Trust and knowledge sharing in diverse global virtual teams

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Pinjani, P., and Palvia, P. (2013). "Trust and Knowledge Sharing in Diverse Global Virtual Teams." *Information & Management.* 50, (4), 144-153.

Made available courtesy of Elsevier: http://dx.doi.org/10.1016/j.im.2012.10.002

Abstract:

Global virtual teams (GVTs) allow organizations to improve productivity, procure global knowledge, and transfer *best practice* information instantaneously among team members. GVTs rely heavily on IT and have little face-to-face interaction, thereby increasing problems resulting from geographic barriers, time language, and cultural differences, and inter-personal relationships. The purpose of our study was to design a normative framework that would assist organizations in understanding the relationship between diversity, mutual trust, and knowledge sharing among GVTs, with additional focus on understanding the moderating impact of collaborative technology and task characteristics. Empirical data was collected from 58 GVTs and analyzed using a Hierarchical Multiple Regression technique. Results showed that in GVTs, deep level diversity has a more significant relationship with team processes of mutual trust and knowledge sharing than visible functional level diversity. This relationship is moderated by the collaborative capabilities of available technology and levels of interdependence of the task. Furthermore, knowledge sharing and mutual trust mediate the relationship between diversity levels and team effectiveness.

Keywords: Global virtual teams | Knowledge sharing | Mutual trust | Collaborative technology

Article:

1. Introduction

Global virtual teams (GVTs) are groups that (a) are identified by their organizations and group members as being a team; (b) are responsible for making and implementing decisions important to the organization's strategy [8]; (c) use technology-supported communication more than face-to-face communication; and (d) work and live in different countries. Compared to virtual and co-located traditional teams, GVTs connect people across organizational units whose policies, systems, and structures may not mesh together easily. They involve people from multiple disciplines, functions, location, and culture; organizations work together on specific

opportunities. Also, their major use of electronic medium is to aid the GVTs; team members must operate quickly and effectively and this requires high levels of technological support. Technology has therefore become absolutely critical for GVTs in carrying out their basic team functions: communicating, decision-making, learning, collaborating, and managing knowledge.

GVTs allow organizations to improve efficiency and productivity, procure global expert knowledge from internal and external sources, and provide best practice information nearly instantaneously. GVTs thus have little face-to-face (F2F) interaction and are seen as a new form of organizational structure [26]: they cut across organizational and national cultures and functional areas, increasing team diversity which may result in less effective performance.

While GVTs offer an expanded range of benefits, their implementation is at risk if organizations fail to address the many challenges they present [23]. Challenges are caused by distance and time zone changes, by language and cultural differences, by adoption and implementation of technology, by member interaction, and by a lack of trust and shared understanding among the team members. Project failures have been reported and calls for better understanding of GVT problems have been made.

Three areas must be considered when designing a collaborative GVT environment: *people*, *process*, and *technology*. Members of the GVT have no history of working together and may lack the skills needed to work effectively with people of different cultures, working in different time zones, and using incompatible systems. Members who are not competent in using new technologies present further challenges to team performance and member satisfaction [3]. Recent literature in GVT highlights the importance of relationship building, cohesion, and trust as processes that foster team effectiveness. GVTs also face significant difficulty in achieving such processes. To date, the majority of virtual team research has focused on conflict, interpersonal trust, group and individual identity, and group cohesiveness [16]. Little empirical research has explored the socio-emotional processes inherent in the virtual work environment. Models that could be used to understand better team development and effectiveness have been limited to those based on the traditional co-located teams.

GVTs can potentially bring together people with knowledge and perspectives from different parts of the world to meet their objectives. But problems are complicated, because team members may be unwilling to share knowledge, and lack trust that their knowledge will be “stolen” and used by potential competitors. For teams unable to establish a shared knowledge base, problems include a failure to communicate, difficulty in understanding the importance of information, and difficulty in interpreting the meaning of silence by others [6]. Compared to FTF interaction, GVT members find it hard to establish trust in a new working relationship: it is also difficult to assess teammates’ trustworthiness without ever having met.

Although various technologies offer many benefits, technological differences can result in delayed communication, frustration, and with decreased productivity and effectiveness. Thus the purpose of our study was to design a normative framework to assist organizations in understanding trust and knowledge sharing among diverse GVTs, with a focus on understanding the impact of task interdependence.

2. Literature review

2.1. GVT diversity

Considerable research has been conducted to understand the differences in the performance of diverse teams compared to their homogenous counterparts [5]. Perhaps the greatest problem facing GVT is in understanding the relationships between team members; developing cohesion among them is a challenge. Thus a growing body of research addresses the issues of improving collaboration between members of a GVT[20].

Diversity poses both opportunities and threats and empirical findings about team outcomes and performance are mixed [11]. Organizational scholars considering the link between diversity and performance have generally concluded that the relationship is neither simple nor direct. In some studies, diverse teams outperformed homogeneous teams by bringing a broader array of knowledge and experience to the group, while in other situations homogeneous teams performed better by avoiding conflicts and communication problems. If managed properly, team heterogeneity can create significant operational synergy, but mismanaged team diversity can be an impediment by causing intra-group conflict, miscommunication, and lack of trust.

Diversity due to demographic differences such as age, sex, or race, is termed *surface level diversity*, whereas diversity due to personal characteristics, such as idiosyncratic attitudes, values, and preferences are termed *deep-level diversity* [27]. A third form of diversity termed *functional diversity* is the extent to which team members differ in their functional background. In this, the underlying assumption is that different functional backgrounds result in non-overlapping knowledge and expertise, resulting in team members having a larger knowledge base on which they can draw in making decisions and taking actions.

Prior research has found that in contexts that reduce the effects of surface level diversity, deep level diversity has a strong effect [15]. The literature points out that GVTs offer the opportunity to overcome surface level and demographic diversity as most communication and interaction takes place through electronic media. However, because of GVTs dispersed nature and inherent membership diversity, *overall diversity* has a significant impact on GVT performance and outcome. Harrison and Klein [10] noted that, although the different types of diversity are qualitatively and distinctively different, they may be linked over time. However, we know of no empirical research that exists to validate such relationships.

2.2. Mutual trust

Trust, the positive and confident expectation of the behavior of another party, is a vital quality for effective virtual teams and online exchanges [19]. Trust in a team context has been defined as the degree of confidence of team members in one another. For GVT, the risk of potential misunderstanding and mistrust is heightened [30]. GVTs develop a “swift” form of trust but it is very fragile and temporal; however, trust amongst group members may be improved through social communication that complements rather than substitutes task communication. Trust and team performance are apparently positively correlated with effective communication among members.

2.3. Shared knowledge

The intellectual power of a virtual team is in its diffused expertise and ability to blend different experiences to create shared knowledge. When individuals work within a GVT, they can utilize others' knowledge as well as develop their own [9]. The more effective their knowledge sharing, the better it they can perform their tasks [13]. Shared knowledge in team settings occurs through joint training and by experience gained through problem-solving among members. When shared knowledge is incomplete, individuals' interrelate less. When team members are unable to interrelate, knowledge integration is less likely to occur. Efficiently managed team knowledge has a positive influence on the success of the team's project [2].

2.4. Collaborative technology

The technology used by GVT is important, as media richness has been found to impact team effectiveness, efficiency, level of communication, relationships among team members, and team commitment [29]. Effective ICT increases the positive impact of diversity and mitigates the negative effects of cultural diversity. Prior research has found that technology can improve inter personal processes like socialization [1] and reduce conflict.

Recently Sarker et al. [25] developed a model of technology adoption by groups based on a *valence* perspective. Based on this, they proposed that group supportability may be assessed by determining how technology can increase parallelism, transparency, and sociality within the group.

2.5. Task interdependence

This can be defined as the degree to which completing a task requires the interaction of team members. Several researchers have argued that the degree of task interdependence has a substantial effect on team processes and outcomes; it moderates the relationship between team diversity and team performance by influencing team member interaction and coordination. The role of task design and its impact on team performance has been investigated resulting in a belief that task differences moderate the relationships between team inputs, processes, and outputs.

Recently, the focus has been on treating diversity as a single construct without understanding the various facets of diversity, and without looking at the effects of functional level and deep-level diversity. Much of the research has also ignored the effect of building relationships on trust and knowledge sharing among team members. Overall, research on GVT is fragmented and much of the focus has been on comparisons of traditional teams with GVTs.

3. Research model and hypotheses

Given the inherently complex nature of GVT environment, we argue that *GVT effectiveness*, as a dependent variable, will increase with the development of mutual trust and knowledge sharing among the team members, which will be affected by diversity and moderated by task and collaborative features of the technology used.

We examined two levels of diversity at the *input level*: functional diversity and deep-level diversity. At the *process level*, the relationship between mutual trust and knowledge sharing was considered. At the *outcome level*, the focus was on GVT effectiveness consistent with operationalization, and included are team performance and members' satisfaction with the activities of the team.

A careful review of the model led us to identify two prime moderators: *task* and *frequency and duration* of interactions. Task holds conventional teams together, while communication and collaborative technologies serve as additional bonds linking the members of a GVT [24]. Technology allows GVT members to communicate and share information despite disparities in location and time-zone.

From the input–process–output perspective, our research model may be represented as shown in Fig. 1.

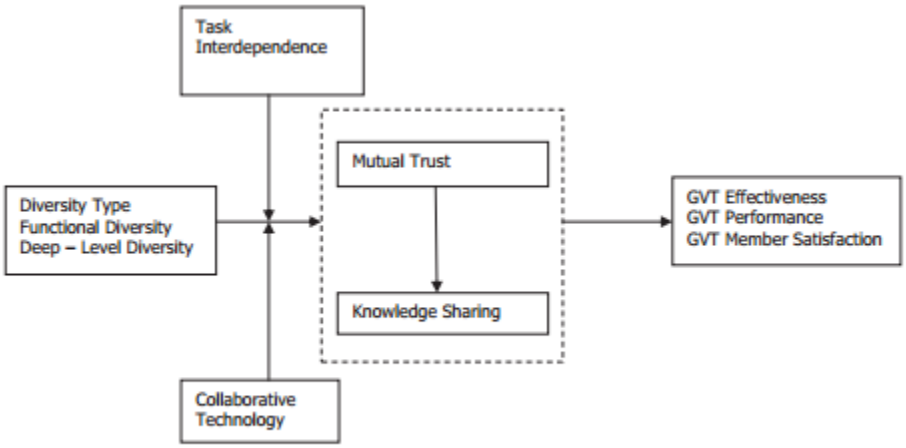

Fig. 1. Conceptual research model.

The essence of teamwork is to coordinate diverse contributions and accomplish a goal that could not have been achieved by any of the contributors working alone. Past research has suggested that members with different educational backgrounds lead to increased task related debates. Specifically, diversity increases relationship and process conflicts. Differences between individuals generally increase negative outcomes, such as less attraction and trust of peers, less frequent communication, lower team commitment, and increased relationship conflict among team members. Thus we hypothesized:

H1a.
Functional level diversity is negatively associated with mutual trust in GVTs.

H1b.

Functional level diversity is negatively associated with knowledge sharing in GVTs.

H1c.

Deep level diversity is negatively associated with mutual trust in GVTs.

H1d.

Deep level diversity is negatively associated with knowledge sharing in GVTs.
Prior research suggests that task interdependence moderates the relationships between team inputs and processes. When task interdependence is high, team members depend on each other for expertise, information, and resources to complete a task. High levels of task interdependence force team members to work together closely, exchange information and resources, and further develop shared norms for effective team functioning. In a low task interdependence situation, however, team members tend to operate as individuals with less intense interaction and coordination, thereby reducing affective outcomes and increasing a potential for lack of trust and shared knowledge arising from member heterogeneity. Therefore,

H2a.

Task interdependence will moderate the relationship between GVT functional diversity and mutual trust in global virtual teams in that the relationship is weaker for teams with high levels of task interdependence, than teams with low level of task interdependence.

H2b.

Task interdependence will moderate the relationship between GVT functional diversity and knowledge sharing in global virtual teams in that the relationship is weaker for teams with high levels of task interdependence, than teams with low level of task interdependence.

H2c.

Task interdependence will moderate the relationship between GVT deep-level diversity and mutual trust in global virtual teams in that the relationship is weaker for teams with high levels of task interdependence, than teams with low level of task interdependence.

H2d.

Task interdependence will moderate the relationship between GVT deep-level diversity and knowledge sharing in global virtual teams in that the relationship is weaker for teams with high levels of task interdependence, than teams with low level of task interdependence.
An increase in electronic interaction between team members gradually affects the team's feelings and attitudes, leading to an increased sense of trust and belonging. Also, collaborative technologies encourage greater participation in two ways: first, they allow free exchange of communication without having to wait (parallel processing) and second, visual anonymity reduces inhibitions of minorities. Thus,

H3a.

Collaborative technology will moderate the relationship between GVT functional diversity and mutual trust in global virtual teams in that the relationship is weaker for teams with high levels of collaborative technology, than teams with low level of collaborative technology.

H3b.

Collaborative technology will moderate the relationship between GVT functional diversity and knowledge sharing in global virtual teams in that the relationship is weaker for teams with high levels of collaborative technology, than teams with low level of collaborative technology.

H3c.

Collaborative technology will moderate the relationship between GVT deep-level diversity and mutual trust in global virtual teams in that the relationship is weaker for teams with high levels of collaborative technology, than teams with low level of collaborative technology.

H3d.

Collaborative technology will moderate the relationship between GVT deep-level diversity and knowledge sharing in global virtual teams in that the relationship is weaker for teams with high levels of collaborative technology, than teams with low level of collaborative technology.
Trust plays a key role in effective information sharing, leading to mutual understanding in the team. Trust is an effective way to manage people who cannot meet face-to-face, and interact: members are then willing to open themselves to each other and cooperate to solve a problem. Trust is thus pivotal in GVTs in order to bridge the psychological distance between people who are culturally and geographically apart. Thus,

H4.

Mutual trust is positively associated with knowledge sharing in GVTs.

When team members have high levels of mutual trust, common goals, unified rewards, and knowledge sharing, they tend to agree on norms regarding work, and this promotes harmony and decreases interpersonal tensions [7]. In the group working environment, trust is an important premise of successful group decision-making in terms of decision quality, satisfaction and utility. Trust has a positive impact on knowledge sharing, when members care about each other, an individual team member will be more willing to spend effort in providing knowledge [12].

Like trust, knowledge sharing has a positively affect team performance. Group decision-making requires team members to play different roles in a group, while sharing knowledge in order to obtain high quality decisions. Also, effective knowledge sharing is positively associated with decision outcomes. Thus:

H5.

High levels of mutual trust will lead to an increase in GVT performance in diverse GVTs (mediating effects).

H6.

High levels of knowledge sharing will lead to an increase in GVT member satisfaction in diverse GVTs (mediating effects).

4. Research methodology

4.1. Data collection

Hypotheses were tested using a field survey [18] because we found that it was necessary to obtain real world knowledge about GVTs.

In order to balance the data requirements of our study and requests of management that we minimized time demands on employees, an *informant sampling approach* was adopted. This recognized that a sample of the most knowledgeable people in the group could be used to represent responses to all questions about the activities of interest [28]. In this part of the survey, the inter-rater reliability can be assessed and, if convergence is demonstrated, a *balanced perspective* can be obtained by averaging informants' perceptions. Thus, all items in our instrument/questionnaire were framed as applicable to *informants* rather than *respondents* and team-members evaluated their team rather than their own behavior or attitudes.

Normal good practice was used in developing an instrument with desirable properties; IS research was surveyed to help in developing the questionnaire. The conceptual definitions of the constructs were examined and identified dimensions were verified. Items that captured the domain and had high reliability were selected.

4.2. Pre-test

The instrument was pre-tested in order to refine the items in terms of wording and conveying the overall meaning. Four graduate students, four faculty members, and two industry executives tested the instrument and, based on their recommendations, the instrument was refined. An important modification was the use of 7-point rather than a 5-point Likert scale to assess the responses. All the recommendations were considered and necessary changes were made.

4.3. Pilot study

A pilot study was conducted using an online version of the instrument with software development teams in South Asia. A total of 11 teams representing 22 team members completed the online instrument. The average team size was 7 members and average team tenure was 5.3 months.

Qualitative open-ended questions were collected from team members. Their wording, meaning, and understandability were discussed; some managers rewrote questions while others contacted the researchers for clarification. Thus a number of items were reworded.

4.4. Instrument

The final instrument (see Appendix A) consisted of 38 items with responses measured on 7-point Likert scale; it was administered to various GVTs in several multi-national organizations. Table 1 presents the items, their definitions, some literature references, and the number of items. All of the items together represent the underlying constructs of the instrument [21].

Table 1
Instrument constructs and items.

Construct	Definition	Reference	Item #
Functional diversity	Degree to which team members differ in their backgrounds	[11]	3
Deep level diversity	Degree to which team members differ in individual characteristics; e.g., idiosyncratic attitudes, values, and preferences	[15]	9
Mutual trust	Degree of confidence and willingness between partners		4
Shared knowledge	Degree of understanding or appreciation among team members for the issues that affect performance		3
Task interdependence	Degree to which team members interact and depend on one another to complete the task		3
Collaborative technology	Degree to which a technology is perceived to support team processes	[25]	6
GVT effectiveness	Team-produced output (performance) and consequences to team members (satisfaction)		10

Senior executives were contacted in many organizations soliciting their approval of employees to participate in our study. Positive respondents were asked to provide the names of a responsible external manager and the team members. If the participating organization asked for it, they were to be provided with an executive report giving our results and how their teams compared to the sample. Generally, the survey was administered electronically: this constituted a convenient, effective, sample of global virtual teams and their members.

A total of 213 usable responses from 58 teams were collected and analyzed. The average number of informants per team was 4. The sample consisted of 70% males and 30% females. A little more than half of the sample was from 25 to 35 years old, with 31% between the 35 and 45 years, and 11% older than 45. Forty-five percent reported being Asian, 37% White or Caucasian, 8% African Americans, and 8% Hispanics. Data was reported on functional area background; a majority, about 44%, belonged to IS departments. Others were in Engineering: 13%, with R&D and management being 10%. GVTs cut across many functional areas. 58% had some form of graduate degree, 32% reported undergraduate studies, and 5% had doctorate degrees. Overall, 29 organizations participated in our sample.

The IS industry was heavily represented in our study (41%). Manufacturing was involved in 17%, Telecommunications in 21%, and Banking and Finance in 14%. The average team size was 11.2 members and average team tenure was 9.2 months. Our sample had members from 15 countries and some teams spanned 4 countries.

5. Results

The survey scales were assessed for reliability, construct, convergent, and discriminant validity to ensure that they could be used to test our hypotheses. The ability to aggregate the individual

level responses to provide a group level response was assessed using James $R_{wg}(J)$ index, with ICC(1) and ICC(2). Once these were confirmed, hypotheses testing for moderator and mediator effects were conducted using Hierarchical Multiple Regression Analysis (HMRA).

5.1. Scale validity

To assess the validity of the scales, a four-step approach was undertaken.

Cronbach's α was used to establish internal consistency. Our reliability coefficients for the different variables ranged between 0.64 and 0.93 and thus we considered them good.
Next, item-to-corrected total correlations were examined to assess its construct validity. We subtracted the item value from its total score in order to avoid spurious part-whole correlation and calculated the corrected item total score; this was then correlated with the item score. All our item-to-corrected total variable correlations were under the acceptable limit of 0.4.

The analysis of the GVT effectiveness construct was performed at two levels, the higher one represented by GVT effectiveness and at the construct level represented by GVT member satisfaction and GVT performance. For the construct level, a higher level of cutoff of 0.5 was preferred, since items should directly measure the construct. Low correlations among the items belonging to these two constructs were not observed; it was therefore possible to combine them into a single construct. Results from exploratory factor analysis were analyzed to make a decision.

Principal components factor analysis with Kaiser criterion and VARIMAX rotation was conducted. The three items representing functional level diversity produced a single factor structure with factor loading ranging from 0.74 to 0.84, and nine items measuring Deep level diversity loading on a single factor, with loading ranging from 0.61 to 0.89. The four items measuring variable mutual trust loaded on a single factor with factor loadings ranging from 0.74 to 0.86. Shared knowledge was measured by three items and had factor loadings ranging from 0.82 to 0.86. Task interdependence was represented by three items with a single factor structure and factor loading ranging from 0.83 to 0.89. The six items measuring collaborative technology loaded on a single factor with loadings ranging from 0.66 to 0.85. GVT effectiveness was represented by two constructs: GVT performance and GVT member satisfaction, but ultimately represented a single factor structure with loadings ranging from 0.56 to 0.86. All the items from the two constructs loaded on a single component, with the exception of one item. Therefore, we decided to merge these two constructs under a single construct: *global virtual team effectiveness*.

Then we examined the convergent and discriminant validity using a multitrait–multimethod matrix approach. For every construct, the correlations on the validity diagonal were higher than zero ($p < 0.001$), establishing convergent validity. Based on this, minor modifications were made, such as merging GVT performance and GVT member satisfaction into GVT effectiveness.

Finally, reliabilities of all the scales was reassessed and analyzed to determine a more reliable scale for measurement of the variables and constructs (see Table 2).

Table 2
Instrument reliabilities ($N=213$).

Construct	# of items	Reliabilities
Functional level diversity	3	0.81
Deep level diversity	9	0.94
Mutual trust	4	0.89
Shared knowledge	3	0.88
Task interdependence	3	0.89
Collaborative technology	6	0.86
GVT effectiveness	10	0.86
Total	38	0.87

5.2. Data aggregation

The most common indicator of the validity of aggregated group-level constructs is within-group agreement; i.e., the degree to which raters provide essentially the same rating. A measure of within-group agreement is the $R_{wg}(J)$ index, obtained by comparing the observed variance on a set of items in a group to the variance that would be expected if the group members responded randomly. The higher the $R_{wg}(J)$ value, the more group members agree about the value of the target variable: values of 0.70 or higher are considered to show satisfactory agreement.

To further assess the degree of variability in responses at the individual level that must be attributed to team membership, interclass correlation coefficient (ICC) values were computed. These depend on both within- and between-group variance. ICC yields a single value for the entire sample. ICC(1) may be seen as a measure of inter-rater reliability and may be considered as a criterion for aggregating. Alternatively ICC(1) has been considered the proportion of total variance that can be explained by group membership. A range of 0.0–0.5 being considered appropriate. Also reliability of the group means, as measured by ICC(2) was computed. This pertains to the reliability of the means and not to the agreement among individuals, and teams can be differentiated in terms of their responses. As may be seen in Table 3, the inter-rater agreement coefficient, $R_{wg}(J)$, for all the variables and constructs was above the acceptable standard of 0.70, suggesting that informant ratings within a given team were highly consistent with each other and also that the ICC(1) values were within the prescribed range. ICC(2) values above 0.50 are generally considered to be valid.

Table 3
Data aggregation $R_{wg}(J)$, ICC(1) and ICC(2) ($N=213$).

Construct	$R_{wg}(J)$	ICC(1)	ICC(2)
Functional diversity	0.80	0.16	0.40
Deep diversity	0.69	0.06	0.19
Mutual trust	0.90	0.13	0.74
Shared knowledge	0.91	0.15	0.95
Task interdependence	0.90	0.14	0.86
Task complexity	0.93	0.11	0.61
Collaborative technology	0.94	0.12	0.63
GVT effectiveness	0.83	0.07	0.64
Overall	0.86		

Mean, standard deviations, and correlations for the aggregate variables are provided in Table 4.

Table 4
Descriptive statistics ($N = 58$ teams).

	Mean	Std dev	Functional diversity	Deep diversity	Mutual trust	Shared knowledge	Task inter-dependence	Collaborative technology
Functional diversity	5.05	0.67	1					
Deep diversity	3.21	0.69	0.15	1				
Mutual trust	5.48	0.36	0.09	−0.0.46**	1			
Shared knowledge	5.48	0.32	0.16	−0.32*	0.83*	1		
Task inter-dependence	5.44	0.36	0.05	−0.51**	0.77**	−0.84**	1	
Collaborative technology	5.5	0.37	0.60**	−0.046	0.47**	0.56**	0.28*	1
GVTE effectiveness	5.09	0.46	0.03	−0.040	0.37**	0.47**	0.41**	0.27*

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

5.3. Hypotheses testing

Team size and *tenure* were used as control variables. It is important to control for team size because large teams may find it hard to develop a trusting relationship among team members. Also, team tenure is important, because the longer the team has been in existence, the longer its members have interacted and had time to develop harmonious relationships.

To test Hypotheses H1a and H1c, mutual trust was regressed on *functional* and *deep-level* diversity. Analysis showed that the higher the deep level diversity, the lower the mutual trust among its members (β: −0.25, $p < 0.001$, $R^2 = 0.22$), supporting HypothesesH1c. However we found no support for H1a.

To test Hypotheses H1b and H1d, knowledge sharing was regressed on *functional*- and *deep-level* diversity. Analysis showed that the higher the deep level diversity in the group, the lower the level of shared knowledge among its members (β: −0.15, $p < 0.01$,$R^2 = 0.11$), thus supporting H1d. However, there was no significant support for H1b.

Because of the lack of support for relationships between functional level diversity and mutual trust and shared knowledge, analyses for effects of functional diversity were not performed; i.e., Hypotheses H2a, H2b, H3a and H3b, were not tested. Functional level diversity was used as a control variable in testing the remaining hypotheses.

H2 and H3 primarily involved analyzing the moderating effects of task interdependence and collaborative technology on the relationship between diversity, mutual trust, and shared knowledge. Moderator variables should be independent and not correlated with predictor or criterion variables. Unfortunately, in our analysis, these criteria were not completely met; therefore we centered the moderator variables to reduce their effects of co-linearity. Two interaction terms were created: “deep level diversity x collaborative technology” and “deep level diversity × task interdependence”.

For Hypotheses H2c and H2d, tests were conducted as follows:

1. Control variables: team size, team tenure, and functional level diversity were entered into the regression equation.

2. Main effects for deep level diversity and task interdependence were entered.

3. The interaction effect for deep level diversity and task interdependence was entered.

4. To test for the moderator effect, the single degree freedom *F* test was examined for significance.

Analyses were conducted separately for H2c using mutual trust as a dependent variable and for H2d using shared knowledge as a dependent variable.

Table 5 presents the moderator analysis for task interdependence. Task interdependence showed significant evidence for moderation for both dependent variables ($F = 16.4$, $p < 0.001$ for mutual trust and $F = 39.0$, $p < 0.001$ for shared knowledge).

Table 5
Moderator analysis for task interdependence.

Independent variables	Regressing mutual trust on diversity, task interdependence	Regressing shared knowledge on diversity, task interdependence
	β	*β*
Step 1: Control variables		
Team size	0.00	−0.00
Team tenure	0.01	−0.00
Functional level diversity	0.02	0.04
F(Model)	0.24	0.86
Step 2: Main effects		
Deep level diversity	−0.07	0.03
Task interdependence	0.78	0.88
F(Model)	16.9***	28.8***
Step 3: Interactions		
DL diversity × task interdependence	−0.20	−0.26
F(Model)	16.4***	39.0***

Only unstandardized coefficients reported.
*** Significant at $p < 0.001$.

Similarly, for Hypotheses H3c and H3d, the moderating effects of collaborative technology on dependent variables mutual trust and shared knowledge were tested. Table 6 depicts the moderator analysis for collaborative technology. Collaborative technology showed significant moderation effect for both mutual trust ($F = 9.39$,$p < 0.001$) and shared knowledge ($F = 7.81$, $p < 0.001$).

Table 6
Moderator analysis for collaborative technology.

Independent variables	Regressing mutual trust on diversity, collaborative technology	Regressing shared knowledge on diversity, collaborative technology
	β	β
Step 1: Control variables		
Team size	0.02	0.01
Team tenure	0.00	−0.01
Functional level diversity	−0.14	−0.04
F(Model)	0.24	0.86
Step 2: Main effects		
Deep level diversity	−0.17	−0.16
Collaborative technology	0.62	0.60
F(Model)	10.35***	9.51***
Step 3: Interactions		
DL diversity × collaborative technology	−0.300	0.06
F(Model)	9.39***	7.81***

Only unstandardized coefficients reported.
*** Significant at $p < 0.001$.

For Hypotheses H4 about the positive relationship between mutual trust and knowledge sharing, step-wise regression analysis was conducted. The analysis provided significant support for the relationships ($F = 27.24$, $p < 0.001$) thus supporting H4.

Hypotheses H5 and H6 involved detecting mediator effects. They were tested using GVT effectiveness as a single composite variable and using the four-step mediated regression approach. The first step is to show that there was a significant relation between the predictor and the outcome (path c). The second step was to show that the predictor was related to the mediator (path a). The third step was to show that the mediator was related to the outcome variable, and it was estimated by controlling for the effects of the predictor on the outcome (path b). The final step was to show that the strength of the relationship between the predictor and outcome was significantly reduced when the mediator was added to the model (path c′). If the variable was a complete mediator, then the relation between the predictor and the outcome would not differ from zero after the mediator was added to the model (comparing path c with path c′).

Table 7 presents the results from the mediated regression analysis for mutual trust (H5). First, model 2 tested the significance of path c. It was significant with an F value of 0.61 ($p < 0.1$). Thus step 1 was established. Second, the significance of predictor–mediator relationship was to be established (path a). Model 1 had an overall F of 4.70 significant at$p < .001$ level. Thus step 2 was successful. Model 3 tests for both paths b and path c in the same equation. In model 3, the F value of step 1 model was 2.63 significant at $p < .05$ level which established the significance of path b. Also the coefficient of the mediator variable, mutual trust, was positive 0.56 and significant at $p < .001$. Further, the significance of path c′ was established by looking at the overall F of the model, which was 2.36 and significant ($p < .05$). Thus, mediation was supported.

Table 7
Mediator analysis for mutual trust.

Independent variables	Path a Model 1: Regressing mutual trust on diversity β	Path c Model 2: Regressing GVTE on diversity β	Path b and c′ Model 3: Regressing GVTE on diversity controlling for mutual trust β
Step 1: Control variables			
Team size	0.01	0.01	0.01
Team tenure	0.00	0.01	0.01
Functional level diversity	0.12	0.03	−0.04
Mutual trust			0.56***
F(Model)	0.24	0.77	2.63**
R^2	0.01	0.04	0.17
Adjusted R^2	−0.04	−0.01	0.10
Step 2: Main effects			
Deep level diversity	−0.27	−0.04	0.12
F(Model)	4.70***	0.61*	2.36**
R^2	0.26	0.04	0.18
Adjusted R^2	0.21	−0.03	0.11
ΔR^2	0.25	0.00	0.02

* Significant at $p < 0.1$, ** Significant at $p < .05$, *** Significant at $p < .01$.

A careful analysis of various coefficients clearly depicted the changes in the explanatory power of the model by including the mediating term. The coefficient of deep level diversity increased from −0.27 to 0.12, indicating the positive effect of developing mutual trust on GVT effectiveness.

The mediator analysis for knowledge sharing is shown in Table 8. In model 2, the F value of 0.61 was significant ($p < 0.1$). Thus step 1 was established. Model 1 had an F value of 3.11 significant at $p < .05$. Thus step 2 was supported. In model 3, the F value of the step 1 model was 5.32 significant at $p < .001$, establishing the significance of path b. The coefficient of the mediator variable, knowledge sharing, was positive at 0.81 and significant at $p < .001$. Further, the significance of path c′ was established by looking at the overall F of the model, which was 4.63 and significant at $p < .001$. Thus, mediation was once again supported. The coefficient of deep level diversity increased from −0.18 to 0.11, indicating the positive effect of knowledge sharing.

Table 8
Mediator analysis for knowledge sharing.

Independent variables	Model 1: Regressing shared knowledge on diversity Path a β	Model 2: Regressing GVTE on diversity Path c β	Model 3: Regressing GVTE on diversity controlling for shared knowledge Path b and c′ β
Step 1: Control variables			
Team size	0.01	0.01	0.01
Team tenure	−0.01	0.01	0.02
Functional level diversity	0.15	0.03	−0.09
Shared knowledge			0.811***
F(Model)	0.86	0.77	5.32***
R^2	0.05	0.04	0.29
Adjusted R^2	−0.01	−0.01	0.23
Step 2: Main effects			
Deep level diversity	−0.18	−0.04	0.11
F(Model)	3.11**	0.61*	4.63***
R^2	0.19	0.044	0.31
Adjusted R^2	0.13	−0.03	0.24
ΔR^2	0.14	0.00	0.02

* Significant at $p < 0.1$, ** Significant at $p < .05$, *** Significant at $p < .01$.

6. Discussion

Our study extended our understanding of team member diversity to the new organizational form of global virtual teams. Due to geographical dispersion and high use of IT, the transfer of knowledge and establishing mutual trust are difficult. We separately assessed the impact of two levels of diversity and tested the moderating role of collaborative technology and task interdependence on the relationship between member diversity and mutual trust and knowledge sharing. We showed that a relationship exists between mutual trust and knowledge sharing in these teams, and examined the mediating role of mutual trust and knowledge sharing on GVT effectiveness.

There was no effect of functional level diversity on mutual trust and knowledge sharing. The sample team members had an average tenure of 9.2 months and it is possible that the members may have overcome functional differences by then and were not letting these differences influence the level of trust and knowledge sharing. On the other hand, deep level diversity was found to be negatively associated with both mutual trust and knowledge sharing. If teams had been in existence for some time, members should be more aware of such differences and may be biased in their relationship with members of the team [17].

As expected, task interdependence and collaborative technology had a moderating effect on the relationship between deep level diversity and mutual trust and knowledge sharing. Task interdependence was found to have moderating effects on both mutual trust and knowledge sharing. With high task interdependence, team members overcome their individual diversity differences and collaborate effectively. At low levels, members tend to operate as individuals, thereby strengthening the negative relationship between deep level diversity and mutual trust and knowledge sharing. We found that high levels of collaborative technology weaken the negative relationships between deep level diversity and mutual trust and knowledge sharing.

The level of mutual trust was found to be positively related to knowledge sharing in global virtual teams. Thus our findings empirically support the theoretical claims that trust is essential for relationship building and team effectiveness.

It was evident from the analysis and comparison of regression coefficients that team effectiveness can be increased by increasing mutual trust among the members and enhancing shared knowledge among its members. Shared knowledge and mutual trust are components in collaborative value creation and managers should foster an environment that facilitates knowledge sharing and trust in teamwork [4]. In essence, collaborative creation is dependent on the degree to which people in the organization combine their emotional efforts to achieve common goals.

6.1. Implications for practice

Teamwork in the global workplace is challenging. Many managers have an ongoing struggle to build commitment to common goals, align and enforce performance expectations, build mutual trust, motivate members to share knowledge and navigate personality issues. Team members must be able to adapt to different work styles and cultures, leverage harmonious team processes,

and utilize appropriate technologies to create efficiencies in the global workplace. The findings from this study are an important step in this direction. Managers and stakeholders who are involved in the functioning of global teams need to understand diversity and its various forms. Managers should understand the potential presence of deep level attributes in team members and as such, training should be provided to help in the process of relationship building among team members. Furthermore, managers themselves should be trained and advised on the development and improvement of team processes in order to reap greater effectiveness and returns from their teams. Managers also need to understand the interaction between team diversity and task requirements; our results suggest that more diverse teams can be entrusted with interdependent tasks that require higher levels of motivation from the members.

Global virtual teams usually rely on technologies, such as email and group decision support systems. Our findings suggest that decision makers should focus on the collaborative aspects of the technology. For example, managers should select a technology that promotes parallelism, transparency, and sociality. Designers of communication technology should incorporate such features when developing new technology. Once the technologies have been selected, managers need to provide training to promote the use of these new features.

6.2. Contribution to research

Research findings on diversity within teams have been divided into optimistic (focusing on diverse teams' access to resources providing increased creativity, innovation, and performance) and pessimistic (focusing on affective problems, as predicted by the similarity attraction paradigm and social categorization theories) [14]. The findings from our study support the optimistic camp and the claims that greater diversity entails relationship building among team members and leads to increased team effectiveness. By broadening our view to include types of diversity, and by focusing more carefully on mediating and moderating mechanisms, we provided results that examine the effect of diversity at functional and deep levels. Moderator effects of task interdependence and collaborative technology were analyzed and the mediating role of mutual trust and knowledge sharing was established. Our results extend the diversity research to organizational forms which face an increased challenge in diversity management.

6.3. Limitations

One limitation of the study is its sample size and sample characteristics. Even though the findings are based on 213 individuals, the team level analysis was reduced to 58 teams. Although this sample size is similar to previous studies, the statistical power of the analysis is limited. A non-probability sampling approach was used; therefore statistical inferences from the study should be cautiously approached. Random sampling was not an option, since our study involved a sampling frame of world-wide virtual teams. While we attempted to gather a sample from various industries, it was a secondary consideration.

Another limitation is common method variance. It may be a result of the reliance on self-reported measures. This is generally attributable to survey based research. Since all items are seeking responses from team members on team level constructs, respondents might be biased in their reporting. Podsakoff et al. [22] state that common method variance is a potential problem in

behavioral research. They identify four sources of it as: arising from having a common rater, measurement context, item context, and arising from the characteristics of the items themselves. One solution is to have team supervisors' respond on the dependent variables and team members' respond on the independent variables. However, due to supervisors' lack of availability, such separate responses were not feasibility. In order to assess the common method variance and similarity of responses from team stakeholders and team members, a *t*-test was conducted between two data sets: 7 responses from stakeholders and responses from members of the 7 teams, to test for differences. The *t*-test statistic was not significant, confirming our assumption that the means between stakeholder response and member response were not different.

A final limitation relates to the treatment of non-response bias. Non-response for teams not responding was not of concern as there were no teams that did not respond. Non-response by members within a team can be problematic. Thus prior to aggregating individual responses to the group, within-group agreement was analyzed to assure that perceptions of the team construct were sufficiently similar. James index $R_{wg}(J)$ and ICC(1) and ICC(2) values were calculated and reported. The values supported within-group agreement.

7. Conclusion

The purpose of our research was to understand the different facets of diversity present in global virtual teams and to show how differences among individual members can be harnessed by developing a trusting and sharing environment, leading to greater GVT effectiveness. Furthermore, in understanding the relationship between mutual trust, knowledge sharing, and diversity, our research demonstrated the moderating effects of collaborative technology and task interdependence. We explored the mediating effects of trust and knowledge sharing in mitigating the negative effects of diversity in the team and found that it is essential in such an environment to motivate mutual trust and knowledge sharing. We also established that task interdependence and collaborative capabilities of technology have significant impact on the functioning of team processes.

Appendix A. Instrument items and factor loadings

Functional diversity	
Members of the team are similar in terms of their functional expertise	0.85
Members of the team are similar in terms of their educational background	0.86
Members of the team are similar in terms of their length of organizational experience	0.74
Deep level diversity	
Members of the team are similar in terms of their personal values	0.88
Members of the team are similar in terms of their personalities	0.89
Members of the team are similar in terms of their attitudes towards the project	0.90
Members of the team are similar in terms of their attitudes towards project goals	0.89
The well being of fellow team members is important to members of the team	0.83
It is important for members to maintain harmony within the team	0.77
Members of the team like sharing information with my fellow team members	0.73
It is important for members to consult other team members before making a decision	0.73
Members help fellow team members in their time of difficulty	0.62
Mutual trust	
Team members in this team are considerate of other's feelings	0.85
Team members are friendly towards other	0.79
Team members can rely on fellow team members	0.86
Members in the team are trustworthy	0.74

Shared knowledge	
Members in this team share work reports, methodologies, and official documents within the team	0.86
Members of this team share their functional experience and know-how with others on the team	0.82
Members of this team share their knowledge from education or training with other members of the team	0.85
Task interdependence	
Members of the team have to rely on information or material from other others within the team	0.89
Tasks performed by team members are related to one another	0.89
Members have to obtain information and advice from other team members in order to complete the assigned task	0.84
Collaborative technology	
Team members are equipped with adequate tools and technologies to perform their tasks	0.67
Technology enables team members to work on different subtasks simultaneously	0.81
Technology enables team members to view other's work whenever mutually desirable	0.85
Technology enables team members to modify other members' work whenever desirable	0.74
Technology enables the development of social relationships among team members	0.77
Technology enables the sharing of knowledge among team members	0.80
GVT effectiveness	
In the past, the team has been effective in reaching its goals	0.78
The team, at present, is meeting its business objectives	0.84
Completion of work is generally on time	0.86
Completion of work is generally within the assigned budget	0.85
In the past, the team has been efficient in performing the task	0.83
The team, at present, is producing work of the highest quality	0.86
Each member's input is valued by the team	0.84
The team members' morale is high in this team	0.81
Members enjoy being a part of this team	0.78
Members would be interested in participating in another virtual team in future	0.56

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