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A Study of Virtual Project Team Types and Their Impact on Project Success.

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ABSTRACT

Based on a global survey, this paper presents empirical data to support evidence of a number of virtual team types. The study develops a simple measure of project team virtuality, which is supported by existing research and current practitioners. Based on this measure and the empirical data gathered, a number of virtual team types are defined. Using data gathered on a set of soft characteristics defined from the literature, further virtual team types are defined. The research studies the relationship of the identified team types with project success, their ability to cope with temporal dispersion and their level of usage of communication technology.

KEYWORDS: Virtual teams, Project success, Team Leadership, Team Structure

INTRODUCTION

The virtual team concept emerged in the early 1990s when U.S. multinationals and their affiliates overseas began using dispersed teams in order to integrate their work practices (Kirkman et al. 2002). Since then increased globalization and rapid improvements in communication technology have resulted in growth in the use of virtual teams, with Martin et al., (2004) contending that nearly all organizational teams are virtual to some extent. It is therefore important that the working and functioning of virtual teams is well understood.

This paper contributes to our understanding of virtual teams and project management by exploring virtual team types and their impact on project success. The team types are developed based on virtual team attributes defined from the academic literature and tested on a sample of more than 500 project managers.

The research presented here distinguishes itself from previous research on virtual project teams and adds to the body of knowledge in several ways. First, unlike previous research that has tended to focus on specific aspects or topics of virtual teams, this research provides a broad view of virtual project teams. Second, empirical data is used to define virtual team clusters. Finally, using a global study conducted across multiple companies and industry sectors, the impact of team characteristics on overall project success is analysed.

The paper is structured as follows: A review of the literature on virtual project team characteristics identifying core themes is presented, followed by a description of the research methodology employed and the development of a survey addressing these themes.

The survey results are presented and analysed. Finally a discussion of the findings and their implications for researchers concludes the paper.

LITERATURE REVIEW

Earlier research into the virtual team typology focused on defining characteristics that could be used to classify virtual teams. These characteristics include locations, number of projects, number of managers (Evaristo and Van Fenema, 1999; Cascio and Shurygailo, 2002); time, place and organisations (Lipnack and Stamps, 2000; Kimble et al., 2000; Fisher and Fisher, 2001); and people, technology and process (Bal and Grundy, 1999; Dundis and Benson, 2003). Fiol and O'Connor (2005) use the attributes of uncertainty, visibility, rich individuating cues, diversity and politeness rituals to define three virtual team types – pure, hybrid, face to face, while Bell and Kowzloski (2002) use the dimensions of member roles, lifecycle, boundaries and temporal distribution to develop a structured framework. In a meta review of academic literature on virtual teams Martins et al. (2004), identify a move away from early research of contrasting virtual teams with traditional teams, to focusing on 'virtualness' as a potential characteristic of all teams. It is noticeable that many of the structures/models proposed are based on theory and very few of the frameworks are empirically tested.

More recent publications have been based on empirical research. Gilson et al. (2015) in a review of 10 years of empirical research of virtual teams classify 10 themes – research design, team inputs, team virtuality, technology, globalisation, mediators and moderators, trust, outcomes and ways to enhance virtual team success. Many published case studies and experiments examine the cultural, communication, leadership and effectiveness of virtual teams (Han et al., 2011; Cheng et al. 2012; Domschker et al., 2009; Ocker et al., 2011; Edwards and Sridhar, 2003). Quantitative and qualitative studies explore team structure and knowledge sharing (Bal & Gundry, 1999; Klitmoller and Luring, 2013; Reich et al., 2012). However, there is little empirical research that studies virtual teams from a general project management perspective. Some notable exceptions to this are five surveys that use project managers as their population sample (Curlee, 2008; Anantatmula and Thomas, 2010; Bourgault, Drouin, & Hamel, 2008; Henderson, 2008; Verburg et al., 2013). Most empirical research on virtual teams tends to focus on certain aspects or traits rather than actual team typologies.

Seven key themes emerge from the literature on virtual project teams, these are 1) temporal dispersion, 2) geographic dispersion, 3) culture, 4) politics, 5) social, 6) team membership and 7) communication technology. These are summarised in Table 1. Within each of these themes, virtual team attributes can be classified as either hard or soft. Hard attributes are generally used to describe a team's temporal and geographic dispersion and cannot be changed by the project manager. Soft attributes include factors such as the expertise of team members, the team's experience and reputation and the ability of the team leader.

Temporal and geographic dispersion pose many challenges for virtual teams including the difficulty of executing tasks in parallel, delayed communication, problems with developing functional working relationships, all of these have been found to impact on project success (Chudoba et al., 2005). Team dispersion also increases the cultural diversity of a project team, thus cultural experience and adaptiveness are important characteristics for virtual teams (Espinosa et al., 2006). The political standing of a virtual team's leader within an organisation plays an important role in the functioning of a virtual team (Mukherjee et al., 2012). Team leadership is critical for aligning and sharing the vision and knowledge of highly dispersed teams while the size, structure and membership of a virtual team have also been

Table 1: Seven key themes of virtual teams.

Theme	Attributes	References
1. Temporal dispersion	<p><u>Hard Attributes:</u> Team members in different time zones. Time difference between time zones. Extra hours worked.</p> <p><u>Soft Attributes:</u> Difficulty of task execution. Impact on functional or workshop relationship between team members. Lack of understanding of different physiological and social habits or norms. Time delays cause confusion.</p>	Chudoba et al., 2005; Connaughton and Shuffler, 2007; Saunders et al., 2004; Martin et al., 2004; Dundis and Benson, 2003; Sarker and Sahay, 2002; O'leary and Cummings, 2007
2. Geographic dispersion	<p><u>Hard Attributes:</u> Number of locations. Key location.</p> <p><u>Soft Attributes:</u> Geographical distribution of locations. Team structures at locations.</p>	Schweitzer and Duxbury, 2012; Hoch and Kozlowski, 2014; O'leary and Cummings, 2007; Foil and O'Connor, 2005.
3. Culture	<p><u>Soft Attributes:</u> Recognizing different cultural situations. Understanding different economic, social, and legal conditions. Adapting to different cultural situations. Sensitivity to cultures reflected in communication and interaction. Dominance of organizations. Use of organizational processes. Integration of functional department members and subject matter experts into the team.</p>	Gibson and Cohen, 2003; Espinosa et al., 2006; Watson-Manheim et al., 2002; Au and Marks, 2012; Schlenkrich and Upfold, 2009; Zhang et al., 2006; Gibson and Gibbs, 2006; Kim et al; 2006
4. Political	<p><u>Soft Attributes:</u> Team and team leaders' political reputation and standing. Team autonomy and freedom. Team leaders' interactions with team and team organizations.</p>	Bal and Teo, 2000; Lipnack and Stamps, 2000; Mukherjee et al., 2012; Zander et al., 2012. Harvey et al., 2005.
5. Social	<p><u>Soft Attributes:</u> Team vision and goals. Alignment to vision and goals. Formal job role versus expertise and knowledge. Knowledge transfer and sharing.</p>	Bal and Teo, 2000; Geber, 1995; Moser and Axtell, 2013.
6. Team membership	<p><u>Soft Attributes:</u> Experience of working on virtual teams. Experience of working with other team members. Diversity of knowledge. Number of fully dedicated members. Number with dedicated roles. Number reporting directly to team leader. Number of contractors.</p>	Staples and Cameron, 2005; Lee-kelley, 2002; Zhang et al., 2006; Nader et al., 2007; Henry and Hartzler, 1997; Connaughton and Shuffler, 2007; Wong and Burton, 2000.
7. Communication technology	<p><u>Soft Attributes:</u> Experience of using communication technology. Usage of communication technologies.</p>	Nader et al., 2009; Watson-Manheim and Belanger, 2002; Domscheker et al., 2009; Webster and Wong, 2008.

related to its performance (Staples and Cameron, 2005; Wong and Burton, 2000). Finally, virtual teams rely on electronically mediated communication and the research suggests that certain types of media are more useful for knowledge sharing than others (Kiltmoller and Lauring, 2013).

In summary, while the themes identified in Table 1 have emerged from the literature as having a key impact on the functioning of virtual teams they have to date been studied in isolation rather than in the context of the overall operation and success of the project team.

The objective of this study is to take a more integrated look at the operation and success of virtual teams. Specifically, a selected range of soft attributes identified in Table 1 – culture, political, social, team membership - are used with the hard attributes relating to temporal and geographic dispersion to define virtual project team classifications. These classifications are then compared using the key themes of temporal dispersion and use of communication technology.

Project success will be defined using the factors developed by Pinto and Slevin (1988) – 1) completion on schedule, 2) within or on budget, and 3) achievement of quality and performance objectives. An additional fourth constraint, meeting client expectations, is included (Jugdev and Muller, 2005).

While the main aim of this study is to identify the virtual team types that are linked with project success there are two secondary aims. The first is to examine how virtual teams cope with the challenges posed by temporal dispersion. The second is to examine the levels of usage of communication technology by virtual teams. The next section of this paper describes the methods used to conduct this study.

METHOD

The research method used was grounded exploratory research using a quantitative survey. The survey tool was Survey Monkey and study population was a section of Project Management Institute (PMI) members with a target size of more than 5000. An original questionnaire was developed based on the frameworks outlined in the literature review. The seven data categories for the questionnaire were 1) temporal dispersion, 2) geographic dispersion, 3) culture 4) political, 5) social 6) team membership and 7) communication technology. The survey also gathered data to measure project team performance, in order to analyse the impacts of key virtual team attributes on performance. A pilot survey was distributed to 20 experienced project management professionals and based on feedback a revised questionnaire was distributed to members of the PMI, using the PMI chapter member's advisory group and PMI chapter mentors who contacted selected PMI Chapter presidents requesting them to email the survey to their membership. The survey was issued to PMI members in over 30 countries and the total number of responses collected was 521. Each respondent was asked to complete the questionnaire based on a project that was recently completed by a virtual project team of which they were a member.

In addition to the main survey described above, a further small-scale study of 50 practitioners with experience working on virtual project teams was used in order to establish a working measure of virtuality. This research found that two hard attributes are deemed to have the most impact on the level of virtuality of a team: 1) the number of hours' difference in time zones between the two locations of the virtual team; and 2) the number of team locations existing for the virtual team. This definition was used to identify the level of virtuality of teams within the study.

Using the data gathered from the two surveys, data analysis was conducted to identify virtual team types and study their impact on project success. This data analysis is described in the next section.

Data Analysis

Data analysis was conducted in four phases. First, component factor analysis was conducted on the virtual team soft attribute data to identify key factors of virtual project teams. Cluster analysis using the key factors, was then performed to identify the teams that had positive or advanced attributes and those that had negative or basic attributes. This team type was labelled basic/advanced.

Second, based on the measure of virtuality defined in the method section above, the sample was divided into those project teams that were “highly virtual” and those that were “moderately virtual”. This team type was labelled moderately virtual/highly virtual. (Note: All teams were virtual to some extent, as this was a prerequisite for participating in the study). The third phase of the data analysis, compared the project success results for each of the team types. For the final analysis phase, the challenges posed by temporal dispersion and the level of usage of communication technology for each of the team types is studied.

Developing Team Types based on Soft Virtual Team Characteristics

Statistical analysis was conducted using IBM SPSS Version 22 software. Component factor analysis was used on the data gathered to reduce the soft characteristic attributes of the key themes of team membership, political, social and culture to nine common factors. (Appendix 1 details the results of the factor analysis). These are

- Dedicated team members – the level of dedication to project, role and project manager.
- Virtual team experience – experience of working on virtual teams and with the other team members.
- Team leader status – team leader’s achievements, recognition and interaction with team and organisation.
- Team status - teams reputation , political power and independence
- Vision and goals - clearly defined team vision and goals and aligned to them.
- Expertise and knowledge - expertise more important than role and there is strong knowledge sharing among the team.
- Common processes – one set of organisational policies, processes and methodologies.
- Cultural awareness – team members understand each other’s economic, social and legal conditions
- Cultural adaptiveness – team members work hard to adapt to the different cultures within the team.

Cluster analysis was conducted on the data set with the nine soft factors identified from the component factor analysis in order to identify whether teams could be grouped based on these factors. Using K means cluster analysis, three clusters were identified (Table 2).

Table 2: Cluster Analysis Results.

Nine Common Factors	Cluster 1 (N=84)	Cluster 2 (N=232)	Cluster 3 (N=194)
Dedicated team members	-0.06	0.35	-0.39
Virtual team experience	-0.23	0.45	-0.43
Team leader status	-0.85	0.28	0.01
Team status	-0.46	0.45	-0.36
Vision and goals	-1.63	0.37	0.21
Expertise and knowledge	-0.10	0.40	-0.45
Common processes	-0.86	0.43	-0.16
Cultural awareness	-0.47	0.56	-0.47
Cultural adaptiveness	-0.79	0.24	0.04

The numbers in the columns are the mean scores for each cluster of the component factor scores for each of the nine factors. As the total sample mean component factor score for each of the factors is equal to zero, Cluster 1 (17% of the total sample) can be identified as the group with mean scores for all nine factors below the total sample mean. Thus Cluster 1 is labelled 'Basic' as teams within this cluster demonstrate below average performance in all nine virtual team characteristics. Cluster 2 (45% of the total sample) is the group in which the mean scores are above the total sample mean, and is therefore labelled 'Advanced' as teams within this cluster demonstrate above average performance for all nine virtual team characteristics. Cluster 3 (38%) is the group with a mix of mean factor scores above and below the total sample mean and is labelled 'Neutral' as teams in this group demonstrate performance both above and below average for the nine factors. This research focuses on only the basic and advanced clusters as these two clusters have the maximum differences in performance. A detailed description of the differences between basic and advanced classification is given in Table 3.

Developing Team Types based on Hard Virtual Team Characteristics

Two hard attributes relating to temporal and geographic dispersion were deemed to have the most impact on the level of virtuality of a team. The upper and lower quartile figures for these two attributes from the main data set (the 521 responses) were then used to classify teams as highly virtual or moderately virtual. These are defined as follows:

Highly virtual: The difference in time zones between two locations is greater than six hours, *and* the number of team locations is greater than four.

Moderately virtual: The difference in time zones between two locations is fewer than six hours, *and* the number of team locations is less than four.

Of the 521 survey responses, 107 (20%) of the sample can be classed as belonging to the moderately virtual typology and 134 (26%) can be classed as belonging to the highly virtual typology, see Table 3. The remaining 280 (54%) responses were in between these extremes and are omitted in the analysis that follows.

Table 3: Basic versus Advanced Team Properties

Attribute	Basic	Advanced
Dedicated team members	<ul style="list-style-type: none"> The team members are less likely to be dedicated to the project, have a dedicated role, or report directly to the project leader. 	<ul style="list-style-type: none"> The team members are dedicated to the project, have a dedicated role, or report directly to the project leader.
Virtual team experience	<ul style="list-style-type: none"> The team members are less likely to have experience working on virtual teams and are unlikely to have worked together. 	<ul style="list-style-type: none"> The team members have previous experience working on virtual teams and have previously worked together.
Team leader status	<ul style="list-style-type: none"> The team leader or leaders were well known, have achieved recognition, and have a high degree of interaction within the team and within the organization or organizations to which the team belonged. 	<ul style="list-style-type: none"> The team leader or leaders were very well known, have achieved recognition, and have a very high degree of interaction within the team and within the organization or organizations to which the team belonged.
Team status	<ul style="list-style-type: none"> The team is likely to have a strong reputation for having the political power to get things done and is likely to be allowed the freedom to run the project as it wishes. 	<ul style="list-style-type: none"> The team has a strong reputation for having the political power to get things done and is likely to be allowed the freedom to run the project as it wishes.
Vision and goals	<ul style="list-style-type: none"> The team has a clearly defined vision, goals, and objectives, and team members are aligned to them. 	<ul style="list-style-type: none"> The team has a strong and clearly defined vision, goals, and objectives, and team members are strongly aligned to them.
Expertise and knowledge	<ul style="list-style-type: none"> Team members' expertise and knowledge is considered more important than job title or position, and team members are encouraged to, and willingly share their knowledge with the rest of the team. 	<ul style="list-style-type: none"> Team members' expertise and knowledge is considered much more important than job title or position, and team members are strongly encouraged to, and actively share their knowledge with the rest of the team.
Common processes	<ul style="list-style-type: none"> The team is likely to have one set of organizational policies, methodologies, and processes. 	<ul style="list-style-type: none"> The team has one set of organizational policies, methodologies, and processes.
Cultural awareness	<ul style="list-style-type: none"> The team members are likely to be good at recognizing the different cultural situations that arise within the team and are likely to understand the different economic, social, and legal conditions of the various countries in which the other team members lived. 	<ul style="list-style-type: none"> The team members are good at recognizing the different cultural situations that arise within the team and understand the different economic, social, and legal conditions of the various countries in which the other team members lived.
Cultural adaptiveness	<ul style="list-style-type: none"> Team members are likely to work hard to adapt to the different cultural situations that occur within the team and are likely to be sensitive to other team members' cultural behaviours. This is likely to be reflected in the way team members communicate and interact within the team. 	<ul style="list-style-type: none"> Team members work hard to adapt to the different cultural situations that occur within the team, and are sensitive to other team members' cultural behaviours. This is reflected in the way team members communicate and interact within the team.

In summary, using component factor analyse the soft attributes for cultural, political, social and team member characteristics were reduces to nine factors from which two distinct team types are identified which are labelled basic and advanced. A basic team registers below-mean responses for the nine attributes and an advanced team registers above-mean responses for the nine attributes. From a secondary survey, the greatest difference in time zones and number of locations were the two physical characteristics of virtual teams that have the most impact on the level of virtuality. Based on the quartile percentage findings for the survey questions on difference in time zones and number of locations, two further team types were identified—highly virtual and moderately virtual.

The primary aim of this research is to link virtual team types to project success. The next section will study the impact the identified team types have on project success and will then explore the challenges of temporal dispersion and the level of communication technology usage for the four team types.

RESULTS

Impact of Virtual Team Types on Project Success

Pearson's chi squared tests for difference was conducted on the data gathered from the survey questions used to study project success as the question formats used a standard 5 point likert scale ranging from 1- 'Strongly disagree', 2- 'Disagree', 3- 'Neutral', 4- 'Agree' to 5- 'Strongly agree'. The Pearson chi-squared test for difference results indicate that there is statistically significant differences between basic and advanced teams for the four success factors (Table 4). The mean scores show that for all success factors, advanced teams perform better than basic teams.

Table 4: Project Success: Basic versus Advanced

Success factors	Basic Mean	Advanced Mean	Pearson Chi-Squared Test for Difference
Completed on schedule	2.86	3.73	0.000**
Completed within budget	2.84	3.72	0.000**
Achieved quality and performance objectives	3.08	4.14	0.000**
Deliverables met client expectations	3.3	4.08	0.000**

** Statistically significant difference $p < 0.05$

From Table 5, Pearson's chi squared test for difference show there is no statistically significant difference between the performance of moderately virtual and highly virtual teams. Therefore, although the mean scores show that highly virtual teams perform better than moderately virtual teams, there is no statistically significant evidence that one team type out performs the other with regard to project success.

Table 5: Project Success: Moderately versus Highly Virtual.

	Moderately Virtual Mean	Highly Virtual Mean	Pearson Chi-Squared Test for Difference
Completed on schedule	3.4	3.44	0.665
Completed within budget	3.52	3.44	0.873
Achieved quality and performance objectives	3.72	3.97	0.196
Deliverables met client expectations	3.82	4	0.554

** Statistically significant difference $p < 0.05$

Team Performance in a Temporal Dispersed Environment.

Table 6 details the results of the performance of basic and advanced teams with regard to their ability to cope with temporal dispersion. As a 5- point likert scale was used to capture information on the challenges of temporal dispersion, Pearson's chi-squared test for difference was used to compare the ability of the team types to cope with temporal dispersion. The data shows a marked difference between basic and advanced teams with all factors having statistically significant differences. The mean scores of basic teams are consistently higher than those of advanced teams. This indicates that basic teams are impacted more by time-zone dispersion than advanced teams.

The findings that emerge are:

- Basic teams find doing tasks in parallel more difficult than advanced teams.
- Basic teams experience more delays in communication than advanced teams.
- The functional and working relationship between team members is negatively impacted by time-zone difference to a greater extent on basic teams than on advanced teams.
- Basic teams experience more confusion with clock times than advanced teams, resulting in missed meetings and task deadlines.
- In basic teams, there is a greater lack of understanding of the different physiological and social norms of the team members than in advanced teams, and this causes conflict.

Table 6: Ability to Cope with Temporal Dispersion: Basic versus Advanced Teams

	Virtually Basic Mean	Virtually Advanced Mean	Pearson's Chi- Squared Test for Difference
Executing tasks in parallel is difficult	3.37	2.78	0.020**
Delays in communication	3.8	2.97	0.000**
Negatively impacted the functional working relationship	3.42	2.33	0.000**
Lack of understanding of the different physiological and social norms	3.41	2.35	0.000**
Lack of understanding of the different physiological and social norms caused conflict	3	2.16	0.000**
Confusion over clock times caused missed scheduled meetings	2.34	1.87	0.003**
Confusion over clock times caused missed task deadlines	2.36	1.73	0.000**

** Statistically significant difference $p < 0.05$

Comparison of the differences between moderately and highly virtual team structures for temporal dispersion factors show that the differences are not as striking as the differences between basic and advanced virtual teams (Table 7). Only one factor - executing tasks in parallel is difficult - has a significantly statistical difference between low and highly virtual teams. The mean scores for most of the factors for moderately virtual teams are consistently lower than those of highly virtual teams.

Level of use of Communication Technology

To capture information on communication media usage, the Webster and Wong (2008) 7 point likert scale for communication media usage, was adapted to a 6 point likert scale ranging from 1- 'Never', 2- 'A number of times in a 6 month period', 3- 'A number of times a month', 4- 'A number of times a week', 5- 'A number of times a day', to 6- 'Almost continuously'. The question on experience of using communication technology used a standard 5 point likert scale. A comparison of the level of usage of communication technology for basic and advanced team structures shows that one technology type has a statistically significant different level of usage- team and organisation web portals (Table 8). Also the level of experience of using communication technology is also different with advanced teams members have more experience than basic team members. Apart from fixed line phones, the mean level of usage by advanced teams for all other technologies is higher than that of basic teams. We can therefore suggest there is no statistically significant difference between basic teams and advanced teams in their usage of communication technology, apart from team and organisation web portals. Also advanced teams are more experienced in using communication technology.

Table 7: Ability to Cope with Temporal Dispersion: Highly versus Moderately Virtual Teams

Temporal Dispersion challenges	Moderately Virtual Mean	Highly-Virtual Mean	Pearson Chi-Squared Test for Difference
Executing tasks in parallel is difficult	2.59	3.26	0.004**
Delays in communication	2.96	3.41	0.101
Negatively impacted the working relationship	2.39	2.69	0.256
Lack of understanding of the different physiological and social norms	2.80	2.65	0.129
Lack of understanding of the different physiological and social norms caused conflict	2.69	2.37	0.358
Confusion over clock times caused missed scheduled meetings	1.86	2.10	0.109
Confusion over clock times caused missed task deadlines	1.78	2	0.315

** Statistically significant difference $p < 0.05$

The study of the comparisons between moderately and highly virtual teams for the level of usage of communication technology is outlined in Table 9. Analysis of the data shows that there is little difference between moderately and highly virtual teams in the experience of and use of communication technology. Only the usage of web conferencing tools, instant

Table 8: Use of Communication Technology: Basic versus Advanced Teams

Usage of Communication Technology	Basic Mean	Advanced Mean	Pearson's Chi-Squared Test
Experience of using communication technology	3.92	4.4	0.000**
Stand-alone video conferencing	1.92	2.05	0.776
Web conferencing	3.24	3.76	0.217
Instant messaging	3.64	4.32	0.152
Remote access and control tool	2.38	2.88	0.250
Email	5.51	5.57	0.656
Fixed telephone	4.5	4.45	0.682
Mobile phone	4.08	4.27	0.351
Letter/Fax	1.51	1.53	0.825
Social networks	1.15	1.54	0.106
Data-sharing repositories	3.7	3.92	0.484
Team and organization web portals	2.59	3.62	0.001**

** Statistically significant difference $p < 0.05$

messaging tools, and data-sharing repositories have statistically significant differences. Thus we can conclude that there is no statistically significant difference between moderately virtual and highly virtual teams in the usage of communication technology, apart from the use of web conferencing, instant messaging and data sharing repositories portals.

Table 9: Use of Communication Technology: Highly versus Moderately Virtual Teams

Usage of communication technology	Moderately-Virtual	Highly-Virtual	Pearson chi squared test for difference
	Mean	Mean	
Experience of using communication technology	4.20	4.40	0.058
Standalone video conferencing	2.00	1.94	0.054
Web conferencing	3.13	3.95	0.003**
Instant messaging	3.89	4.60	0.044**
Remote access & control tool	3.01	2.80	0.464
Email	5.49	5.63	0.314
Fixed telephone	4.49	4.47	0.54
Mobile phone	4.11	4.02	0.127
Letter /Fax	1.58	1.35	0.211
Social networks	1.42	1.36	0.881
Data sharing repositories	3.45	4.35	0.002**
Team and organisation web portals	3.18	3.46	0.601

** Statistically significant difference $p < 0.05$

DISCUSSION

This research into virtual project team types provides three contributions to the body of knowledge of virtual project teams.

First, a clear definition of virtuality is provided, that will prove useful to virtual team researchers and practitioners. Virtual teams that have more than four team locations and a time difference of more than six hours between locations are classified as highly virtual, while those with fewer than four team locations and a time difference of less than six hours are moderately virtual. Teams in between these two extremes can be simply classified as virtual. While earlier researchers have used various definitions of team virtuality (Bell and Kozlowski, 2002; Fiol and O'Connor, 2005; Griffith and Neal, 2001), none have produced a simple, easy-to-operationalize measure.

The second contribution is the identification of a basic / advanced typology for virtual teams based on key soft characteristics of virtual teams. The characteristics are developed from the literature and have a sound theoretical basis. Using data gathered from a large scale survey of virtual teams working in a wide range of industry sectors the following traits were identified for advanced virtual teams:

- Team members are dedicated to the project and have fully dedicated team roles.
- Team members have previous experience of working on virtual project teams.
- Team members have previously worked other team members.
- The team leaders are very well known and have a high degree of interaction within the organisation and the virtual team.
- Advanced teams have a strong reputation within their organisation.
- Advanced teams have very clearly defined vision and goals and are strongly aligned to them.
- The level of expertise and knowledge of team members is considered more important than the role/position of team member.
- Advanced team members willingly share their knowledge amongst the team.
- Advanced teams use one set of organisational policies, methodologies and processes.

- Advanced team members are culturally aware and are adaptive to other cultures.

The third contribution provides evidence of the project success rates of virtual teams, the functional performance of teams in a dispersed time zone environment and their level of usage of communication technology.

The basic /advanced team type which is based on the soft characteristics of culture, team member traits, team social and political aspects, have a significant impact on project success. Advanced teams outperform basic teams in all project success factors – on schedule, on/ within budget, achievement of quality objectives and meeting client expectations. There is no difference between moderately virtual teams and highly virtual teams – a typology derived from physical virtuality factors of level of times zones dispersion and number of team locations – in the success of projects performed. Advanced teams have the best project success rate and basic teams have the worst project success rate. The project success rates of moderately and highly virtual teams' lies between basic and advanced teams, with highly virtual teams slightly outperforming moderately virtual teams.

Temporal dispersion has a greater negative impact on the workings of basic teams. Advanced teams are not as impacted and they outperform basic teams in executing tasks in parallel across time zones, have better working relationships with team members that are dispersed across time zones, demonstrate a better understanding of the different physiological and social norms of team members in different time zones and are less likely to miss deliverable deadlines as a result of confusion over times. There is no real difference in the impact temporal dispersion has on the team performance of moderate virtual and highly virtual teams. The only factor where temporal dispersion has differing impacts is executing tasks parallel, with highly virtual teams having greater difficulty than moderately virtual teams.

Advanced virtual teams are more experienced than basic teams in the use of communication technology. They differ significantly with basic teams with a higher level of usage of team and organisation websites, and show slightly higher usage of email, phone, and web conferencing. While team members of moderately virtual and highly virtual teams show no difference in their level of experience of using communication technologies, there is significant differences between the team types in their use of web conferencing, instant messaging and data sharing repositories, with virtually advanced teams demonstrating higher level of usage than virtually basic teams for all three. Moderately virtual teams show slightly higher level of usage of phones than highly virtual teams.

CONCLUSION

This research is based on a detailed global study of 521 virtual teams. It shows that virtual teams have been adopted globally as a standard way of managing projects.

The study has developed a simple measure of project virtuality - using the two physical measures of largest time zone difference and number of team locations- that is supported by existing research and current practitioners. Analysis of teams classified as moderately virtual and highly virtual by this measure of virtuality, shows that there is no difference in the success of projects performed by moderately virtual teams and the success of projects performed by highly virtual teams.

Using a set of soft characteristics defined from the literature, this research developed two further virtual team types – basic and advanced. Teams classed as basic, have performance factors scores below the mean average for the soft attributes of dedicated team members,

virtual team experience, team leader status, team status, vision and goals, expertise and knowledge, common processes, cultural awareness and cultural adaptiveness. Advanced teams have performance factor scores above the mean for all the above. Significantly this research shows that advanced teams have a higher level of project success than basic teams. It is worth noting that apart from the soft characteristics of virtual team experience, cultural awareness and adaptiveness, the other characteristics apply equally to traditional co located project teams. This highlights that the team characteristics to focus on when developing successful virtual projects teams are very similar to the team characteristics focused on in the development of successful traditional co located project teams.

For researchers, this study addresses some of the limitations of previous research (Martin et al., 2004; Nader et al., 2009; Powell et al., 2006) by providing a better understanding of how virtual teams operate and the patterns and practices that they must adopt in order to perform effectively. The measure of virtuality developed can be adopted in future work to improve consistency between studies. The characteristics of advanced virtual teams can also be built on to deepen our understanding of how project team characteristics have an impact on successful outcomes.

Future research on this topic could focus on some of the issues and limitations of this paper. The survey only gathered information from a single member of the virtual team, in most cases the project manager. The study was based on only one project performed by the virtual teams and there was no examination of the project methodologies being used by the teams. Finally, the demographic data also gathered, but not discussed in this paper suggests a high level of usage of virtual teams to execute projects; thus the need for further research.

APPENDIX 1

Component Factor Analysis

Principle component factors analysis (Varimax rotation) was conducted for each of the themes. The table below details the themes, the number of survey questions associated with each theme and the resulting component factors. In all cases the Kaiser Meyer Olkin measure of sampling adequacy (KMO) was greater than 0.5, which is acceptable. Also the Bartlett's test of sphericity was significant at $p = 0.000$ for all cases. A factor loading of > 0.5 was accepted.

Nine soft factors of virtual teams.

Key Themes	No. of Questions	Factors	Meaning
Team Membership KMO = 0.55 FL > 0.7	5	<ul style="list-style-type: none"> • Dedicated team members E=1.6, %V=33 	The level of dedication of team members: Dedication-measuring factors are: dedicated to the project, dedicated roles, and reporting directly to the project manager.
		<ul style="list-style-type: none"> • Virtual team experience E= 1.3, %V=27 	The team members were experienced with working on virtual teams and also had previous experiences working with other team members.
Political KMO = 0.73 FL > 0.6	5	<ul style="list-style-type: none"> • Team leader status E= 2, %V= 39 	The team leader or leaders were well-known, had achieved recognition, and had a high degree of interaction within the team and within the organization or organizations to which the team belonged.
		<ul style="list-style-type: none"> • Team status E=1.4, %V=28 	The team had a strong reputation for having the political power to get things done and was allowed the freedom to run the project as it wished.
Social KMO= 0.83 FL > 0.6	7	<ul style="list-style-type: none"> • Vision and goals E= 3, %V= 43 	The team had a clearly defined vision, goals, and objectives and team members were aligned to them.
		<ul style="list-style-type: none"> • Expertise and knowledge E= 2, %V=28 	Team members' expertise was considered more important than job title or position, and team members were encouraged to share their knowledge with the rest of the team.
Organizational Culture KMO = 0.68 FL > 0.7	4	<ul style="list-style-type: none"> • Common processes E=2.4, %V=59 	The team had one set of organizational policies, methodologies, and processes.
National Culture KMO = 0.87 FL > 0.5	7	<ul style="list-style-type: none"> • Cultural awareness E=2.6, %V=37 	The team members were good at recognizing the different cultural situations that arose within the team and understood the different economic, social, and legal conditions of the various countries in which the other team members lived.
		<ul style="list-style-type: none"> • Cultural adaptiveness E=2, %V=30% 	Team members worked hard to adapt to the different cultural situations that occurred within the team and were sensitive to other team members' cultural behavior. This was reflected in the way team members communicated and interacted within the team.

Note 1: Extraction method: Principle component analysis and rotation method: Varimax with Kaiser Normalization.

Note 2: KMO = Kaiser Meyer Olkin measure of sampling adequacy; E = eigenvalue; % V = percentage of variance; FL = Factor loadings

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