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MANAGING GLOBAL VIRTUAL TEAMS: AN EXPLORATION OF OPERATION AND PERFORMANCE

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Abstract

As Global Virtual Teams (GVTs) operate across diverse geographies, time-zones, and cultures, they present particular problems for project management in that their characteristics may negatively affect team performance. While a significant body of research exists on project management and GVTs, previous studies have not fully elaborated on the collective impact that GVT characteristics, such as temporal distance and geographical distance, etc., have on operation and performance. This paper develops a conceptual model from existing research and generates hypotheses to explore the impact of GVT characteristics on team operations and performance. The model is then applied in a broad survey of software developers participating in GVTs. Significantly; the study found that different GVT characteristics contribute to (i) GVT operational problems and (ii) negatively impact team performance. These findings have important implications for research and GVT practitioners' ability to operate such teams and ensure desired project outcomes.

Keywords: Global Virtual Teams, Project Management, Software Development.

1 INTRODUCTION

Global Virtual Teams (GVTs) may be defined as teams that have members who work and live in different countries and are culturally diverse (Powell et al., 2004). There is widespread use of GVTs in software development (Nunamaker Jr. et al., 2009; Ramasubbu et al., 2011). Such teams provide several opportunities to practitioners such as the possibility of a 24-hour working day, sourcing of highly skilled team members, exploiting local knowledge, and reducing labour costs (Ó'Conchúir et al., 2006; Palacio et al., 2010). However, there exists a counter-argument within research that GVTs present difficulties for project managers with the potential for low individual commitment, control problems, chronic misunderstandings, communication problems, delayed response times, role overload, role ambiguity, absenteeism, social loafing, and coordination problems (Carmel & Agarwal, 2001; Herbsleb & Moitra, 2000; Jarvenpaa & Leidner, 1999). Recently, there have been calls for researchers to focus on solutions for GVTs rather than dwelling on reported challenges (Babar & Lescher, 2014). However, before solutions to virtual project management issues may be explored, the exact nature and behaviour of GVT problems needs to be elaborated.

Verburg et al. (2013) observe that while there is ample attention paid to the organisation of projects in project management literature, studies focusing on virtual teams are limited. Traditionally, project success was based on effective project monitoring and control of time, budget and quality (Lee-Kelley et al., 2008). However, software development projects have a well-documented reputation for poor quality, budget overruns and schedule overruns (Brooks, 1995; Scott & Vessey, 2002). In the past, such problems, in co-located teams, were addressed through the establishment and application of formal project management processes (such as communication, control and coordination). However, the use of GVTs for software development work presents new, challenging characteristics for project managers that need to be resolved (Beise, 2004). Casey & Richardson (2006) note that virtual project management for software development is a difficult and complex task. This is due, in part, to the often highly interdependent nature of software development work (Kraut & Streeter, 1995) and the geographical, temporal, linguistic and cultural diversity that can present in GVTs (Powell et al., 2004).

Existing GVT research has identified geographical distance, temporal distance, language differences, cultural differences and lack of trust etc. as characteristics that cause particular performance issues for such teams (Iorio & Taylor, 2014; Powell et al., 2004). However, while these characteristics have been established in existing research, their individual and collective behaviour (in relation to operations and performance) has not been fully elaborated (Kroll et al., 2013; Pinjani & Palvia, 2013; Richardson et al., 2012). These characteristics need to be studied in order to properly assess their impact and identify potential measures that project managers can employ to minimise their effect (Casey & Richardson, 2006). A first step in helping to overcome the project management GVT challenge should be to explore the individual impact of GVT specific characteristics on operations and team performance. Given that existing research varies in its reporting of the negative impact of GVT characteristics on team performance a research study is warranted.

Therefore, the objective of this study is to explore how specific GVT characteristics contribute to operational problems and impact team performance. It begins by building a conceptual model from existing research and presenting a set of hypotheses. The model is applied via a survey of GVT practitioners and statistical analysis is conducted to corroborate the model. Both the conceptual model and the empirical findings of the study make a significant contribution to existing research, as will be seen.

2 BUILDING A CONCEPTUAL MODEL TO EXPLAIN THE IMPACT OF GVT CHARACTERISTICS ON TEAM PERFORMANCE

This section develops a conceptual model to theorize the relationship between GVT problems, effective coordination and team performance. A systematic literature review (Kitchenham et al., 2009) was undertaken in order to analyse the existing GVT literature and to identify constructs for use in building theory. Over 2000 articles were identified using EBSCO, Science Direct, IEEE Digital Library, JSTOR and the ACM Digital Library. Following the processes described by Kitchenham, et al (2009), we identified a core group of 42 journal articles suitable for informing the design of the conceptual model. The model draws on existing research in the areas of virtual teams and software development in order to identify constructs and hypotheses to explain the impact of GVT characteristics. Sources for the review were analysed and selected according to credibility and suitability standards set forth by the University of Oregon critical evaluation of information sources guidelines (Bell & Smith, 2009) and applied by Leverman (2008). The model's constructs are now delineated.

2.1 Team Performance

Team performance maybe defined as the extent to which the group's outputs meets the required standards and measures (Lurey and Raisinghani, 2001). This is a view prevalent in GVT related literature (Kanawattanachai & Yoo, 2007; Kirkman et al., 2002; Montoya-Weiss et al., 2001; Townsend et al., 1998) as well as general teamwork related literature (Aubé & Rousseau, 2011; Guinan et al. 1998; Hoegl & Gemuenden, 2001). However, there is a lack of consensus on how best to measure team performance accurately. For example, Guinan et al. (1998) describe team performance as a multi-measure that is best assessed by objective and subjective measures. Team performance has been used extensively in research as a measure for the outcomes achieved by virtual team (Powell et al., 2004). In GVT related existing research, team performance has been described as a measure of virtual team effectiveness (Lin et al., 2008; Martins et al., 2004; Weimann et al., 2013). Lurey & Raisinghani (2001) argue that team member perceptions can be valid predictors of the team's effectiveness since team members are central to the work, and therefore, directly influence performance. An effective team will produce high quality output (Jarvenpaa & Ives 1994). As such, this study used a set of subjective measures by which to assess team performance. Therefore, a team performance construct is introduced into the conceptual model as it is a critical measure for assessing successful software development outcomes achieved by GVTs.

2.2 GVT Characteristics and Problems

Previous studies have identified GVTs in terms of a virtuality construct which is multi-dimensional (Kirkman et al., 2004; O'Leary & Cummings, 2007; Shin, 2004). While the exact attributes of this virtuality construct differ across GVT studies, there is consensus when it comes to multi-dimensionality and the complexity of the GVT phenomena (Hertel et al., 2005). This perception of GVTs suggests that they cannot be defined by a single attribute, and are, instead multi-faceted. Therefore, when exploring GVTs, it is critical that the multi-faceted nature of such teams is observed in both determining performance issues and identifying potential solutions. Several characteristics (or attributes) have been identified as influencing both the operation and performance of GVTs viz. geographical distance (Powell et al., 2004), temporal distance (Cummings et al., 2009), leadership (Kristof et al., 1995), language differences (Sarker and Sahay, 2004), knowledge sharing (Kanawattanachai and Yoo, 2007), cultural differences (Maznevski and Chudoba, 2000) and trust (Dubé and Paré, 2001). Based on our extensive analysis of existing research, we selected five of these characteristics. There is support in existing literature to suggest that geographical distance, temporal distance, language differences, cultural differences and lack of trust negatively impact project team performance (Sarker and Sahay, 2004; Powell et al., 2004). Hence, we propose the following constructs:

- Geographical distance: Defined as the physical separation of team members across geographically dispersed project sites (Saunders et al., 2004).
- Temporal distance: Defined as the time difference(s) between the project sites (Herbsleb et al., 2000).
- Language differences: Conceptualized as the difficulties arising when the GVT's working language is not the native language team members across all project sites (Dubé and Paré, 2001).
- Cultural differences: GVT coordination will be affected by the fact that team members may possess diverse ethnic, national, and organizational backgrounds (Kotlarsky and Oshri, 2005).
- Lack of trust: Defined as the unwillingness to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trusting party, irrespective of the ability to monitor or control that trusted party (adapted from Mayer et al., 1995)

Though it is widely assumed that these individual GVT characteristics influence project team performance (Cummings et al., 2009; Dubé and Paré, 2001; Maznevski and Chudoba, 2000; Powell et al., 2004; Sarker and Sahay, 2004), there is a paucity of research that studies the impact of these characteristics collectively. Therefore, we posit the following hypotheses:

H1a: Geographical Distance negatively impacts Team Performance.

H1b: Temporal Distance negatively impacts Team Performance.

H1c: Language Differences negatively impacts Team Performance.

H1d: Cultural Differences negatively impacts Team Performance.

H1e: Lack of Trust negatively impacts Team Performance.

However, these individual characteristics are not always independent of each other. In much the same way that the degree of virtuality is captured through a multi-dimensional construct (Hertel et al., 2005; Kirkman et al., 2005), so too should the multi-dimensionality of GVT characteristic related problems. The negative impact of GVT characteristics may only exhibit in concert with other characteristics. For example, geographical distance, by itself, might not impact the team, but when combined with lack of trust it negatively influenced team operations and performance. Such GVT specific scenarios might be where remote team members did not complete tasks, took too long to complete assigned work and used the virtual team structure to hide or delay response to project requests. Existing research highlights the possible cumulative effects (Espinosa et al., 2003; Watson-Manheim, 2012) of GVT characteristics and the importance of capturing them. GVT characteristics combine to create problems and differ from other problems software development projects might encounter as they are attributable to the multi-national, distributed nature of the team (lack of visibility, logistical issues etc.). The recognition and capturing of this cumulative effect is critical to understanding GVT operational concerns. As such, the GVT Operational Problems construct is included in the model to represent the practitioner's acknowledgement of the presence of GVT characteristics that collectively impact team operations.

Hence, we posit the following hypotheses:

H2a: Geographical Distance positively contributes to GVT Operational Problems

H2b: Temporal Distance positively contributes to GVT Operational Problems.

H2c: Language Differences positively contributes to GVT Operational Problems

H2d: Cultural Differences positively contributes to GVT Operational Problems

H2e: Lack of Trust positively contributes to GVT Operational Problems

2.3 Research Model, Questions and Hypotheses

This study conjectures that temporal, geographical, linguistic, cultural and distrust characteristics (i) contribute to GVT operational problems and (ii) negatively impact team performance Figure 1 presents the conceptual model for this study and associated hypotheses.

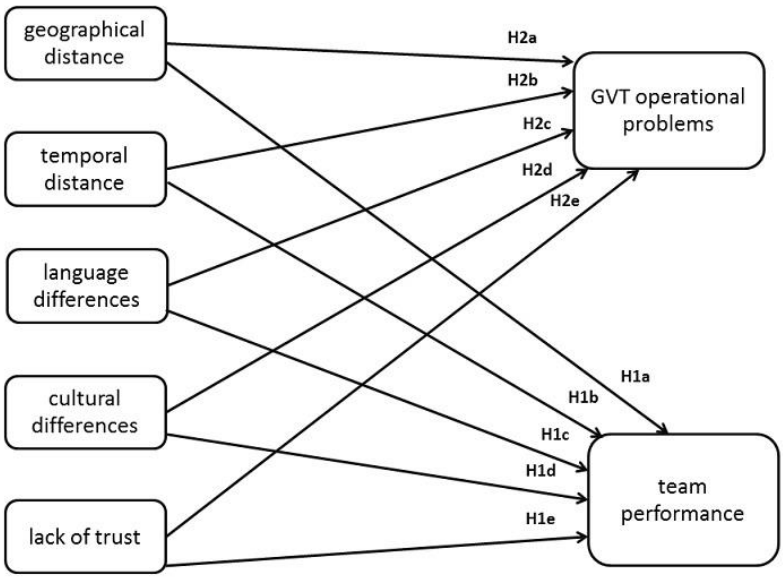

Figure 1. Conceptual Model (with associated hypotheses)

3 RESEARCH DESIGN

This study's research design consisted of a survey-based field study of GVT members engaged in software development projects globally. Building on the hypotheses presented in the previous section, we first designed a survey instrument that measures individual team member's perceptions of temporal, geographical, linguistic, cultural and distrust characteristics and their impact on team operations and performance (Table 1).

Construct	Code	Measure Description
Geographical Distance	gdisr1	The impact of geographical distance was evident in the working of the team
	gdisr2	The team experienced difficulties as a result of geographical distance
Temporal Distance	tdisr1	The team experienced difficulties as a result of time zone differences amongst team sites
	tdisr2	Time zone difficulties were evident in the working of the team
Language Differences	lanr1	Problems arose in the working of the team due to language differences
	lanr2	The team experienced difficulties as a result of language differences amongst individual team members
Cultural Differences	culr1	Diverse cultural practices were evident within the team
	culr2	Some team members had different cultural backgrounds
Lack of Trust	trur1	I could not trust others in the team
	trur2	Overall, the people in my team were not trustworthy
GVT Operational Problems	gvtr1	The team experienced difficulties due to the distributed nature of the work
	gvtr2	The distributed nature of the team resulted in work difficulties
	gvtr3	Problems occurred as a result of the multi-national nature of the team
Team Performance	perr1	I worked in a high performing team
	perr2	This was a well performing team

Table 1. Survey Measures

Measures for GVT operational problems, geographical distance, temporal distance, language difficulties, cultural differences and lack of trust were adapted from validated instruments used in previous studies and, where this was not possible, we also inferred measures from previous research and validated them using practitioner interviews. Team performance measures were adapted from existing studies (Lin et al., 2008; Lurey & Raisinghani, 2001). All statements were measured on a five-point Likert scale (1=strongly agree, 5=strongly disagree). The questionnaire was pretested using several practitioners that had extensive industry experience of GVTs and by four academics with related research experience.

Content validity was established via a literature review and feedback from eight purposively selected GVT members from one software development project. Selection of the eight participants was designed to achieve maximum feedback from various roles, locations and levels of expertise. Interviews began quite broadly with review of overall topics before focusing on a highly structured item by item examination of the draft instrument. In this approach, content validity was emphasized by encouraging participants to single out superfluous questions and suggestions for new areas of enquiry. Construct validity was also attained through the use of qualitative interviews with the aforementioned GVT members in order to locate and correct weaknesses in the questionnaire instrument (cf. Straub et al., 2004). This phase also allowed for testing of reliability via the identification of discrepancies or variations in answers to questionnaire items. The survey instrument therefore evolved through several iterations which reflected improvements stemming from participant suggestions.

Pre-testing resulted in a survey instrument with improved sequence, language and reduction in overall length. A pilot test was conducted with twenty software development practitioners from several GVTs. Participants in the pilot test were drawn from teams that were not part of the eventual distributed survey. The test was conducted to ensure that questionnaire items were clear and identified issues of concern to the survey participants. Minor adjustments were subsequently made to the survey instrument. The final online survey consisted of 20 distinct questions, which was distributed to global virtual software development team practitioners. Industry contacts, social networking sites and professional organizations were used to target the key demographic for the survey. The survey received 171 complete responses out of total of 200 submitted surveys. Table 2 presents a demographic profile of the survey respondents.

Respondent Role	Team Size	Project Duration	Number of Locations
Project Manager 40.1% Developer 32.6% Analyst 7.6% Other 19.7%	1-10 18% 11-20 27.9% 21-30 15.7% 31-40 12.8% 41-50 5.8% > 50 19.8%	< 1 month 0.6% 1-6 months 22.1% 7-13 months 33.7% 14-20 months 20.3% 21-24 months 9.9% > 24 months 13.4%	1-2 locations 17.5% 3-5 locations 55.6% 6-8 locations 22.8% 9-11 locations 2.9% > 12 locations 1.2%

Table 2. Demographic Profile of Respondents

4 RESULTS

While quantitative data may be analysed in a number of ways, the requirement to test a model and associated hypotheses drove the selection of a specific branch of statistical modelling: Partial Least Squares (PLS) path modelling (PM). The use of PLS has been gaining interest and use among IS researchers in recent years (Chin et al., 2003). PLS falls under the umbrella of Structural Equation Modelling (Jiacheng et al., 2010). Structural Equation Modelling (SEM) has become the preferred data analysis tool for empirical research in IS (Kim et al., 2009).There are a number of reasons for employing PLS. PLS makes fewer demands on the underlying data distribution, sample size and is also capable of analysing both reflective and formative indicators (Chin, 1998; Henseler et al., 2009). PLS PM is particularly appropriate when the research model is in the early stages of development, as here. SmartPLS 2.0 (Ringle et al., 2005), a structural model based tool was employed to test the model.

4.1 Tests for Validity and Reliability

Confirmatory factor analysis and reliability analysis were conducted to test the constructs for the model. The subsequent loadings and cross-loadings (Table 3) indicate that scale items exhibit high levels of convergent validity. The indicator variables exhibit high levels of convergent validity with loadings of measures on their respective constructs in the range of 0.731 and 0.965 (all significant at the 0.1% level).

	cult. diff.	geog. dist.	gvt probs.	lack of trust	lang. diff.	team perf.	temp. dist.
culr1	**0.965079**	0.357609	0.396121	0.167351	0.530936	-0.207197	0.206397
culr2	**0.731779**	0.140314	0.122256	-0.058448	0.307343	-0.131241	0.097312
gdisr1	0.29959	**0.940034**	0.789312	0.427217	0.499291	-0.361526	0.686657
gdisr2	0.321423	**0.940935**	0.793861	0.481351	0.508161	-0.366925	0.710876
gvtr1	0.211062	0.716432	**0.86468**	0.326572	0.331643	-0.295959	0.622591
gvtr2	0.32091	0.817457	**0.91616**	0.421438	0.483331	-0.367603	0.721347
gvtr3	0.39062	0.615646	**0.786842**	0.501108	0.570781	-0.32288	0.464198
lanr1	0.444637	0.432178	0.416026	0.311299	**0.89642**	-0.325592	0.409759
lanr2	0.507645	0.541034	0.551506	0.41403	**0.942701**	-0.433975	0.483624
perr1	-0.176623	-0.368451	-0.373887	-0.448244	-0.398562	**0.935135**	-0.196978
perr2	-0.209861	-0.355184	-0.344562	-0.438297	-0.385889	**0.933542**	-0.163472
tdisr1	0.201938	0.715102	0.688364	0.219527	0.495763	-0.164018	**0.925266**
tdisr2	0.154706	0.644831	0.614049	0.257175	0.398038	-0.191393	**0.908713**
trur1	0.165762	0.478334	0.459793	**0.909234**	0.417356	-0.465549	0.255455
trur2	0.025873	0.366789	0.386094	**0.858688**	0.279081	-0.365346	0.197494

Table 3. Cross Loadings

The examination of the structural model indicates that the model explains 75% of the variability in GVT Operational Problems (R^2 = 0.747) and 31% of the variability in Team Performance (R^2 = 0.311). The measurement model of eight constructs was estimated using reflective indicators (Table 4). Composite reliability was used to assess convergent reliability. All construct reliabilities were above Nunnally's (1978) recommended 0.7 benchmark (Table 4). Convergent validity was examined using AVE (average variance extracted). Again, all constructs were well above the 0.5 benchmark (Fornell and Larcker, 1981).

Discriminant validity was tested via correlation matrix (Table 5). As suggested by Fornell and Larcker (1981) the correlation of the construct was also compared with and the square root of AVE. At construct level, discriminant validity is adequate when the variance shared between a construct and any other construct in the model is less than the variance that construct shared with its indicators (Fornell 1982). Table 5 shows that the diagonal values are greater than the off-diagonal values in their corresponding rows and columns, which indicates that discriminant validity is not an issue for the constructs. The cross-loading method recommended by Chin (1998) was employed as an additional test for discriminant validity.

Construct	Items	Composite Reliability/ AVE	Loading
GVT Operational Problems R^2 : 0.75	gvtr1	C.R.: 0.892531, AVE: 0.73538	0.865
	gvtr2		0.916
	gvtr3		0.787
Team Performance R^2 : 0.31	perr1	C.R.: 0.932188, AVE: 0.872989	0.935
	perr2		0.934
Geographical Distance	gdisr1	C.R.: 0.938717, AVE: 0.884511	0.940
	gdisr2		0.941
Temporal Distance	tdisr1	C.R.: 0.913591, AVE: 0.840939	0.925
	tdisr2		0.909
Cultural Differences	culr1	C.R.: 0.843771, AVE: 0.733439	0.965
	culr2		0.732
Lack of Trust	trur1	C.R.: 0.877594, AVE: 0.782026	0.909
	trur2		0.859
Language Differences	lanr1	C.R.: 0.916603, AVE: 0.846127	0.896
	lanr2		0.943

Table 4. Measurement Model

In general, measurement items loaded higher on their respective construct than measurement items intended for other constructs. However, the GVT Problems construct does exhibit high variance with the GDISR1 and GDISR2 items which may be explained by possible similarities in the item wording.

	cult. diff.	geog. dist.	gvt probs.	lack of trust	lang. diff.	team perf.	temp. dist.
cult. diff.	**0.856**						
geog. dist.	0.330198	**0.940**					
gvt probs.	0.355528	0.841687	**0.858**				
lack of trust	0.116248	0.483137	0.481357	**0.884**			
lang. diff.	0.520775	0.53562	0.534576	0.400845	**0.920**		
team perf.	-0.206717	-0.387284	-0.384559	-0.47445	-0.419827	**0.934**	
temp. dist.	0.195611	0.743032	0.711787	0.258834	0.489692	-0.192995	**0.917**

Table 5. Correlations between constructs (diagonal elements are square roots of AVE)

4.2 Tests of Power and Common Method Variance

G*Power 3.1.2 was used to conduct power analysis. The test results indicate power= 0.9999972 and critical t of 1.9740167. This indicates that a sample size of 171 is more than sufficient to explain medium population effects. The sample size also complies with Chin's (1998) guidelines for estimating sample size. As a further test of the model, common method bias was considered. Common method bias occurs when the same method (Likert scales etc.) is used to measure variables (Podsakoff et al., 2003). Common method bias is a major threat to internal validity as the use of identical methods may result in erroneous results. For this reason, it is appropriate to test for common method variance (CMV). A one-factor Harman test was conducted in SPSS (version 19) using an exploratory factor analysis (EFA). With a one-factor Harman test, if a single factor emerges from the unrotated solution or if the first factor explains the majority of the variance then CMV may be an issue for the study. EFA results indicate that CMV is not a major concern.

4.3 Tests of the Hypotheses

The results of PLS path modelling are displayed in Figure 2. Ten hypotheses were examined using the loadings and significance of path coefficients (Table 6). The significance test of each path was estimated using bootstrapping method (1000 samples) to obtain error estimates and t values (Chin, 1998).

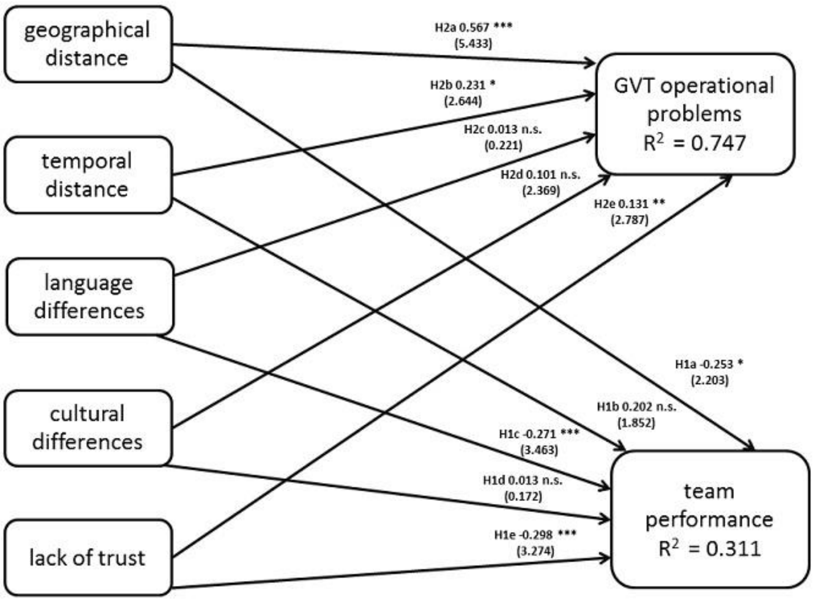

Figure 2. Results (p<0.05; ** p<0.01; *** p<0.001)*

The results show mixed support for the initial research model. There is strong support for geographical distance (H2a), temporal distance (H2b) and lack of trust (H2e) as contributors to GVT operational problems. Together these three characteristics explain a substantial 75% of the variation in GVT operational problems. However, we find no association between language differences and GVT operational problems and therefore reject H2c. Likewise H2d is rejected, with no association found between cultural differences and operational problems.

Construct	Path Coefficient (β)	t-statistic	Significance level	Hypothesis
Geographical Distance	-0.253	2.203	p<0.05	H1a - supported
	0.567	5.433	p<0.001	H2a - supported
Temporal Distance	0.202	1.852	n.s.	H1b - rejected
	0.231	2.644	p<0.05	H2b – supported
Language Differences	-0.271	3.463	p<0.001	H1c - supported
	0.013	0.221	n.s.	H2c – rejected
Cultural Differences	-0.013	0.172	n.s.	H1d - rejected
	0.101	2.369	n.s.	H2d – rejected
Lack of Trust	-0.298	3.274	p<0.001	H1e - supported
	0.131	2.787	p<0.01	H2e – supported

Table 6. Hypothesis Testing

In relation to team performance, three GVT characteristics were found to negatively impact team performance. Geographical distance, language differences and lack of trust all had a significant, negative impact on team performance (therefore, H1a, H1c and H1e are supported). However, no direct associations were found between GVT characteristics and team performance for temporal distance and cultural differences. Therefore, H1b and H1d are rejected.

As a final step, organizational size, project duration, team size, number of time zones and number of geographical locations were introduced into the model and tested as possible control variables. The point of these tests was to ascertain whether the organizational size (for example) might influence the model results. The control variables were tested in relation to GVT operational problems and team performance respectively. Each control variable was tested separately and also collectively against the endogenous variables. However, no significant path from any control variable to any endogenous construct was reported. This means that the size of a respondents organization, their reported team size and project duration do not appear to influence results. In addition, the number of geographical locations and time zones do not appear to influence the occurrence of GVT problems or levels of team performance.

5 CONCLUSIONS

This study contributes to the cumulative body of research on GVTs. The model provides novel insights for both practitioners and researchers. This is achieved by identifying how GVT characteristics contribute to operational problems and negatively impact team performance.

The results indicate that GVT characteristics (i) contribute to GVT operational problems and (ii) negatively impact team performance. Cultural differences were found to have no significant relationship with GVT operational problems or team performance (H1d and H2d are rejected). In relation to GVT operational problems, geographical distance (H2a), temporal distance (H2b) and lack of trust (H2e) are significant contributors. This means that for GVTs that exhibit high levels of geographical distance, temporal distance and lack of trust amongst team members, there is a higher occurrence of operational problems. In respect of team performance, geographical distance (H1a), language differences (H1c) and lack of trust (H1e) have a negative impact on outcomes, causing lower levels of team performance. Therefore, where high levels of geographical distance, language differences and lack of trust manifest in a GVT, there will be lower levels of team performance.

These findings are interesting as they indicate that GVT characteristics largely impact team performance collectively, rather than directly and individually. It suggests that these characteristics act in concert. Therefore, studies that assess the negative impact of characteristics individually are missing the collective behaviour and influence of such GVT characteristics. This, in turn, means that any studies that approach GVTs with a view to exploring project management solutions should treat characteristics as both contributors to operational problems and lower levels of team performance.

This study has a several implications for research. The study supports existing research (e.g. Espinosa et al., 2007; Kankanhalli et al., 2007; McDonough et al., 2001; Zakaria et al., 2004), which posits that GVTs that are geographically dispersed, temporally distant, linguistically diverse, culturally diverse, and manifest high levels of distrust will experience low levels of team performance. However, contrary to existing research (Maznevski and Chudoba, 2000; Powell et al., 2004) this study finds no support for cultural differences impacting operations and performance. The study also demonstrates that GVT characteristics contribute to GVT operational problems (Beise, 2004; Cramton & Webber, 2005; Lin et al., 2008; Powell et al., 2004).

Hence, this study provides empirical support to existing theoretical and empirical research (e.g., Lin et al., 2008; Kanawattanachai & Yoo, 2007; Massey et al., 2003). As with any empirical study, this paper has several limitations that should be considered when interpreting the findings. First, the GVT characteristics in this study do not represent an exhaustive list. There are several other characteristics that could be used in identifying the contribution to operational problems and impact on team performance. This study purposefully selected five characteristics that have been heavily reported as negatively impacting team performance. Second, this study uses subjective measures to assess for GVT characteristics and is, therefore, driven by practitioner perspective. Finally, this study does not explore the likely interdependencies between GVT characteristics. These interdependencies should be explored in order to identify the influence that one characteristic might have on another (for example, cultural differences influence on language differences).

In relation to practice, this study has demonstrated that organizations seeking to use GVTs for software development are faced with several challenges associated with GVT characteristics. We argue that the successful use of GVTs for software development is dependent on the degrees of geographical, temporal, linguistic and culturally diversity. The problems that arise in GVTs are only partly explained by the complex nature of software development work. First, given the negative, impact of GVT characteristics on team operations and performance, practitioners should, where possible, reduce the number of GVT characteristics present in a project. By eliminating one (or several) characteristics, practitioners can reduce GVT operational problems and GVT characteristics negative impact on team performance. We know of one case where practitioners have recognized this—in 2011, JRI America Inc. decided to relocate its software development operations from India to Ireland (Firm Shifts Jobs, 2011), in order to minimize the problems it experienced operating software development teams with significant temporal, geographical and cultural differences. Therefore, GVT practitioners should develop a set of metrics to assess the optimal set of GVT characteristics for particular software development projects.

Given the unique aspects of GVTs, they should be viewed as an entirely new work structure that will necessitate their own set of best practices, tools and techniques. With this purpose in mind, the model in this study is a subset of a much larger GVT model. Further research is required to explore, test, and develop a comprehensive theory on the impact of GVTs characteristics and the project management processes (such as coordination, communication and control) that can be employed to moderate their negative influence on operations and team performance. The set of constructs, measures, and corroborated hypotheses of this study can be used by researchers as a starting point for new enquiry. In conclusion, then, the research findings illustrate that the treatment of GVT characteristics and their impact on operations and team performance requires renewed focus, vigour and ingenuity from both researchers and software development project managers.

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