explore and explain how TMS is formed in virtual teams. The contributions to practitioners are as follows: (1) to help project managers, team leaders and virtual team members understand how ICT as a communication medium can help facilitate the communication that occurs during the formation of TMS and (2) to guide project manager and team leaders in deploying the appropriate ICT tools in facilitating TEP unit.

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