

Multitasking and Innovation in Virtual Teams

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Abstract

The limits of human multitasking capabilities in intense conditions are well understood. However, little is known about how increasing and continuous multitasking impacts innovation in virtual teams. During this investigation, we developed a construct called Virtual Distance to understand how both perceived and physical distance impacts innovation on virtual teams and applied it to 223 individuals and managers at seventeen organizations. We then explored Virtual Distance as a moderator of the relationship between Multitasking and Innovation. Our results showed that Virtual Distance has a significant and negative relationship to Innovation. We further found that Virtual Distance significantly moderated the relationship between Multitasking and Innovation. When Virtual Distance is low, there is a positive relationship and when Virtual Distance is high, there is a significant curvilinear relationship. The results have implications for the selection of virtual team members and virtual project management activities when critical project outcomes include Innovation.

Introduction

The use of virtual, distributed teams is rapidly growing. According to recent figures [1], about 12% of the U.S. workforce qualifies as distributed. In urban areas the estimate is 15% and it is predicted that 40% will be distributed by 2012. At some companies, like IBM, 40% of the workforce is already working virtually. At Sun Microsystems, nearly 50% of employees can work from home, cafes, drop-in centers and other locations. Intel reports that over 70% of their global workforce is considered virtual. Accenture reported that they have no physical space and meet each other while crossing paths traveling from client to client across the globe [2].

This trend is challenging large companies to find management tools best suited for virtual teams in the Digital Age [3] and at the same time sustain competitive advantages and innovation in an increasingly global business environment. Success is

highly dependent on the use of virtual teams in a variety of projects including new product development [4] and application software development [5]. In addition, globalizing the innovation process using virtual resources has become an important way to access diverse talent pools and has become an imperative for companies that seek success in this market [6].

The study of innovation is varied and encompasses many different areas of focus including but not exclusive of diffusion, adoption, “innovating” and “innovativeness” [7]. We sought to uncover some of the relationships between distance and innovation activities involving project teams that had a virtual component. Specifically, we wanted to understand the dynamics of perceived as well as physical distance on innovation. We further sought to understand how multitasking impacts innovation in virtual teams.

Virtual Teams, as reported in this study, include members that use electronic communications for some or all of their interactions with other team members. Therefore we considered team members that were co-located as well as teams that were physically and temporally distributed.

Background

It has been argued that virtual proximity, connectedness facilitated by the use of Information and Communication Technology (ICT), cannot completely substitute for physical proximity when it comes to innovation and learning [8]. Quinn argues that services companies (the majority of firms represented in our sample) are particularly dependent on software innovations [9]. For example, the banking industry is becoming more dependent on innovations derived from ICT [10]. Global services companies are expanding their use of distanced workers; depending more on outsourcing and global virtual teams to develop application software. However much of the management literature does not generally look closely at innovation activities in these environments [11].

Innovations in software development at the project level eventually translate into organizational

innovations or new product offerings. We sought to understand innovation activities in these environments by analyzing how team members perceived their ability to express and share innovative and creative ideas with other team members in order to solve problems and achieve project goals. So in this study, the propensity to innovate, or Innovative Behavior, was used as a proxy for innovation at the project team level.

Multitasking has also intensified during this age of globalization, virtual communications, outsourcing, and higher productivity. However little is understood about how multitasking in virtual teams impacts innovation. Having access to the internet and work devices twenty four hours a day, seven days a week has imposed increasing levels of multitasking on virtual team members. Yet we do not yet have a good theoretical grasp on the limits of human performance under such circumstances [13].

While there is a wide body of research regarding human workload limits in circumstances that require intense bursts of concentration such as fighter cockpits [14], investigations need to be extended into the realm of virtual teams when everyday demands vie for members' attention on a continual basis.

Human and organizational limits are also described in absorptive capacity, "the company's ability (via its collective employees) to absorb or exploit available information for the development of new products." [15]

Innovation through knowledge sharing fuels competitive advantage. Knowledge sharing is an inherent feature of absorptive capacity. However, virtual or distant relationships, such as those found in outsourcing, subjugate individual knowledge acquisition and storage to outside organizations or distanced work groups and this may have a negative impact on the company's absorptive capacity [15] and therefore on innovative performance as well.

Multiple project participation is also important to enhancing absorptive capacity because acquiring and storing knowledge among team members is not usually developed with just one group or through single projects [15]. So we would expect to see that multiple project assignments add value to innovation through more extensive and diverse knowledge sharing.

However, an increasing number of virtual projects and multiple project assignments may also lead to potential problems for virtual team members [16]. One factor that has been found to have an effect is perceived distance. As described in Evaristo and Scudder in their Dimensions of Distributedness, perceived distance is shown to be a key component of understanding distributed project management [17].

Perceived distance between one team member and another can be influenced by a variety of factors. These include spatial, temporal, technical, organizational and social factors that shape the perceptions of individuals engaged in collaborative work.

In the present investigation we explored how these factors collectively impacted work related attitudes, behavior and performance. Based on a review of management, information systems and psychological literature and several dozen interviews with senior executives responsible for virtual teams, we identified the factors described below, as most likely to influence the perception of distance between team members.

Spatial (Geographic) Distance

Research suggests that physical separation or closeness is of great importance to interactions and that the closer one is physically to another, the greater the chance to form social ties [20]. Physical distance also impacts the tendency to deceive, ability to influence and the likelihood of cooperation [21].

Temporal Distance

Differences in time zones amongst virtual team members is often cited as one of the factors that play a role in virtual team interactions [22, 23]. It has also been suggested that temporal distance be considered when structuring organizations [24], globalizing an organization [25], and assessing team boundary issues [26].

Relational Distance

Relational distance refers to the difference between team members' organizational affiliations. For example, an employee of a company is relationally closer to another employee of the same company versus an outsourced employee. Relational distance has been shown to play a key role in social cohesion [27], information systems networks, as well as leader effectiveness [28].

Cultural Distance

Cultural differences have to date, been a focus of some of the research in virtual environments and innovation; virtual teams [29, 23], new product teams [4], risk mitigation [35], virtual societies [31], consensus building using group support systems [32],

majority influence [33], software development [34] and more. Cultural distance has also been used to study foreign investment expansion, entry mode choice, and the performance of foreign invested affiliates, among others [35]. Cultural distance is also used to interpret network ties amongst managers [36].

Social Distance

Social distance has been studied in a number of contexts including economically defined class or status differences [37], feelings of social closeness and distance based on social interactions in social space [38], as a factor in direct and networked exchanges [39], as a function of management [40], a dimension of the Systematic Multiple Level Observation of Groups (SYMLOG) management behavior assessment [41], as a perceived measure contributing to the concept of leader distance [42], and as a factor in friendship networks [43].

Relationship History

One indicator of social distance is relationship history. This includes both the extent to which members have had a prior relationship or relationships with some of the same people. Relationship history has been shown to be important in mentoring [44] and trust building [45]. Relationship history has also been found to positively impact openness, trust, and information sharing in computer-mediated teams [46].

Task Interdependence

Interdependent tasks require more communication [47], which should lead to decreased distance between team members. Task interdependence has also been related to both organizational commitment and team commitment and organizational citizenship behavior [48, 47].

Face to Face (FTF) Interaction

The notion of social presence has been used in research on virtual work to describe the extent to which team members feel the presence of other group members and the feeling that the group is jointly involved in communicating [49,50] . One end of the continuum of social presence is FTF so frequency of FTF interaction should be related to perceptions of distance.

Technical Skill

Studies have shown that a member's comfort level with technology plays a role in their interactions with distant team members [51]. Less technically competent team members may be less inclined or able to communicate and form the kinds of relationships that would decrease social distance. Major corporations have also found that technical and interpersonal skills are important to the selection of virtual team members who are likely to be committed to the project and to each other [52].

In addition to the various views on stored knowledge and learning as reflected in an organization's absorptive capacity, and an emerging body of literature on multiple project management and distributed projects and the effects of perceived distance, there is disagreement about how multitasking impacts virtual team members.

Tang describes two opposing effects of multitasking; "Multitasking Attention Deficit" and "Multitasking Attention Dexterity" [13] suggesting that multitasking might have different impacts on individuals under a range of conditions.

Linda Stone describes one artifact of multitasking in the Digital Age as "continuous partial attention", underscoring the on-going nature of multitasking in today's work settings which can have both positive and negative influences on team members and other organizational resources [19].

The conflicting discussions of multitasking and varying views on perceived distance, multiple project assignment and their effects on innovation in virtual teams have yet to be resolved through a parsimonious explanation. This study was conceived to take a step toward doing so.

Research Approach

We first took the perceived distance factors described in the previous section together to form the multi-dimensional construct, Virtual Distance.

Virtual Distance enabled us to look more closely at the combined effect of real physical and temporal distance related issues (as noted in much of the literature as the primary building blocks upon which virtual teams are formed) and the effects of perceived distance which is often missed.

Subsequently, we measured Virtual Distance as an independent variable against Innovation. Innovation was operationalized using Innovative Behavior as a proxy.

Our approach is supported by other research. For example, in a recent innovation study findings showed that companies with strong innovative performance exhibit certain characteristics; one of them being that organizational members perceive the innovative climate as open and feel free to behave in such a way as to share new ideas and take creative risks [12].

To some extent, Innovative Behaviors are similar to Organizational Citizenship Behaviors (OCBs) in that they are outside the prescribed roles assigned to team members. Thus, we expected that Multitasking and Virtual Distance would play a role in Innovative Behavior.

Innovative Behavior was measured using three items including: "I felt free to express new ideas about how to solve problems", "My teammates often shared new ideas with each other", and "Innovative solutions to problems were encouraged."

H1: Virtual Distance will have a significant and negative effect on Innovation.

We then explored the Virtual Distance construct as a moderator between Multitasking and Innovation. We sought to both describe and provide some explanations for variations in innovation that are related to increasing levels of multitasking in virtual teams.

Since there are differing arguments related to the impact of multitasking on behavior, we hypothesized that Multitasking would have both a positive and a negative effect on Innovation depending upon varying levels of Virtual Distance.

Given that multiple project groups are shown to enhance knowledge sharing and absorptive capacity [15], we hypothesized that when Virtual Distance was low, Innovation would be positively effected.

However, given that perceived distance can influence multiple project management and that knowledge acquisition and tacit knowledge sharing among virtually distant team members may become harder to sustain as multitasking leads to more complex interactions [18], we hypothesized that when Virtual Distance was High, Innovation would be negatively impacted.

Multitasking was operationalized as multiple project assignment and multiple deliverables due concurrently. Items for Multitasking included, "I usually have multiple deliverables due at any given time" and "While working on this project I was assigned to several other projects."

H2a: When Virtual Distance is low, increasing levels of Multitasking will have a significant and positive effect on Innovation

H2b: When Virtual Distance is high, increasing Multitasking will have a significant and negative effect on Innovation.

Method

A survey was developed to collect the data. The survey was first tested with 36 Master Degree students representing manager level and above at companies headquartered in the Northeast attending the Stevens Institute of Technology. The survey was then modified to improve reliability and a large sample of project teams was obtained through recruiting efforts by the primary investigator. Participants were directed to a website developed by the investigator and the survey was completed on-line.

A total of 360 surveys were completed. However, after data cleansing procedures were applied, 233 surveys were available for analysis. Participants included individuals working on a variety of projects. Industries included Financial Services 41%, Software, Telecommunications and University, 7% each, Outsourcing and Services, 5% each, Med. Devices, 4%, Aerospace, Govt. Specialty Chemicals, 3% each, Manufacturing, Publishing, Packaged Goods, Marketing, NGO, Media, Consulting, & Engineering, 1% each.

Most of the respondents worked in technology-related fields and held positions ranging from Vice-president to programmer. Seventeen different organizations were represented. The two largest functional areas represented included Information Technology (33%) and Engineering (15%). Respondents' organizations also varied considerably in size with half having less than 5,000 employees and half more than 5,000 employees.

Procedure

All respondents were asked to complete a web-based questionnaire describing their organization, current position and their experiences with a recently completed project. Eight scales measuring individual distance components were included in the questionnaire. The measure of Virtual Distance, the Virtual Distance Index (VDI), was calculated as a simple linear composite of each of the standard scores for the distance variables described earlier. Each of the variables in the model was first converted to a standard score and all scores were averaged with appropriate

positive or negative sign so that higher average VDI scores indicated greater Virtual Distance. We also measured Multitasking and Innovation using the items described in the Research Approach section.

Internal consistency reliabilities, means and standard deviations and intercorrelations were calculated for all variables and are shown in Table 1.

Table 1 - Means, Standard Deviations and Intercorrelations for Key Variables

Variable	Mean	SD	VDI	Innov	Mult
VDI	45.71	6.08	(.88)	-.40**	-.13*
Innovation	3.96	0.65		(.79)	.19**
Multitasking	4.05	0.87			(.67)

** = significant at $p < .01$; * = significant at $p < .05$
 Cronbach's alpha shown in parentheses for all variables except VDI. VDI reliability was estimated as $1 - \sum VE_i / V_i$; where VE is the error variance for each of the eight components and V is the variance for VDI.

Because our hypothesis was that the functional relationship between Multitasking and Innovation would differ depending upon the level of Virtual Distance, we used a hierarchical regression procedure that accounted first for the linear relationships, next for the non-linear relationships, next for the linear interaction between Virtual Distance and Multitasking and finally the interaction between Virtual Distance and the non-linear (quadratic) component of Multitasking. The methodology was consistent with a method suggested by Lubinsky and Humphreys [53].

Table 2 – Summary of Hierarchical Regression Analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.397 ^a	.158	.154	.59807	.158	4.066	1	219	.000
2	.388 ^b	.156	.151	.60921	.001	1.67	1	218	.883
3	.408 ^c	.167	.155	.59756	.008	2.134	1	217	.145
4	.433 ^d	.188	.173	.59141	.021	5.608	1	216	.019
5	.493 ^e	.244	.226	.57209	.056	15.834	1	215	.000

- 1. Predictors: (Constant), hindex
- 2. Predictors: (Constant), hindex, multitask
- 3. Predictors: (Constant), hindex, multitask, vdis
- 4. Predictors: (Constant), hindex, multitask, vdis, vdmult
- 5. Predictors: (Constant), hindex, multitask, vdis, vdmult, vdmult2

Results

It can be seen in Table 1 that Virtual Distance has a significant negative effect on Innovation.

However, we were specifically interested in the role that Multitasking played in Innovation as Virtual Distance changed. A hierarchical regression analyses was performed for this purpose with Innovation as the dependent variable.

The results for the hierarchical regression listed in Table 2 show that there is a significant interaction between Virtual Distance and the linear term for Multitasking as well as a significant interaction between Virtual Distance and the quadratic term for Multitasking.

These results suggest that the relationship between Multitasking and Innovation is different depending upon the level of Virtual Distance.

Figures 1 and 2 below show the curves for two sub-samples split at the median on Virtual Distance.

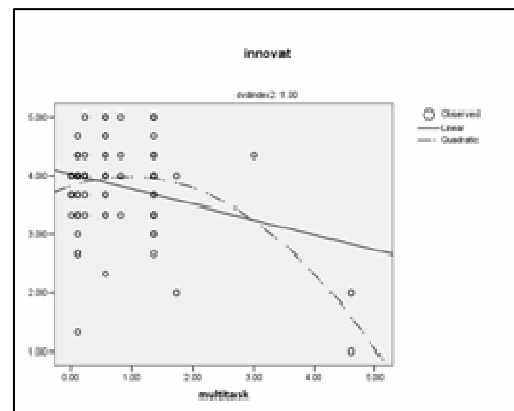


Figure 1 - Multitasking vs. Innovation under High Virtual Distance

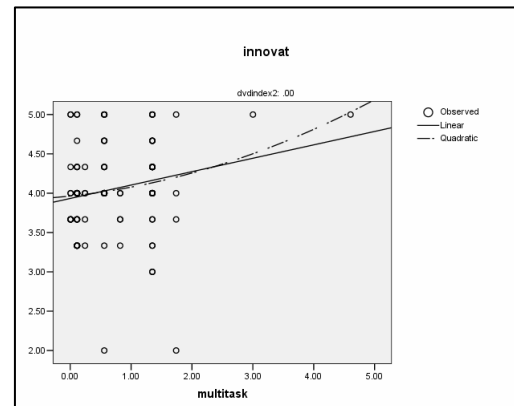


Figure 2 - Multitasking vs. Innovation under Low Virtual Distance

In the low Virtual Distance condition the relationship is essentially a modest linear function. The linear correlation between Multitasking and Innovative Behavior was .20 ($p < .01$). As Multitasking increases Innovative Behavior also increases. The quadratic term was not significant in the low Virtual Distance condition.

The high Virtual Distance condition presents an entirely different story. When Virtual Distance is high Multitasking has a slight improvement on Innovative Behavior but as the project load becomes greater Innovative Behavior declines sharply.

Because Virtual Distance includes a diverse set of variables we conducted an exploratory factor analysis of the major components of Virtual Distance that yielded three orthogonal factors based on the scree plot. The first factor is essentially a Relationship factor and includes Relationship History, Face to Face versus electronic conversations, and team member collocation and same organizational affiliation.

The second factor was interpreted as a Shared Mental Model factor and included recognition that goals and objectives are interdependent, perception that values and communication styles are similar, and the extent to which status within the team is derived from one's contribution to team goals.

The third factor was a Media Technology factor and included one's skill with the communication media being used, the extent to which meetings took place through electronic media and the extent to which status was based on formal authority.

Discussion

A higher level of multitasking is one reason why productivity has dramatically increased over the past decade especially in companies that use information technology extensively [54]. With more work being accomplished with the same number or fewer resources, it is no surprise that multitasking has been rising. Anecdotal stories about the "out of control" nature of multitasking and its effects on activities such as critical thinking regularly appear in major newspapers [55]. An extensive set of literature on the subject of innovation also shows that to thrive and be competitive in the long-term, innovation is of paramount importance [56].

However our understanding of how virtual team performance and innovative behaviors are impacted by both geographic distance as well as perceived distance brought on by the pervasive use of ICT has not been well-understood. Moreover, the study of multiple

project management and multiple project assignments is also in its early stages.

Cases such as the development of the IBM PC [57] and the birth of the company Travelocity [58], suggest that reducing physical distances and distractions, such as multitasking, are important factors in innovation.

But do these relationships still hold in the face of globalization, the rising use of virtual teams and increasing leverage of outsourcing? As distance begins to take on new forms such as those described through Virtual Distance, it is important to understand the relationships between factors such as multitasking and critical outcomes such as innovation.

The low, positive relationship between Multitasking and Innovation may be explained by increased exchange of tacit knowledge, explicit knowledge sharing and building of absorptive capacity. Our results also show the relationship between Multitasking and Innovation differs sharply depending upon the level of Virtual Distance. Teams that are low in Virtual Distance tend to be familiar with each other and meet face to face or via phone on a regular basis. They share information and build knowledge continuously. When Virtual Distance is low team members have past, shared work experiences. So while knowledge sharing was expected to rise given the cross-pollination and new learning of team members working on multiple projects and tasks, the extent or degree to which they gained benefit from these increases was slight given prior relationships and work assignments.

Under conditions of high Virtual Distance the results were significantly different. At lower levels of Multitasking there was some positive benefit to Innovation. One reason may have been that increases in knowledge sharing occurred through multiple team membership and there was some initial development of absorptive capacity. However, these benefits quickly diminished for the virtual team member as multitasking increased.

When Virtual Distance is high, it is more likely that outsourcers and/or contractors are part of the team resource mix. So with more tasks to accomplish, more projects to keep track of, and more virtually distant resources working on projects without the benefit of past work experiences, absorptive capacity and knowledge sharing suffers. Absorptive capacity may significantly decline if the outsourcing element is especially prevalent [15]. Therefore innovative behaviors are likely to do the same especially when complex interactions are needed to accomplish goals [18].

In addition, knowledge exchange is less likely to occur on a regular basis as the phenomenon of “continuous partial attention” builds. In work environments where there are few organic measures to overcome this issue, such as regularly scheduled face to face meetings or phone interactions (measures that are naturally occurring in low Virtual Distance conditions but not high Virtual Distance conditions), innovation degrades.

These results have a number of implications. First, Virtual Distance should be considered as an overall factor that could impact innovation in virtual teams. Innovation has recently been described as the single most important area of focus and concern for organizations in the 21st century [59].

Second, our results suggest that as organizations outsource more business processes and functions, project managers need to keep a close watch on both the extent to which Virtual Distance is present and the “project load” of team members working in a highly virtual workspace.

When innovation is a high priority, a reduction in project load may be warranted. Multiple project management is common among virtual team managers. Given these findings, care should be taken to ensure that resources are not stretched too thin causing project overload when Virtual Distance and the associated risks have not been mitigated appropriately.

Conclusions and Limitations

We have made some progress in understanding how multitasking and multiple project management impact critical organizational outcomes, but the research is still in its infancy. However even in this nascent stage, distance has assumed a prominent role. New models for multiple project management that include both collocated and distributed virtual teams are necessary. Theoretical foundations related to human capacity limits such as absorptive capacity and

tacit knowledge exchange should be part of this development. And further empirical research into the effects of Virtual Distance on behaviors related to innovation and other important outcomes should be done.

In the present investigation we found that Virtual Distance moderates the relationship between Multitasking and Innovation. Conditions of high Virtual Distance can be highly problematic for companies pursuing innovative strategies when virtual team members are overloaded with tasks or embroiled in complex networks of outsourcers and other virtual partners. If these results continue to hold in future research, companies must act swiftly and deliberately to bring people virtually closer.

There are two major limitations to this study. The first is that the sample is composed mainly of service industries and more specifically Financial Services. Most of the projects studied focus primarily on software application development and engineering. Therefore the results may not be generalizable to companies in other industry sectors or other functions within an organization where innovation takes place.

A second limitation is that the definition of Innovation in this study is based on the self report of individual project team members regarding their ability to express innovative behavior.

We hope to remedy these limitations by continuing our research using a broader sample of industry participants and include a variety of measures of innovative outcomes.

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