# “Virtual Teams Processes: A conceptualization and application”


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# Virtual teams processes: a conceptualization and application

## Abstract

Nowadays decision makers are, exceptionally, facing complex problems that generally oblige collaboration between individuals with different expertise from different areas. The use of virtual teams is an effective tool to solve these problems, but this is still a relatively new field for academic research. Also, information technology offers an infrastructure for communication and teamwork tools for virtual teams. Small sample approach, in terms of case study, is still used when virtual teams are empirically researched. The objectives of this paper are: firstly, to identify the virtual teams and their life cycle in Egyptian Travel Agents (ETAs); secondly, to define the variables which present the inputs, process and outputs of the life cycle of virtual teams; and finally, to explore the key factors influencing the *performance* of virtual teams in ETAs. The paper attempts to examine the concept of virtual teams and its application applied to a larger sample of data. Furthermore, it describes the relationships between variables of the suggested model of the life cycle of virtual teams in ETAs. A total of 239 companies in Egypt are used in this paper using an on-line survey. Results so far reveal that there is a direct correlation between the inputs and the outputs of the life cycle of virtual teams. Moreover, using multi-level analysis and interactions between the life cycle of virtual teams' inputs and both Socio-Emotional and Task processes, we reveal a clear effect on the performance satisfaction of the virtual teams' life cycle.

**Keywords:** virtual teams; team processes; life cycle of virtual teams; Egyptian Travel Agents (ETAs).
**JEL Classification:** O15, C46.

## Introduction

A virtual team is a management model that is being used world-wide. In small and large organizations, from private industry to governmental agencies, the trend is to meet and work together using communications technology rather than travelling to a meeting or relocating for the duration of the work. Organizations have started to use teamwork for solving problems and tasks mainly during the last few decades. A team can be defined as 'a group of individuals who work interdependently for solving the problems and accomplishing tasks' (Kirkman, Mathiew, 2004). Relatively recent developments in the field of information and communication technology have also enabled organizations to start using so-called virtual teams (Mihhailova, 2007).

Virtual teams have become an important trend for organizations: firstly, they operate in dispersed geographic contexts and increasingly need to draw on work processes not confined to one immediate geographical place and expertise in different parts of the world. Secondly, these teams have become important as new modalities of communication emerge such as work process design and time cost reduction (Preiss, 1999). Finally, sound business reasons may underpin the rationale for virtual work. These include reduced workspace costs, increased productivity, new ways of enhancing customer service and better access to global markets and environmental benefits (Blaise et al. 2008). Virtual work may also have disadvantages such as high setup, maintenance and training costs, potential cross-cultural difficulties in team interaction, feelings of isolation and lack of trust (Cascio, 2000).

**Definitions of virtual team.** Virtual teams are 'groups of people working on interdependent tasks, geographically distributed, conducting their core work mainly through an electronic medium (a) and share responsibility for team outcomes' (Horwitz et al, 2006, p. 473). They are often "far-flung" not only regionally, but also globally distributed working in the same company or further down the value chain. They may be "communication challenged, culturally challenged and task challenged" (Malhotra, 2003).

This definition suggests that efficiencies are achievable when operating in this manner though not without difficulties. To this effect it is possible to conceive teams that are formed quickly, when required, and that can be readily disbanded. Henry and Hartzler (1998) define a virtual team as a 'group of people that work closely together though geographically separated and may reside in different time zones; and as "cross-functional work groups brought together to tackle a project for a finite period of time through a combination of technologies'. "Virtual teams may therefore work across distance, time, and organizational boundaries" (Langevin, 2004).

**Theoretical model.** Our theoretical model for Life Cycle of virtual teams depends on Powell et al. (2004), who provide a meta-analysis of 44 papers on virtual teams, covering both academic and industrial teams. Their analysis is framed on Saunders' (2000) life cycle model for virtual teams which is divided into three categories, shown in Figure 1:


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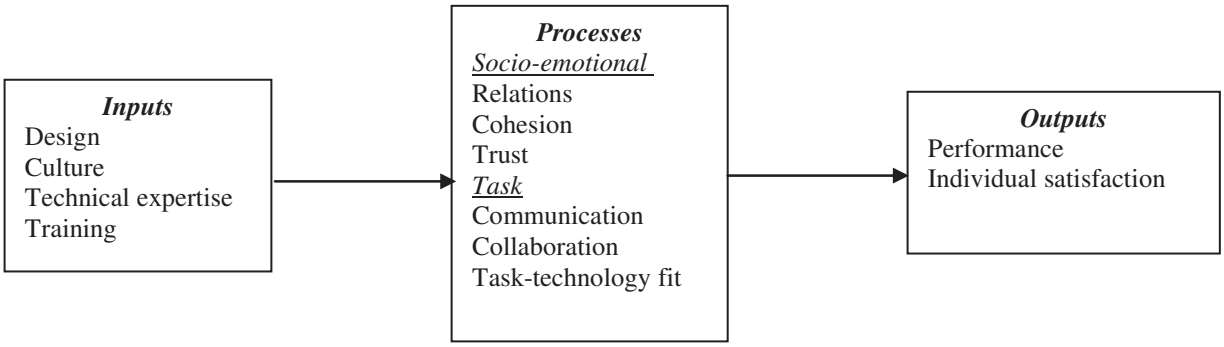


**Fig.1. Life cycle of virtual teams**

Source: Egea (2006, p. 83) based on Saunders' (2000).

As shown in Figure 1, the life cycle of virtual team consists of three stages whsch are as follows:

Powell et al. (2004, p. 8) stated that the **inputs** of virtual teams present the design and composition characteristics of the virtual team and the endowment of resources, skills, and abilities with which the team begins its work. Previous research has investigated the inputs of virtual teams under the labels of design, culture, technical expertise, and training.

The *design* of the virtual team and the structuring of its interactions, particularly early on in the team's life, have been found to impact the development of a shared language and shared understanding by team members. Various designs include different levels of face-to-face interaction, planning of activities and the use of communication media, and the articulation of goals, structures, norms, and values (Powell et al., 2004).

The role of *cultural* differences among team members has been examined in a number of virtual teams studies; cultural differences emerge as a guide to harmonization difficulties (see, for example, Kayworth & Leidner, 2000; Maznevski & Chudoba, 2001; Robey et al., 2000), and create problems to effective communication (Kayworth & Leidner, 2000; Sarker & Sahay, 2002). Cultural and language differences are common in universal virtual teams. However, very slight differences among team members from different regions of the same country may be enough to negatively influence a virtual team (Robey et al.,2000).

Evidence of *technical* expertise on team performance and individual satisfaction has been found. The lack of technical expertise and the failure to manage with technical problems has a negative effect on individual satisfaction with the team experience and performance (Kayworth & Leidner, 2000; Van Ryssen & Godar, 2000). There is also evidence that virtual team members are affected more by the innovation of the technology being used than by the innovation of the team structure itself, as stated by Powell et al. (2004).

Recently, the relationship between team members' *training* and performance has the interest of virtual team research. Early results suggest that reliable training among all team members improves team performance (see, for example, Van Ryssen & Godar, 2000), while virtual teams characterized by various technology skills can experience inconsistency when members are unable to determine differences during a particular task achievement (Sarker & Sahay, 2002).

**Processes** represent the ongoing interaction between group members. It refers to the interdependent actions carried out by members, which transform inputs to outputs (Gaudes, Hamilton-Bogart and Marsh, 2007). The processes category of life cycle is divided into two parts: socio-emotional and task processes.

On one hand, socio-emotional process includes: *relations* building in which all members of a team have to feel they are contributing to achieve purpose of the team. Each member should feel a sense of being part of the team. This interdependence is reliant on three factors. Firstly, the team must have friendly interaction relations and personal contact. Secondly, the members should focus on developing a "Third Way" for the team. This term is a new micro-culture for virtual teams in which the team is not dominated by one culture, person, idea, function, or location (Ratcheva and Vyakarnam, 2001). Thirdly, effective leadership on the part of all team members should be found. All members should possess leadership abilities and "require independent action, such as proactive discussion initiated by team members" (Alexander, 2000). For this reason, it is not recommended that new employees or employees in new positions be placed on a virtual team (Cascio, 2000; Redman, & Chetan, 2003).

*Cohesion* is defined as the tendency of a group to stick together and remain united in the pursuit of instrumental objectives and the satisfaction of members' affective needs (Forrester & Tashchian, 2006). It is an important aspect of the virtual team. Cohen and Bailey (1997) suggest that cohesion is a critical factor influencing the effectiveness of groups/teams. They also conclude that a primary factor leading to team cohesion is the degree of trust among team members. Several studies have focused on cohesion by comparing virtual teams with traditional teams. However, results have been mixed. Warkentin et al. (1997) found that collaborative technologies hindered the development of cohesion in virtual teams and hence had lesser levels of cohesion compared to traditional collocated teams. However, other studies have found that while virtual teams begin with lower cohesion, over time, virtual team members exchange enough social information to develop stronger cohesion (Chidambaram, 1996). Guinan et al. (1998) examined cohesion in teams engaged in software requirements analysis. Balthazard et al. (2004) constructed items for measuring team cohesion and used it as a measure of virtual team performance.

*Trust* is shown to be the prime factor of success because it is the result of team members completing assignments, communicating, participating and being actively on board with the work (Lucas, 2007). The trust that is developed during the work is based on performance by the team members. Lewicki and Bunke (1996), Lashbrook (1997) and Falletta (2002) have shown that trust is developed through actions such as on-time delivery of assignments, ability to perform assigned tasks, providing a completed assignment or task, being proactive and participating in the processes of the team work. This form of trust is based on actual deeds, not social perceptions, and is the measure of a successful virtual team (Clayden, 2007).

On the other hand, task processes category includes c*ommunication* which is considered a heart of any virtual team process. Many researchers have discussed the importance of communication focusing on the need to create superb communicators, on the communication barriers produced by the virtual environment (Lurey & Raisinghani, 2001), and on the selection of the right technology for most successful communication (see, for example, Dune, 2000; Solomon, 2001).

*Collaboration* represents the degree of functional communication and unity of effort between different organizational parts and the extent to which the work activities of team members are logically consistent (Cheng, 1983). Collaboration has been linked to virtual team performance (e.g., Maznevski & Chudoba, 2001). In addition, further research, such as that by Kayworth & Leidner (2000) and Sarker & Sahay (2002), has also highlighted the considerable difficulties that virtual teams face as they attempt to collaborate across time, cultural splits, and mental models.

*Task-technology fit* is important in virtual teams' life cycle to evaluate the possible fit between various technologies available to virtual teams and the tasks which are called upon to be completed. The choice of technology depends on individual preferences, experience with the technology and its ease of use. The need for documentation, and the importance of the task have been investigated (e.g., Hollingshead et al., 1993; Robey et al., 2000).

In this paper our suggested model of virtual teams differs from other models, such as those by Egea (2006) in two aspects: the inputs and the task processes. Other parts of the model are the same. As to the inputs category of life cycle, this consists of leadership, goals, technology, and communications.

*Leadership* is an input that should be presented in successful teams (Konradt & Hoch, 2007). It is important for leaders to create coherence when they are trying to blend the work processes of virtual teams members' home organizations. Conflict is another issue that requires leadership expertise. It is the responsibility of the team leader to be hyper-vigilant to keep these conflicts from spiraling out of control (Bergiet, Bergiel & Balsmeier 2006). Teamwork may imply a division of labor, where some members focus on certain pieces of work and others focus on the coordination of that work within and between teams. Leaders may emerge from ongoing team work and be acknowledged leaders by their peers. The diverse literature on leadership may be grouped into three broad sets of approaches (Kayworth & Leidner, 2002): trait theory, behavioral theory and contingency theory. While trait theory essentially expects leaders to benefit from superior or particularly advantageous skills or capabilities just as criticized before behavioral theories focus on the actually displayed behavior and actions taken by leaders. Due to the empirical limitation of their predictions, Bass (1990), Yukl (2002), Ayman (2004) and Misiolek (2005) have supported contingency theory in arguing that there is no one-best style of action yielding leadership effectiveness. Instead, they argue that different situations and contexts require different behavioral styles.

Clear *goals* are important for all teams, but they are critical for those who do not see or meet each other frequently. A goal is generally hard to understand when a team is not working face-to-face. For this

reason, face-to-face meetings are often set up at the beginning in order to resolve conflicts on the purpose of the project (Redman& Sankar, 2003).

Virtual teams are supported by both hardware and software *technology*. General hardware requirements include telephones, PCs, modems or equivalent, and communication links such as the public switched network (telephone system) and local area networks. Software requirements include groupware products such as electronic mail, meeting facilitation software, and group time management systems.

Although virtual and traditional teams share the common characteristic of good *communications*, one element of communications which almost unanimously separates them is the increased amount of asynchronous communication with virtual teams. Even in the virtual teams where a team chat room has frequent meetings, virtual teams simply don't have the frequency of synchronous real time communications that traditional teams do. The effective use of communication especially at the early stages of the team's development plays an equally important role in gaining and maintaining trust. The success of the team depends on the team members' ability to exchange information despite the challenges of time and place. From the beginning, virtual teams' leaders must work with their teams to establish very strict guidelines regarding not only what and when to communicate, but also how to communicate (Ojala, 2004). Daily communication between a team leader and individual team members is the glue that holds a virtual team together.

As to the **task processes** category, it consists of five stages: virtual teams typically follow the traditional stages of team development including forming, storming, norming, performing, and adjourning (Greenberg & Baron, 1997).

At the *forming* stage, individuals get to know each other's and establish ground rules. They try to discover which behaviors will be acceptable to the group regarding both task related and interpersonal interactions. Often at this stage members get confused and thus become uncertain about how to behave within the team. They may be questioned why and how belonging to this team benefits them.

*Storming*, the second stage, can be a period of high emotionality and tension (Schermerhorn, Hunt & Osborn, 2000). Members may start to question certain actions by other team members or the team's leader. They may show some hostility at this stage and conflict may arise. Team members may resist the control of the team's leader while the other team members may withdraw. However, as conflicts are resolved and members begin to accept the team leader, the team moves through this stage to the third stage, namely is norming.

At the third stage of *norm*ing, virtual teams must establish norms governing both work processes and communication content (Furst et al., 2004). When individuals start to work together and develop standard operating guidelines, they begin to feel a sense of belonging, start to identify themselves as members of the team, and then develop close relationships with team members. The individuals begin to share feelings as well as a desire to find agreeable solutions.

At the fourth stage, *performing*, the team members really start to work together. By this stage any questions about team relationships and leadership have been resolved, and the team is ready to move forward and to complete tasks. Because members have devoted energy to developing good relationships and have accepted the leader, the team can focus on meeting predefined objectives and accomplishing tasks.

At the final stage, *adjourning,* the team ceases to exist and may disband after completing a project or meeting its goals. Other teams may adjourn gradually as the team disintegrates, either because members leave or because the norms that have developed are no longer effective for the team. The adjourning stage of group development is especially important for many temporary groups that are increasingly common in the new workplace (for more details see, for example, Bergiel et al., 2008).

Team **outputs** or outcomes are measured at organizational, group and individual level, such as performance (i.e. effectiveness), satisfaction and innovation by the team. We followed a framework similar to the one used by Saunders (2000) and Egea (2006).

The *performance* of traditional teams versus virtual teams has been compared in several research papers. Sharda et al. (1988) reported greater effectiveness for virtual teams, McDonough et al. (2001) and Warkentin et al. (1997) found that virtual teams could not outperform traditional teams. However, the vast majority of this research work has not found significant difference between the two types of teams (e.g., Burke & Aytes, 1998; Burke & Chidambaram, 1996; Galegher & Kraut, 1994). Almost the same results have been found for *satisfaction*, with few numbers of studies detecting no differences between the two types of teams (e.g., Archer, 1990; Davis and Khazanchi, 2007).

The main objective of this paper is to identify the virtual teams and their life cycle in ETAs. Indeed discussions with key ETAs personnel have suggested that the currently used virtual team is yet partial. Correspondingly, the chosen environment is the Egyptian travel agents, in which no other authors (to the best of our knowledge) have investigated the implications of applying virtual teams in ETAs. Since entire virtual teams (as will be explained in the following part) have not been used in ETAs, there are huge benefits from applying it into the Egyptian market.

This paper is organized as follows: section 1 details the research methodology and data collection. Sec explains the research results. Finally, part four concludes the results of the study and suggests areas for future research.

## 1. Research methodology and data collection

**1.1. Research questions and hypotheses.** Our overall research questions are:

1. How much are virtual teams used in ETAs sector?
2. What are the variables that present the inputs of virtual teams?
3. What are the effects of the variables that present the inputs of virtual teams on socio-emotional processes of virtual teams?
4. What are the effects of the variables that present the inputs of virtual teams on task processes of virtual teams?
5. What are the effects of the processes of virtual teams on the virtual teams' performance in ETAs?

Our overall research hypotheses are:

*H1: There is a positive direct effect of the inputs of virtual teams on the socio-emotional processes of virtual teams.*
*H2: There is a positive direct effect of the inputs of virtual teams on the task processes of virtual teams.*
*H3: There is a positive indirect effect of the inputs of virtual teams on the performance satisfaction.*
*H4: There is a positive direct effect of socio-emotional processes on performance satisfaction.*
*H5: There is a positive direct effect of task processes on performance satisfaction.*

**1.2. A conceptual research model.** In order to develop our research model, we describe the relationships amongst variables in Figure 2. All paths are expected to have positive signs. The justification for these paths is given below.

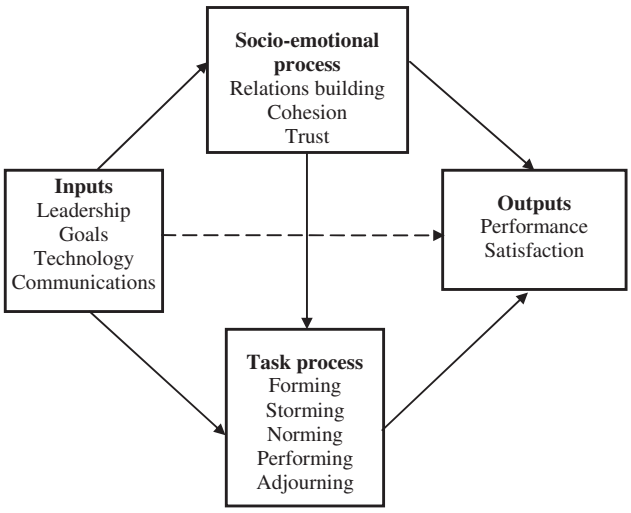


**Fig. 2. Proposed model of life cycle of virtual teams in ETAs**

Multi-level models are designed to analyze variables from different levels simultaneously, using a statistical model that includes the various dependencies and takes into account the fact that the data at the lowest level are nested within a higher order level, effectively resolving the statistical dependencies and the bias this may create (Hox, 2002).

An Intra-Class Coefficient (ICC), as a measure indicating dependency, can be determined from an *intercept-only* model (i.e., a multilevel model with no covariates) as follows:

$$level\ 1 \quad y_{ij} = \beta_{0j} + e_{ij} \ \ldots \tag{1}$$

$$level\ 2 \quad \beta_{0j} = \gamma_{00} + u_{0j} \ \ldots \tag{2}$$

$$y_{ij} = \gamma_{00} + u_{0j} + e_{ij} \ \ldots \tag{3}$$

where $y_{ij}$ is the observed value of the dependent variable for individual $i$ in an organization $j$ " performance satisfaction"; $\beta_{0j}$ is the random intercept parameter, because there are no predictors at Level 1, the random intercepts correspond to the organization means; $e_{ij}$ is the residual for individual $i$ within organization $j$; $\gamma_{00}$ is the intercept of the $\beta_{0j}$ equation, because there are no predictors, this simply represents the organization mean for an average organization (where $u_{0j}$ is zero); and $u_{0j}$ is the residual for the $\beta_{0j}$ equation, because there are no predictors, this simply represents the difference between $\beta_{0j}$ and $\gamma_{00}$ .

By combining equations (1) and (2) this leads to

equation (3), and the intercept-only model is produced. The intercept-only model does not account for any variance in the dependent variable. It only separates the variances of the dependent variable into two parts; that is, the variance of clusters, $\sigma_u^2$, and the variance of observations at Level 1, $\sigma_e^2$. The ICC, written as the symbol "ρ," can be computed on the basis of these two variance components as in Equation (4); ρ ranges from 0 to 1.

$$\rho = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_e^2} \quad (4)$$

If all the observations are independent of one another, the ICC equals 0. At the other extreme, if all the responses from observations in all clusters are exactly the same, the ICC equals 1. A nonzero ICC implies that the observations are not independent. If observations are highly correlated, the variance of observations at Level 1, $\sigma_e^2$, becomes smaller. In turn, the denominator in equation (4) becomes smaller, implying that ICC becomes larger (Hox, 2002).

Extending the Multilevel Model by Adding independent variables:

$$level\ 1 \quad y_{ij} = \beta_{0j} + \beta_{1j} x_{ij} + e_{ij} \quad \ldots \quad (5)$$

$$level\ 2 \quad \begin{cases} \beta_{0j} = \gamma_{00} + u_{0j} \\ \beta_{1j} = \gamma_{10} + u_{1j} \end{cases} \quad \ldots \quad (6)$$

$$y_{ij} = (\gamma_{00} + u_{0j}) + (\gamma_{10} + u_{1j}) x_{ij} + e_{ij} \quad \ldots \quad (7)$$

where $y_{ij}$ is the observed value of the dependent variable for individual *i* in an organization *j*; $\beta_{0j}$ is the random intercept parameter; $\beta_{1j}$ is the slope parameter; $x_{ij}$ is the observed value of the independent variables for individual *i* in an organization *j*; $e_{ij}$ is the residual for individual *i* within organization *j*; $\gamma_{00}$ is the intercept of the $\beta_{0j}$ equation; $\gamma_{10}$ is the intercept of the $\beta_{1j}$ equation; $u_{0j}$ is the residual for the $\beta_{0j}$ equation; and $u_{1j}$ is the residual for the $\beta_{1j}$ equation.

**1.3. Research design and data collection.** To determine the interrelationships among the factors of the proposed model of the life cycle of virtual teams, a questionnaire was **developed** based on an existing instrument (Lurey and Raisinghani, 2000) as a part of virtual teams' typology model development processes. The reason for using the questionnaire tool in the data collection for this research paper was that it is usually indicated in literature that use of virtual teams is increasing. However, there is no empirical survey to reinforce this allegation (Mihhailova, 2007). The data have been collected from all Egyptian Travel & Tourism Agents which have an e-mail address. This data-set was constructed through a web-based questionnaire during 2008 from 239 companies, and based on a ***cluster*** *sampling* where groups are separated. The unit of the analysis in this paper is divided into two parts: members and organizations.

A final total of 156 respondents who opened the e-mail and clicked on the questionnaire link, are used in this paper; of those, 112 team members from sixteen different organizations in total have met our criteria of working in a virtual team. Due to the small sample size, it was a challenging task to analyze and perform multi-level analysis. Consequently, the data were analyzed at two levels instead, individual (i.e. not team) and organization ones.

## 2. Results and discussions

Construct validity was evaluated through principal component and reliability analysis. Internal validity was established through reliability tests (e.g., Scholle et al., 2008; Arries, 2006; Kotsanos et al., 1997). Table 1 shows that the reliability of each construct is higher than 0.70 (except for cohesion which is 0.66) thereby indicating high internal construct validity.

Table 1. Reliability coefficients (Cronbach alpha) of constructs

| Constructs | Cronbach alpha |
|---|---|
| $X_1$ The concept | 0.91 |
| $X_2$ Leadership | 0.84 |
| $X_3$ Goals | 0.71 |
| $X_4$ Technology | 0.92 |
| $X_5$ Communication | 0.81 |
| $X_6$ Relations building | 0.73 |
| $X_7$ Cohesion | 0.66 |
| $X_8$ Trust | 0.70 |
| $X_9$ Forming | 0.74 |
| $X_{10}$ Storming | 0.82 |
| $X_{11}$ Norming | 0.81 |
| $X_{12}$ Performing | 0.78 |
| $X_{13}$ Adjourning | 0.87 |
| $X_{14}$ Performance satisfaction | 0.89 |

**2.1. Statistical analysis.** *Descriptive analysis:* means and standard deviations of all model variables were computed, and correlations were computed to obtain insight especially in the associations between the inputs of the virtual team, processes and the outputs, as shown in Table 2.

Table 2. Means, standard deviations (SD) and correlations (Pearson) of the variables under study (N=112)

| | M | SD | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ | $X_9$ | $X_{10}$ | $X_{11}$ | $X_{12}$ | $X_{13}$ | $X_{14}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $X_1$ | 2.78 | 3.48 | 1.00 | | | | | | | | | | | | | |
| $X_2$ | 1.88 | 1.68 | .71* | 1.00 | | | | | | | | | | | | |
| $X_3$ | 4.05 | 3.13 | .55* | .70* | 1.00 | | | | | | | | | | | |
| $X_4$ | 3.20 | 1.67 | .62* | .32* | .21* | 1.00 | | | | | | | | | | |
| $X_5$ | 2.49 | 2.01 | .80* | .51* | .17 | .34* | 1.00 | | | | | | | | | |
| $X_6$ | 2.80 | 1.95 | .33* | .47* | .01 | .19 | .31* | 1.00 | | | | | | | | |
| $X_7$ | 1.91 | 0.81 | .43* | .40* | .05 | -.07 | .36* | .13 | 1.00 | | | | | | | |
| $X_8$ | 3.56 | 1.26 | .58* | .62* | .03 | .11 | .33* | .21* | .21* | 1.00 | | | | | | |
| $X_9$ | 3.98 | 1.43 | .28* | .66* | .21* | .15 | .20 | .10 | .16 | .27* | 1.00 | | | | | |
| $X_{10}$ | 3.72 | 0.81 | .46* | .41* | .19 | .07 | .14 | -.01 | .06 | -.12 | .07 | 1.00 | | | | |
| $X_{11}$ | 2.77 | 1.64 | .37* | .22* | .32* | .01 | .07 | -.02 | -.01 | -.08 | .12 | .09 | 1.00 | | | |
| $X_{12}$ | 3.36 | 1.56 | .51* | .32* | .11 | .04 | .01 | .01 | -.10 | .13 | .01 | .21* | .18 | 1.00 | | |
| $X_{13}$ | 2.98 | 0.89 | .21* | -.12 | .13 | .13 | .03 | -.17 | -.23* | -.12 | .11 | .09 | .24* | .03 | 1.00 | |
| $X_{14}$ | 2.61 | 0.96 | .11 | .58* | .27* | .16 | .40* | .20 | .30* | .27* | . 12 | .10 | .03 | .18 | -.01 | 1.00 |

Note: p<.05, * significant.

*Testing the relationships:* correlations offer basic insight into the associations among the performance satisfaction, inputs of the virtual teams and socio-emotional, task processes. However, the structure of our data cannot be neglected and needs further examination. As explained in the previous section, the sample consists of more than one respondent per company. As a result of our data collection design the data of the virtual team members (level 1) are not statistically independent, as they are nested within companies/organizations (level 2). Statistical independence is the assumption of many regularly used statistical analysis techniques. Multi-level models are designed to analyze variables from different levels simultaneously, using a statistical model that includes the various dependencies and takes into account the fact that the data at the lowest level are nested within a higher-order level, effectively resolving the statistical dependencies and the bias this may create (Hox, 2002).

The first measure indicating this dependency is the Intra-Class Coefficient (ICC); that is, the average correlation between variables measured on the observations from the same level will be higher than the average correlation between variables measured on observations from another level. In case of our dependent variable performance satisfaction, the ICC is 0.12. Thereby, the 'company effect' (level 2) in our study should be labeled as medium (0.10) to large (.15) according to a 'rule of thumb' by Hox (2002).

The maximum value for an ICC is 1, indicating that the variance in the dependent variable is totally accounted for by the variance at level 2. An ICC of 0 indicates that all variance is accounted for by the variance at the individual level 1 units. The design effect can also be studied, in which the number of observations per group is an important factor. The design effect in our case is 1.51. It is sometimes stated that design effects smaller than 2.5 do not make it necessary to account for a multi-level structure. However, on the basis of the mentioned rule of thumb (Hox, 2002) we decided to use multi-level analysis. We will specify several models and compare them. The first model to be compared includes only an intercept and in the following models predictors can be added consecutively. The superiority of one model over a previous one can be tested using a likelihood ratio statistic, following a _²-distribution with the number of additional predictors as df (Hox, 2002).

MLWiN 2.0 software package is used in this paper (Centre for Multilevel Modelling. MLwiN 2.0. Bristol: University of Bristol), and all variables were standardized based on their grand mean. As there was no reason to expect relationships between independent and dependent variables to differentiate between the companies in the study, we chose not to use model random slopes, but only a random intercept. Another indicator for degree of dependence of the data is a test of the difference between the -2*Log Likelihood (-2*LL) of a first model with fixed intercepts and fixed slopes (not shown in Table 3) and our Null model with random intercept only: the -2*LL of the first model is 234.538, while the -2*LL of our Null model with random intercept is 231.234. The difference between these models (3.304) is not statistically significant (p=.069).

However, due to our relatively small sample size, statistical significance should not be the most important criterion. Therefore, we adhere to the first rule of thumb mentioned above, and go ahead with testing the relationships of interest using multi-level analysis. A series of analyses was conducted to study the relationships between, on the one hand, the inputs of the virtual team and socio-emotional processes and task

processes and, on the other hand, the output of virtual team which is performance satisfaction.

Table 3. Multi-level estimates for Models relating performance satisfaction to the inputs of the virtual team, and in interaction with the emotional processes and task processes

| Model | -2*LL | df | p | Level 1 | Level 2 |
|---|---|---|---|---|---|
| Null model | 231.234 | | | | |
| Model 1 | 202.715 | 28.519 | 0.007 | 0.863(.145) | .124(.111) |
| Model 2 | 149.422 | 53.293 | 0.001 | 0.0612(.103) | .087(.078) |

Notes: Null model: Intercept only; Model 1: Intercept, main effects; Model 2: Intercept, main effects; + interaction effects

We started with a *null* model, in which only a random intercept was specified. In Model 1, the inputs of the virtual team, socio-emotional processes and task processes were included to gain insight into the relationships between these variables and performance satisfaction. Model 2 additionally included the interaction terms: the 4 distinguished inputs of the virtual team setting x the 8 conditions. These interactions are our main focus and indicate whether the strength of the relationship between the inputs of the virtual team and performance satisfaction is modified by the socio-emotional processes and task processes. As can be seen in Table 3, every model mentioned is statistically significantly better in explaining performance satisfaction than the one previously tested. Or, in other words, the interactions of inputs of the virtual team and the socio-emotional processes and task processes add explanatory grounds in predicting performance satisfaction, as compared to a prediction simply based on the separate effects of the inputs of the virtual team and the socio-emotional processes and task processes. In the next section we describe these results for the main and interaction effects in more depth.

Table 4. Performance satisfaction (1 = strongly disagree; 5 = strongly agree)

| | BETA | SE | SIGN |
|---|---|---|---|
| Inputs of virtual teams | | | |
| Leadership | 0.231 | 0.128 | p<.05 |
| Goals | -0.136 | 0.89 | n.s. |
| Technology | 0.204 | 0.08 | p<.05 |
| Communications | 0.435 | 0.97 | p<.05 |
| Socio-emotional and task processes | | | |
| Relationship building | 0.362 | 0.089 | p<.05 |
| Cohesion | 0.467 | 0.110 | p<.05 |
| Trust | 0..421 | 0.120 | p<.05 |
| Forming | -.210 | 0.09 | n.s |
| Storming | -.124 | .094 | n.s |
| Norming | .002 | .015 | n.s |
| Performing | .047 | .085 | p<.05 |
| Adjouring | .010 | .111 | p<.05 |
| Interaction effects between inputs of virtual teams * socio-emotional and task processes | | | |
| Leadership* Relationship building | .321 | .076 | p<.05 |
| Leadership* Cohesion | -.089 | .133 | n.s |
| Leadership* Trust | .411 | .024 | p<.05 |
| Leadership* Forming | .053 | .213 | n.s |
| Leadership* Storming | .122 | .031 | n.s |
| Leadership* Norming | .002 | .091 | n.s |
| Leadership* Performing | .231 | .110 | p<.05 |
| Leadership* Adjouring | .101 | .009 | n.s |
| Goals* Relationship building | .007 | .211 | n.s |
| Goals* Cohesion | .102 | .020 | n.s |
| Goals* Trust | .098 | .102 | n.s |
| Goals* Forming | .190 | .093 | p<.05 |
| Goals* Storming | -.143 | .159 | n.s |
| Goals* Norming | .289 | .103 | p<.05 |
| Goals* Performing | .312 | .145 | p<.05 |
| Goals* Adjouring | -.021 | .081 | n.s |
| Technology* Relationship building | -.171 | .103 | n.s |
| Technology* Cohesion | .294 | .141 | n.s |
| Technology* Trust | .011 | .161 | n.s |

Table 4 (cont.). Performance satisfaction (1 = strongly disagree; 5 = strongly agree)

| | | | |
|---|---|---|---|
| Technology* Forming | -.204 | .124 | n.s |
| Technology* Storming | .061 | .102 | n.s |
| Technology* Norming | -.053 | .079 | n.s |
| Technology* Performing | .273 | .105 | p<.05 |
| Technology* Adjouring | .154 | .113 | n.s |
| Communications* Relationship building | .267 | .108 | p<.05 |
| Communications* Cohesion | .191 | .115 | p<.05 |
| Communications* Trust | .174 | .120 | n.s |
| Communications* Forming | -.385 | .122 | n.s. |
| Communications* Storming | .072 | .113 | n.s |
| Communications* Norming | .075 | .108 | n.s |
| Communications* Performing | .469 | .139 | p<.05 |
| Communications* Adjouring | .081 | .121 | n.s |

**2.2. Discussions.** Table 2 presents means, standard deviations (SD) and correlations of all variables under study. As revealed in this table, the leadership (r =-.58; p<.05), goals (r =.27; p<.05), communications (r = 0.40; p<.05), cohesion (r=.30; p<.05) and trust (r=.27; p<.05) are statistically significantly associated with performance satisfaction. So, in this analysis the other variables are not statistically correlated to performance satisfaction.

Table 4 notes that the focus is upon the effects, as shown by the multi-level analysis, of the inputs and processes of the virtual teams on performance satisfaction. Besides several main effects the results also show several interaction effects. Although our sample is rather small, of the possible interaction effects of the four elements which present the inputs virtual teams on one hand, and socio-emotional and task processes on the other, 10 out of 32 are statistically significant.

Regarding the inputs of virtual teams, the results show that the successful Leadership, Technology and Communications are associated with high performance satisfaction (beta = -.231; 0.204; 0.435; p<.05). The other input of virtual teams (the goals) is not significantly associated with performance satisfaction. Regarding the Socio-emotional and Task processes the analysis shows the relationship between the Socio-emotional processes (relations building, cohesion, trust) and the performance satisfaction (beta = 0.362; 0.467; 0.421; p<.05). It means that the Socio-emotional processes have a positive effect on performance satisfaction. The task processes are not as such associated with performance satisfaction except for performing and adjouring processes (beta = .047; .010; p<.05).

However, the interaction effects between the inputs of virtual teams and socio-emotional processes provide precision in this finding. The interaction effects in Table 4 have shown that successful leadership that builds strong relations is showing more performance satisfaction (beta = .321). Also, it is shown that successful leadership builds more trust and leads to results in performance satisfaction (beta = .411).

However, interaction effects between the inputs of virtual teams and task processes show that successful leadership can achieve good performing task and performance satisfaction (beta = .231). Also, there are interaction effects between tasks of forming, norming, performing and goals. These interaction effects show more performance satisfaction (beta= .190; .289; .312). Regarding the interaction effects between technology and socio-emotional, task processes, there is only interaction effect between technology and performing (beta = .273). However, there are interaction effects between communications and all Relationship building, Cohesion and Performing (beta = .267; .191; .469).

## Conclusion and area for future research

In this paper we have described the concept of the virtual teams and its life cycle, and so explored the inputs of virtual teams and their impact on team processes and performance satisfaction. One of the most important implications for this research paper is that the applications of virtual teams in real field, as evidenced by the ETAs, are increasingly relevant.

Supporting literature and anecdotal evidence, we believe, show that there are some variables which work as inputs for virtual teams and these variables can have an effect on virtual teams' processes and performance satisfaction. Our results reveal that leadership, technology and communications are associated with high performance satisfaction, while goals are not. Also there is a high performance satisfaction associated with relationship, cohesion and trust as socio-emotional processes, indicating that this process has a positive effect on team performance. Only performing and adjouring, as task process, are significant and have a high performance,

while other components, namely forming, storming and norming, are not, indicating that task process is less important than socio-emotional process and results in less performance satisfaction. There are some correlations and some main effects with statistical significance. Mostly, the results concern interaction effects, meaning that only in a certain configuration of conditions, an association is present.

Furthermore, different inputs have interaction effect with some of the socio-emotional and task processes components. Leadership has an interaction effect on relationship, trust and forming; goals have an interaction effect on forming, norming and performing; communications have an interaction effect on relationship, cohesion and performing; while technology has only one interaction effect on performing.

The focus could be upon the dynamic nature of both life cycles of virtual teams' processes. Our paper does not fully acknowledge this fact. The model might suggest that the inputs and the processes are static; yet in real-life they are not. We did not include in our measurements the feedback loop which is important in input-process-output models. The current conditions (both inputs and outcome) of the virtual teams in our sample might be the result of past performance satisfaction. We could not take this into account in our study design.

Therefore, further research is needed. In particular, longitudinal research may open up the rather black box of the influence of time and experience on the different variables affecting the performance of virtual team workers. Longitudinal research is needed to investigate the nature of the conditions, the technology-task fit, the role of the team leader and the social team processes. Expanding the current study can allow the use of hierarchical linear modeling at more than two levels, which have been used in the current paper, which can improve the level of significance of the findings. Finally, the plan is to collect more data, and future studies should aim to use a number of different organizations, and also to investigate number of numbers, i.e. diversity which can have impact on the outcomes or even type of collaboration undertaken (complexity).

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