

Impact of Computer-Mediated Communication on Virtual Teams' Performance: An Empirical Study

Nadeem Ehsan, Ebtisam Mirza, and Muhammad Ahmad

Abstract—In a complex project environment, project teams face multi-dimensional communication problems that can ultimately lead to project breakdown. Team Performance varies in Face-to-Face (FTF) environment versus groups working remotely in a computer-mediated communication (CMC) environment. A brief review of the Input-Process-Output model suggested by James E. Driskell, Paul H. Radtke and Eduardo Salas in “Virtual Teams: Effects of Technological Mediation on Team Performance (2003)”, has been done to develop the basis of this research. This model theoretically analyzes the effects of technological mediation on team processes, such as, cohesiveness, status and authority relations, counter-normative behavior and communication. An empirical study described in this paper has been undertaken to test the “cohesiveness” of diverse project teams in a multi-national organization. This study uses both quantitative and qualitative techniques for data gathering and analysis. These techniques include interviews, questionnaires for data collection and graphical data representation for analyzing the collected data. Computer-mediated technology may impact team performance because of difference in cohesiveness among teams and this difference may be moderated by factors, such as, the type of communication environment, the type of task and the temporal context of the team. Based on the reviewed model, sets of hypotheses are devised and tested. This research, reports on a study that compared team cohesiveness among virtual teams using CMC and non-CMC communication mediums. The findings suggest that CMC can help virtual teams increase team cohesiveness among their members, making CMC an effective medium for increasing productivity and team performance.

Keywords—Computer-mediated Communication, Virtual Teams, Team Performance, Team Cohesiveness.

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I. INTRODUCTION

DURING recent years, the organizational world has turned out to be more globalized than ever. Globalization has immensely changed the business strategies and also the ways organizations do business. With the development in the global corporate community, international businesses are searching new market segments to gain competitive advantage. This search is driving them to employ multicultural and skilled human resource, which is significantly capable of communicating effectively across diverse cultures; hence originating the concept of *Virtual Teams*. Young talented people are being highly paid in Korean companies who are fluent in speaking less common foreign languages.

Communication is considered to be the most important and fundamental tool in organizational dynamics. Whether it is a functional organization, matrix or projectized, the importance of effective communication cannot be underestimated. This effectiveness has become more imperative when it comes to Virtual Teams or Virtual organizations. Most of the companies in US are now depending on such teams to perform day-to-day business activities.

A. *Virtual Teams*

Teams may be short-term (hours or days) or long-term (weeks, months or years) and may be large (more than two hundred individuals) or small (comprising of only two individuals) depending on the nature of job or task assigned to them. The conventional organizational structures of the past were based on hierarchical levels based on authority and functionality. Organizational environment has gone through tremendous changes during the past few years and is now relying on employee empowerment which becomes the basis of team based working environment. This is the working style that delegates power to the employees as well as management; hence making the organizations more decentralized. Team based working style within the boundaries of organizations was a common trend; however teams working outside the geographical boundaries are currently getting more popular. The teams operating across time, space and organizational boundaries are called *Virtual Teams*. Virtual Teams are identified by many other terminologies e.g., Cyberspace, Dispersed, Long Distance, Distributed, and Online. The more popular terminology used other than Virtual Team is

Geographically Dispersed Team.

B. Computer-Mediated Communication in Virtual Teams

The communication that occurs through computer-mediated technologies (i.e., Email, Audio/Video Conferencing etc.) is called *Computer-mediated Communication (CMC)*. The application of this type of communication is more entrenched in virtual environment because this is the only source available to geographically dispersed teams for the exchange of information. *Computer-mediated Communication (CMC)* can be divided into *Asynchronous and Synchronous Communication*. *Asynchronous Communication* is the time-constrained communication (e.g., Text Messaging) and *Synchronous* is without it (e.g., Emails).

The impact of CMC on social aspects of team interaction has caught center-stage attention of various researchers in the recent years. Many worked on the socio-emotional approach to CMC by studying the behavior of virtual teams in various computer-mediated situations. These social studies examine how teams retain interpersonal interaction and mutual collaboration to get their jobs done in computer-mediated virtual environment. With these technical limitations, how virtual employees manage to work as a *Team* while isolated from each other geographically?, How they can generate a profound rhythm of regular Face-to-Face (FTF) settings using various communication media?, are questions to be answered.

II. RELATED THEORIES AND LITERATURE

There are a number of theories that address social impacts of technology and reveal the relationship between technology and society. These theories are tightly linked with *Science and Technology Studies (STS)* and *Communication Studies*. The theories that have been proposed to illuminate the impact of technological mediation on various team processes are called *Group Theories*.

A. Social Presence Theory (Short, et al. 1976)

The theory explains that the communication medium's social effects are caused by the degree of social presence of interaction partners. *Social presence* is the perception of the physical presence of partners involved in communication. Greater perception of social presence leads to better interpersonal relationships between the interaction partners or teams.

B. Medium-Richness Theory (MRT, Daft and Langel (1986)

Daft and Lengel in 1986 presented MTR theory which argues that the uncertainty of communication process depends on the communication medium's richness. Richer the medium, greater will be the precision of the information exchanged between interacting partners. The medium richness depends on the following criteria:

- 1) *The ability of communication medium to transmit personality cues of interaction partners.*
- 2) *The extent of the immediate feedback.*

Face-to-Face (FTF) is considered to be the richest

communication medium based on the above mentioned criteria. FTF is followed by Telephone, Email, Letter, Note, Memo, Bulletin etc. in the medium richness hierarchy. MRT suggests that the choice of medium should be made according to the degree or extent of richness required by the information to be communicated.

C. Media Synchronicity Theory (MST, Dennis and Valacich 1999)

It explains the richness theory (MRT) according to the synchronicity (time constraint) of the communication.

D. The Social Identity Model of Deindividuation Effects (or SIDE Model, Postmes, Spears, Lea 1999; Reicher, Spears and Postmes, 1995; Spears & Lea, 1994)

SIDE stands for the Social Identity model of Deindividuation Effects. This model was developed to describe the inconsistent effects of anonymity and social presence on computer-mediated groups. It argues that lack of social cues made the communication technology more deindividuated. Communication technology, for example, email may hide sender's characteristics, which may result in giving them increased attention to their social distinctiveness. Many researchers have employed this model on different computer-mediated groups and showed that these technologies sometimes could be more *social* than Fact-to-Face (FTF) interaction [6].

E. Time, Interaction & Performance (TIP, McGrath 1991)

TIP-theory illustrates three functions teams have to perform synchronously.

- 1) *Production Function:* Working together on a common task
- 2) *Group well-being:* Sustaining the interaction and communication between teams or group members
- 3) *Member Support:* Coordinating and helping each other in difficult situations

These are the critical factors necessary for the teams to achieve their goals successfully, especially in computer-mediated environment.

Many authors and researchers tried to illustrate the effects of computer-mediated technology on various team processes, such as, *team cohesiveness, status processes, behaviors, communication, decision making, leadership, cooperation, conformity* and *social loafing*. Technological mediation may impact team performance because of changes in these team processes. Quite a lot of authors have compared the performance of groups in both, FTF and CMC environments. One study reported that the groups communicating via CMC are proved to be more beneficial in *requirements negotiation* than the groups communicating in FTF meetings [2]. An empirical study shows that decision making quality and team cohesion improves in computer-mediated groups (CMC) faster with time as compared to Face-to-Face groups (FTF). It further argues that computer-mediated groups have a comparatively lower degree of satisfaction with communication mode than face-to-face (FTF) groups [3].

Empirical investigations are being done to access the effects of interaction styles of both groups (FTF and CMC) on team performance. The interaction styles of FTF teams can be accessed easily as compared to CMC or virtual groups. It further argues that both groups exhibit same interaction styles and hence these styles have the same effect on their decision performance and decision outcomes. CMC groups communicate less frequently than FTF groups and due to this suppression of contextual and social cues (such as facial expressions, posture etc.) in computer mediated groups, reduces diverse opinions and increases more task-related messages. This factor also helps to reduce status differences between members and increase equality of participation [4].

One of the analytical studies reports that “CMC is an effective medium for decision-making in diverse teams”. Lower degree Team Identification in CMC reduces the chances of conflict between the communicating teams. Team members in CMC take time to convey their statements and do not give immediate reactions; hence reduces the chances of escalation of conflicts. Reduction in conflicts among groups may help in building more sophisticated decision making processes. CMC groups can thus manage intra-group conflicts more efficiently as compared to FTF groups [5].

Some theoretical and empirical observations show that the prediction made by “generic distancing model” of electronic media, proposed by Wellens (1986) does not hold good in all types of team environments. The model suggests that “increasing communication richness would lead to increased feelings of psychological closeness between teams and information-lean media are believed to increase interpersonal formality” [6]. This study concludes that medium richness does not give assurance of increased team performance. There are many other factors which should be taken into account while gauging team performance, for example, task demands and individual difference factors. It further suggests that a more comprehensive theory is needed that should test the effects of communication medium on group processes. The medium effects on group performance should be tested taking into consideration the different categories of tasks in which groups under study are involved [6].

III. A REVIEW OF THE RESEARCH MODEL

A more sophisticated communication model has been proposed by James E. Driskell, Paul H. Radtke and Eduardo Salas in their article, “Virtual Teams: Effects of Technological Mediation on Team Performance” in 2003. This model suggests that “technological mediation may impact team performance because of changes in team processes, such as cohesiveness, status, counternormative behavior and communication and that these changes may be moderated by factors such as the type of communications environment, the type of task, and the temporal context of the team” [7].

The main aim of this research paper is to analyze and test one component of this model by conducting an empirical study.

Moderators (type of CMC, type of task and temporal factors) affect the strength of the relationship between dependent variable (Team Performance) and independent variable (Computer-Mediated Communications). These moderators may affect the relationship between Computer-mediated communication and team processes (cohesiveness, status, counter-normative behavior and communication) and between team processes and team performance, as depicted in Fig. 1.

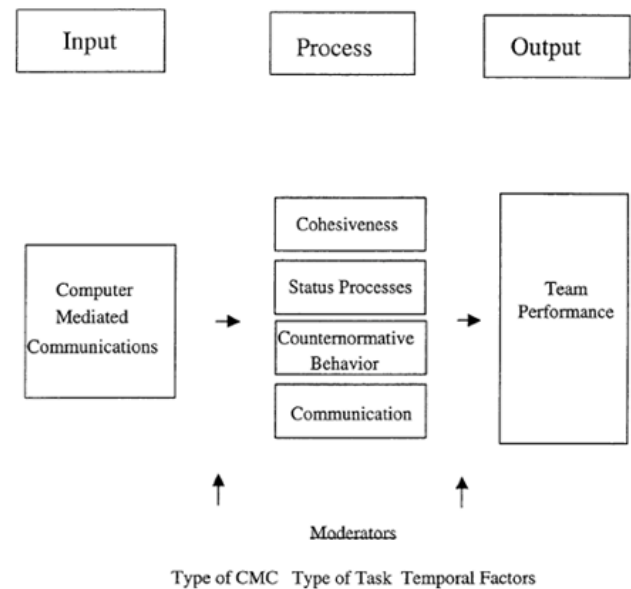


Fig. 1 Input–process–output model of the effects of technological mediation on team interaction

1) *Type of CMC*: The model studies various types of communication modes and their affect on all the variables depicted in Fig. 1. Effect of three communication modes are studied in this research:

- a. Audio-Video
- b. Audio Only
- c. Text Only

Fig. 2 aligns communication modes according to their richness, with reference to Medium-Richness Theory. Richness of communication types may differently impact the team Processes and team performance.

2) *Type of Task*: The model categorizes group tasks and studies their impact on team processes and team performance as depicted in Fig. 1. The categories of task types are [7]:

- a. Mechanical / Technical Tasks (Requiring construction or operation of things)
- b. Intellectual / Analytical tasks (Generation of ideas, reasoning or problem solving)

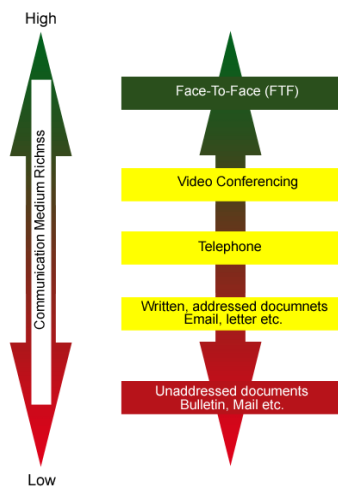


Fig. 2 Communication Medium Richness

- c. Imaginative/ Aesthetic tasks (Creativity or artistic endeavor)
- d. Social / Interactive tasks (Training, supporting or assisting others)
- e. Manipulative / Persuasive tasks (Motivation or persuasion of others)
- f. Logical / Precision tasks (Performance of routine, detailed or standardized tasks)
- g. Executive task

3) *Temporal Factors*: Technological mediation may have a different impact on team performance depending on the type of teams or temporal context of teams. The effect of two types of teams has been studied in this research [7]:

- a. Ad hoc teams
- b. Permanent teams

Ad hoc team is a temporary team whose members work together to accomplish a specific job or task. Their interaction with each other is limited and for a shorter period of time. *Permanent team* is a team whose members work together for a longer period of time. The Ad hoc team members usually work for a single session and are short-term whereas Permanent team is supposed to be long-term.

These three moderators affect the relationships at two points in *Input-Process-Output model* illustrated by arrows in Fig. 1.

A. Cohesiveness

The model considers three primary components of team cohesiveness:

- a) Interpersonal attraction (socio-emotional bond, interpersonal bond)
- b) Group pride/prestige (normative bond)
- c) Task commitment (instrumental bond)

Interpersonal attraction is the feeling of affection and attraction towards other team members, which is definitely an important factor in building trust and collaboration among team members to ultimately achieve better team performance. It falls in the category of *socio-emotional bond or interpersonal bond*.

Group pride is group prestige, shared belief, satisfaction and loyalty towards other team members. It falls in the category of *normative bond*.

Task Commitment is the sense of attraction towards the activities in which the team engages. Loyalty and attractiveness towards the task, satisfaction with the task and goals of the team are interpreted as Task Commitment. It falls in the category of *instrumental bond*.

1) *Effect of Technological mediation on three components of Team Cohesiveness*: The authors in this paper examines that increased distance among virtual members decreases the interpersonal bonds, that's why "technological mediation has a negative impact on cohesiveness when defined as interpersonal attraction" [7].

The paper further suggests that weakened normative bonds may lead to lesser group pride in virtual environment. This group loyalty may be better in permanent teams as compared to ad hoc teams. "Technological mediation has a negative impact on cohesiveness, when defined as group pride, in some situations but not in others." [7].

Task Commitment is believed to be the most important component of cohesiveness and it also get affected in computer-mediated virtual teams. "Technological mediation has a negative impact on cohesiveness, when defined as task commitment". [7].

2) Effect of Cohesiveness on Team Performance:

Cohesiveness-Performance literature suggests that the impact of task commitment component of cohesiveness is more on team performance as compared to group pride and interpersonal attraction. "Technological mediation is more likely to impact team performance through its effect on task commitment rather than through its effect on socio-emotional bonds or normative bonds." [7].

3) Effect of Moderators:

Type of CMC: Due to loss of visual, verbal and contextual cues in Computer-mediated environment, the virtual team members face lesser interpersonal attraction, group pride and task commitment (components of Cohesiveness) as compared to FTF meetings. There is very less empirical evidence to support the impact of Communication mode richness on *group pride* in virtual team environment [7].

Type of Task: The impact of technological mediation on team performance is different for different types of tasks. This is also not supported by significant number of empirical evidences [6], [7].

Temporal Context: Several studies have suggested that Ad hoc teams may have lesser team cohesion (considering all components) as compared to permanent teams due to greater interaction time but cohesiveness improves faster in virtual Ad hoc teams if they are provided sufficient time to develop [7].

B. Status Processes and Authority Relations

The participation of high-status teams is more as compared to low-status teams, generally in all organizations. As a result of globalization and formation of multi-cultured teams and increase in virtual communication due to this, status barriers are believed to be less significant while communicating via

CMC. This status distinction is weakened in computer-mediated communication but not completely eradicated.

1) *Effect of Technological Mediation on Status and Authority Relations*: Reduced transfer of social and contextual cues in CMC groups may lead to lesser status distinction. Some studies also show that technological mediation has no impact on eliminating status differences [7]. Implementations of SIDE (Social Identity Model of Deindividuation Effects) Model [1] show that major and prominent status characteristics gets highlighted often more in CMC environment as compared to FTF groups, for example occupational designation [7]. This could lead to increased transfer of status and hierarchical differences in computer-mediated communication.

2) *Effect of Status Processes on Team Performance*: When status difference reflects hierarchical power and control, its attenuation will have desirable effects. On the other hand, when status incongruence is communicating capability, knowledge and competence, it is desirable for higher status team members to be more participative and influential [7]. In this particular case, indistinguishable status distinction may affect task efficiency and team performance negatively.

3) *Effect of Moderators: Type of CMC*: Reference [4] demonstrates the reduction of status differences and increased equality of participation due to loss of visual, verbal and contextual cues among team members mediated by technology. The extent of this reduction may be inversely proportional to the richness of communication mode. Richer is the mode, lower will be the attenuation of status cues.

Type of Task: The impact of technological mediation on status processes is less significant for *idea generation* or *logical* or *precision tasks* because it doesn't need consensus from other team members. On the other hand, the impact may get significant for *intellective* or *analytical* or *judgment task*, as contribution of more ideas from distinct-status team members would definitely lead to amplified and effective task performance and decision quality [7].

Temporal Context: The impact of technological mediation on status processes is more relevant in Ad hoc teams as compared to Permanent teams whose members interact for a longer period of time. Permanent team members get to know the status of each other well with the passage of time. But in case of Ad hoc teams, knowing each others' status-differences is more significant because they have to communicate for a lesser period of time [7].

C. Counter-normative Behavior

Behavior that deviates from the standard or norm is known as *Counter-normative Behavior* [7]. Behavior that is more positive, or more negative than normal, both are considered to be in this category of *un-inhibited behavior*. Some literatures also discuss it as *negative behavior*.

1) *Effect of Technological Mediation on Counter-normative Behavior*: According to many researchers, virtual team members mediated by technology are more likely to exhibit counter-normative behavior [7]. But SIDE model suggests

that computer-mediation could offer better performance results and consistency in some situations [1]. However, it is a general consensus among many authors that computer-mediation may cause greater counter-normative behavior as compared to FTF groups [7].

2) *Effect of Counter-normative Behavior on Team Performance*: A very little research has been executed on the impact of counter-normative behavior on team productivity. If counter-normative behavior is taken as negative behavior then it may affect negatively on team performance [7].

3) *Effect of Moderators*:

Type of CMC: The relationship between Communication mode richness and Counter-normative behavior is inversely proportional to each other. Richer is the mode, lesser will be the exhibition of un-inhibited behavior [7].

Type of Task: The impact of technological mediation on counter-normative behavior is more salient in *social* or *persuasive tasks* than in *intellectual/analytical tasks* or *mechanical/technical tasks* or *logical/precision tasks*.

Temporal Context: Exhibition of Counter-normative behavior is reduced in Long-term or permanent teams than in short-term or Ad hoc teams. This is supported by many researchers who argue that ad hoc teams are more unfriendly, aggressive and impersonal as compared to permanent teams [7].

D. Communication

The process of Communication includes both verbal and non-verbal components [7]. The verbal component includes, e.g., intonation, pitch, volume of speech and non-verbal component may be explained by the famous saying, "Actions speak more than words!" These include body language, facial expressions, posture, gestures and all physical movements.

1) *Effect of Technological Mediation on Communication*: The transmission of visual and contextual information in case of computer-mediated communication is very less and often not present in majority of CMC modes. Due to this, Computer-mediated communication is believed to be less effective source of information as compared to FTF interaction. One of the most familiar methods of understanding the transmitted information is through acknowledgement. These acknowledgements could be communicated by verbal and also by non-verbal cues, e.g., through eye contact etc. which lacks in CMC groups. Team members may obtain feedback from other members' glimpse, nod or frown that are not easily transmitted while communicating through CMC mediums.

2) *Effect of Communication on Team Performance*: Lack of transmission of contextual nods, varying task related impressions may be communicated amongst virtual team members using CMC medium for exchange of information. Timely acknowledgement and timely feedback are considered to be critical factors in achieving desired performance especially in virtual team environment. Many researchers reported negative impact of computer-mediated communication on team performance.

3) *Effect of Moderators: Type of CMC*: Speech is the vital medium for interpersonal communication. Therefore, audio communication is believed to be more reliable mode of communication than text-based, e.g., email, instant messaging etc. Likewise, audio-video communication e.g., video-conferencing enhances computer-mediated communication more than audio-only communication. Non-verbal reactions can be easily communicated through audio-video communication modes and hence leads to the successful transmission of visual and contextual cues among team members who are geographically dispersed from each other. Many authors and researchers also believe that adding video to audio communication does very little in enhancing communication in computer-mediated environment. Some says that minimal interaction in case of text-based and audio communication can also lead to effective judgment of each others' personality and reactions in some situations. Lesser benefits experienced in adding video to audio-based communication is may be because of poor use of social cues by individuals. Proper training can enhance the encoding of these cues and may result in more successful results.

Type of Task: The impact of technological mediation on communication is more significant in *social/persuasive or negotiation tasks* that have greater interpersonal requirements than in *intellectual/analytical tasks* or *mechanical/technical tasks* or *logical/precision tasks*. Lesser interpersonal attraction among virtual team members is mainly due to the loss of visual cues while communicating through CMC.

Temporal Context: Lesser communication problems exist in long-term or permanent teams as compared to ad hoc teams. Over time the permanent teams get familiar with the communication mediums more easily and communicate well even with less rich mediums. Moreover, use of audio-video mediums in newly formed teams will not do any good to them because transmission of social cues may hold less meaning in these types of teams.

This paper is an attempt to analyze the relationship between Computer-mediated Communication (CMC) and Team Performance, moderated by four team processes. The empirical study has been built on the bases of the prior *Input_Process_Output model of the effects of mediation on team interaction*, suggested by James E. Driskell, Paul H. Radtke and Eduardo Salas, as depicted in Fig. 1. The primary focus of this study is to predict that the three moderators, *type of CMC*, *type of task* and *temporal context* of the virtual teams will moderate the relationship between *Computer-mediated Communication* and the three components of *Team Cohesiveness* and hence its impact on *Team Performance*.

IV. HYPOTHESES

Based on the Model Review, the following sets of hypotheses are formulated and tested in a multi-national R&D organization.

H0: In virtual project team environment, Computer-mediated Communication decreases Team Performance.

HA: In virtual project team environment, Computer-mediated Communication increases Team Performance.

H1: In virtual project team environment, Computer-mediated Communication increases team cohesiveness, when defined as an interpersonal attraction.

H2: In virtual project team environment, Computer-mediated Communication increases team cohesiveness, when defined as group pride.

H3: In virtual project team environment, Computer-mediated Communication increases team cohesiveness, when defined as task commitment.

H4: In virtual project team environment, the effect of Computer-mediated Communication on cohesiveness differs according to the type of task the virtual team is performing.

H5: In virtual project team environment, the richness of the mode of communication moderates the effect of Computer-mediated Communication on team cohesiveness.

H6: In virtual project team environment, the type of virtual team moderates the effect of Computer-mediated Communication on team cohesiveness.

V. RESEARCH METHODOLOGY

The approach of the research conducted in this study is based on the following methods:

- 1) Through in-depth interviews with all the employees.
- 2) Using a questionnaire and then recording the varied opinions of employees in SPSS to conduct Hypothesis Testing through statistical analysis. The sample comprises of 100 respondents from a multi-national organization.
- 3) Hypotheses have been tested in SPSS using the following statistical tools:

Histograms, Bar Graphs, Frequency tables etc.

A. Research Site

In this era of globalization and multi-culturism, one of the emergent organization types is parent-subsidiary organization in which a parent company operates its subsidiaries in different locations. All the organizational rules are established in parent company, which are then communicated to all the subsidiaries operating in different cultures.

Medical Transcription and Billing Company (MTBC) is a parent-subsidiary organization, geographically dispersed over two subcontinents: USA and ASIA. The main office is located in New York, USA and its site offices (also called client offices) are located at California and in two big cities of Pakistan, Islamabad and Muzzaffarabad. There are 25 employees working in different departments in the Head office of United States, while each client office comprises of 200-300 employees, performing different type of tasks or jobs.

The company is offering three types of services to its client (physicians and medical doctors) like medical billing, medical transcription, free EMR and some other value added services as web-login, web accessible patient information, online financial reports and practice analysis.

Communication Modes: In MTBC, the virtual team

members communicate and exchange project information through communication modes such as, Phone, Email, Instant Messaging, Audio/Video Conferencing, VoIP and VPN (Virtual Private Network) – for data transfer. Marketing department in the head office at New York advances sales promotion to their clients who are physician doctors by profession. The first step is to gather the initial data i.e., their clients' history, their business data, first agreement, sign off, old billing and final agreement through face to face meetings, emails and fax and hence transfer to NAS department through VPN (Virtual Private Network). This whole process creates a new account setup of the client. NAS department then separates information (in technological and financial aspects) and sends it to respective departments at client offices. Each department like IT, Finance, Billing, Customer Support and HR obtains the client information from NAS department and starts working to provide relevant services to their clients.

VI. DATA ANALYSIS

Hypotheses are tested using various Charts. Responses taken through questionnaires analyzed in SPSS to measure "Cohesiveness" among the virtual team members of MTBC. Three components of Team Cohesiveness comprising of Interpersonal attraction, Group Pride and Task Commitment are measured individually using 5 point likert scale, which is ranged from (5) *Agree* to (1) *Disagree* mostly and (5) *Fully* to (1) *Partially* as per response requirements of questions. Individual Means are then computed for all the three component variables. A cumulative Mean is also calculated from the means of three variables which represents Team Cohesiveness. These Means are plotted against CMC mediums (Email, VoIP, Audio/Video Conferencing) and non-CMC medium (Telephone). Bar Charts are plotted to measure the impact of Computer-mediated Communication (CMC) on Team Cohesiveness and hence its effect on Virtual Team Performance (H0 to H3). The effect of three moderators comprising of Type of CMC, Type of Task and Temporal Context of Virtual Teams are also tested through hypotheses from H4 to H6.

In this analysis, it is assumed from meta-analyses of cohesiveness–performance literature [7] the overall positive impact of team cohesiveness on team performance. Hence cohesiveness is assumed to be directly proportional to performance. Increase in cohesiveness would result in increase in team performance.

VII. RESULTS/DISCUSSIONS

Statistical Analysis through Hypothesis Testing leads to the following results:

A. H0 and HA

The Null Hypothesis (H0), which predicts that CMC decreases Virtual Teams' Performance is not supported and is clearly revealed through Bar Charts as depicted in Fig. 3 and Fig. 4. Cumulative Mean computed from the means of all the three component variables of team cohesiveness (interpersonal

attraction, group pride and task commitment) is plotted against different communication modes including CMC (Email, Instant Messaging, VoIP, Audio/Video Conferencing) and against non-CMC medium (Phone). Cohesiveness is highest among employees communicating through video-conferencing followed by VoIP and Email. Communicating through Phone (non-CMC) depicts an average cohesiveness as compared to CMC mediums. Lowest cohesiveness has been illustrated against Instant Messaging and Audio Conferencing.

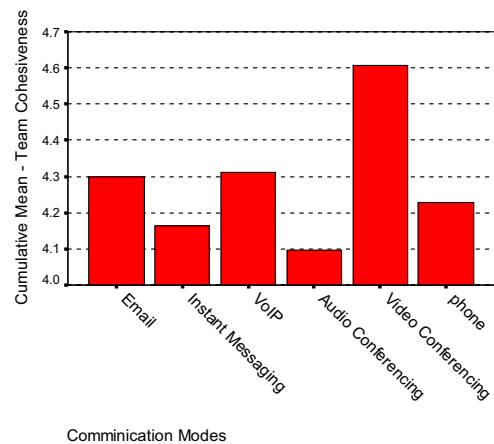


Fig. 3 Impact of Communication mediums on Team Cohesiveness

Based on above results, H0 is rejected and HA (Alternate Hypothesis) is accepted which states that CMC increases Team cohesiveness and hence increases Virtual Teams' Performance. This is clearly depicted in Fig. 4 in which comparison of Team Cohesiveness is drawn between CMC and non-CMC mediums.

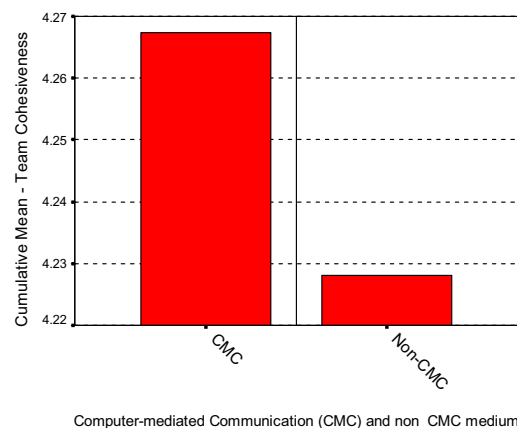


Fig. 4 Comparison of Impact of CMC mediums Vs. Non-CMC mediums

B. H1

The first component of Team cohesiveness i.e., Interpersonal Attraction is highest in case of communication through video-conferencing followed by Email, Phone and VoIP. Instant Messaging shows an average attraction among

virtual team members while Audio-conferencing depicts the lowest.

Interpersonal Attraction does not vary considerably when compared CMC with non-CMC mediums but the graph in Fig. 5 depicts that CMC increases team cohesiveness, when defined as an interpersonal attraction. Therefore, Hypothesis H1 is accepted and holds true.

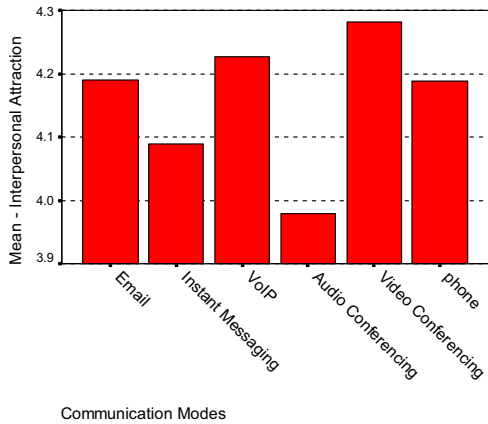


Fig. 5 Impact of Communication mediums on Interpersonal Attraction

C. H2

The second component of Team cohesiveness i.e., Group Pride is highest in virtual teams communicating through video-conferencing followed by VoIP. Using Phone and Audio-conferencing as communication medium shows the same group pride among their virtual team members. Email and Instant Messaging depicts considerably lesser group pride component of team cohesiveness.

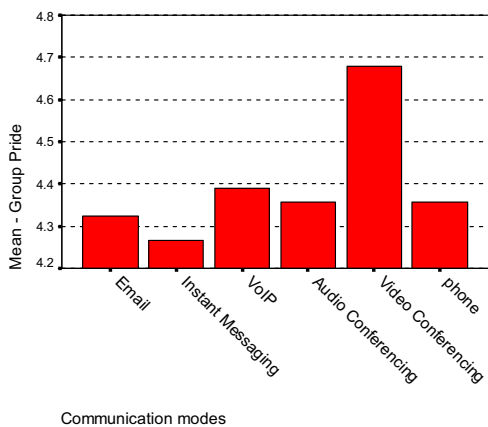


Fig. 6 Impact of Communication mediums on Group Pride

Group Pride does not vary considerably when compared CMC with non-CMC medium but the graph in Fig. 6 depicts that CMC increases team cohesiveness, when defined as Group Pride. Hence Hypothesis H2 is accepted and holds true.

D. H3

The third component of Team cohesiveness i.e., Task

Commitment is highest in case of communication through video-conferencing followed by Email, VoIP. Teams using Phone and Instant Messaging are not seemed to be more committed towards their tasks or jobs. Least Task Commitment is shown in virtual teams using Audio Conferencing as communication medium.

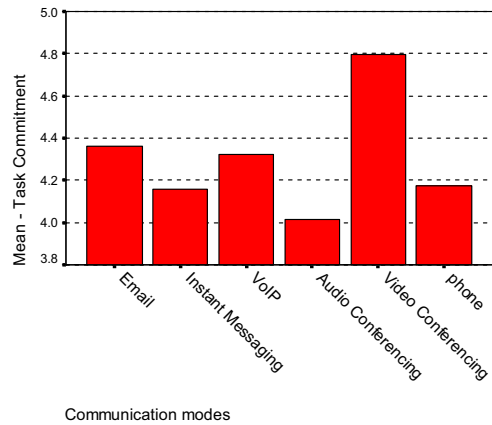


Fig. 7 Impact of Communication mediums on Task Commitment

Task Commitment does not vary considerably when compared CMC with non-CMC mediums but the graph in Fig. 7 depicts that CMC increases team cohesiveness, when defined as Task Commitment. Hence Hypothesis H3 is accepted and holds true.

It is reported by Mullen and Copper (1994) [7] that Task Commitment has the strongest effect on Team Performance as compared to Group Pride and Interpersonal Attraction components of Cohesiveness. The comparison of the impact of three components of cohesiveness on team performance in the said organization is shown by line graph and bar chart in Fig. 8 and Fig. 9.

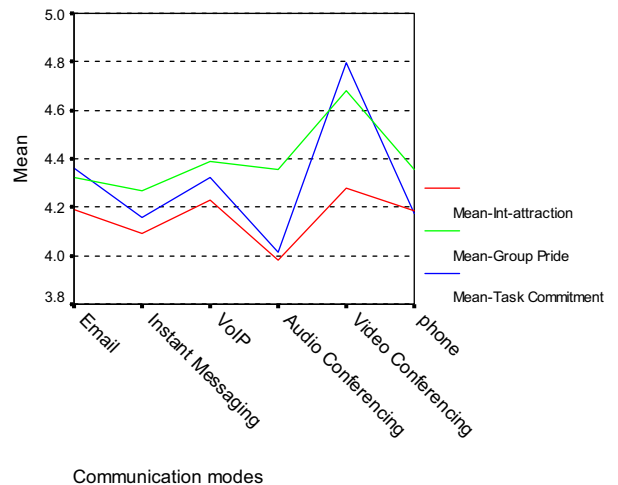


Fig. 8 Comparison of three components of team cohesiveness

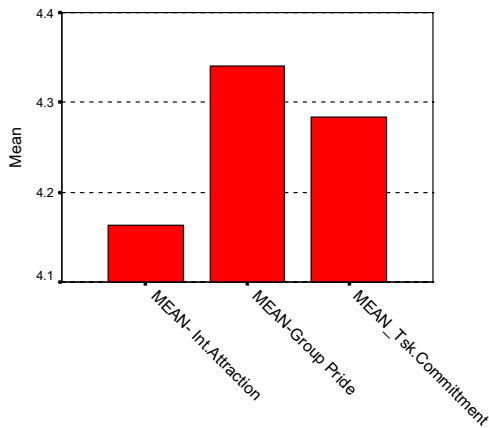


Fig. 9 Comparison of three components of team cohesiveness

Fig. 8 and Fig. 9 clearly illustrates the mean effects of all the three *cohesiveness* components, which show that Group Pride has the strongest effect on the virtual teams' performance, interpersonal attraction has the least and task commitment has an average mean effect. Higher task-based cohesiveness leads to greater team performance and hence it can be concluded that group-based cohesiveness is more as compared to attraction-based or task-based cohesiveness in the multi-national organization under study.

E. H4

Hypothesis H4 holds true as depicted in Fig. 10. Teams engaged in executive type of tasks experience highest cohesiveness among them followed by intellectual/analytical tasks and social/interactive tasks. Technical employees have the least cohesiveness among their team members. Although, higher team cohesiveness is very much imperative especially amongst technical team members to attain task-based goals effectively but the graphs do not show the required results.

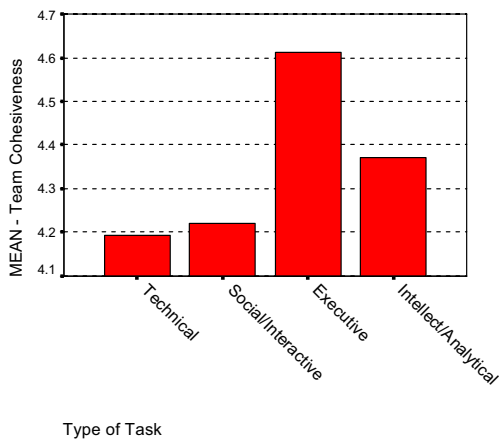


Fig. 10 Comparison of types of tasks and virtual team cohesiveness

The line chart depicted in Fig. 11 shows that technical task that have greater task-based requirements, depicting lower mean effect of task commitment as compared to executive and

intellectual tasks. Whereas, Social/Interactive tasks depict higher Group pride and Interpersonal attraction which is obviously the inevitability to perform such tasks more effectively. Executive tasks are tasks for which team members must look for consensus from other members to reach a preferred decision. The bar chart in Fig. 11 illustrates lesser interpersonal attraction and greater group pride and task commitment for executive employees, though interpersonal attraction should have been greater to perform such tasks more efficiently. Intellectual/Analytical tasks require solving problems with a correct answer provided that one person has that right answer and consensus is not required from other members. The chart shows lower cohesiveness means for such tasks as compared to executive tasks.

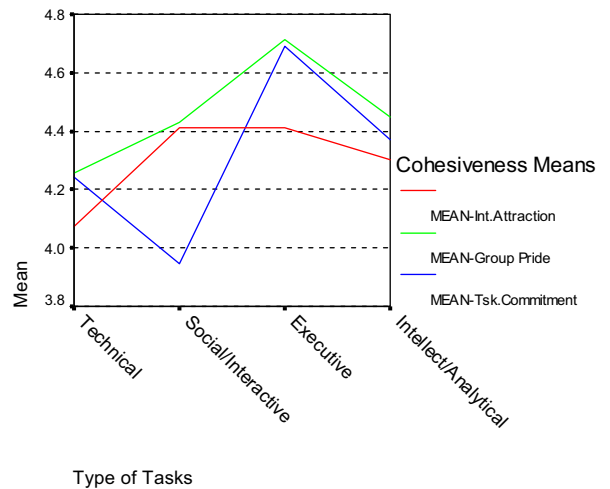


Fig. 11 Mean effects of components of cohesiveness on types of tasks in virtual team environment

F. H5

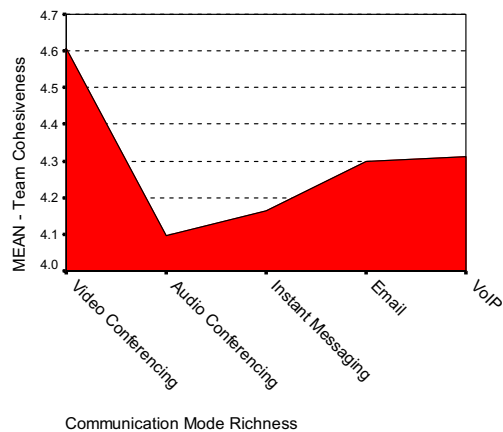


Fig. 12 Effect of CMC-richness on team cohesiveness

The area chart depicted in Fig. 12 shows that richness of mode of communication moderates the effect of CMC on team cohesiveness; hence H5 is accepted and holds true. Video-Conferencing is richer mode of communication than Audio-Conferencing. The chart illustrates the effect of computer-

mediated communication modes aligned from left to right according to their richness (communication medium richness also depicted in Fig. 2 aligned from top to bottom).

G.H6:

H6 holds true from bar chart illustrated in Fig. 13, which depicts that the type of virtual team moderates the effect of Computer-mediated Communication on team cohesiveness. It also shows that Permanent teams possess higher team cohesiveness amongst their members as compared to Ad hoc teams which interact for a shorter span of time.

Several studies have suggested that Ad hoc teams may have lesser team cohesion as compared to permanent teams due to greater interaction time available to them [7].

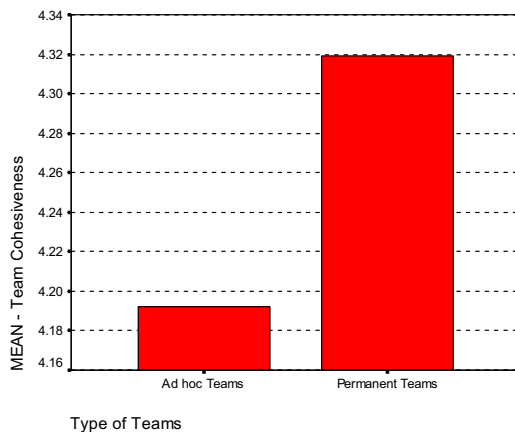


Fig. 13 Effect of CMC on cohesiveness in two types of virtual teams

VIII. CONCLUSION

As the corporate world has globalized, distributed work system and distributed teams have become unavoidable. Non-distributed work obviously is easy to manage than distributed work. Due to the additional overhead of inter-location communication, more emphasis has been given to the reliability of communication technology to enhance the consistency of exchange of information. Making the projects successful through distribution is a difficult task but can be done by having an effective communication system with reliable technologies in place. This study will enhance the value of computer assisted networking in the teamwork.

The significance of having social interaction between virtual distributed team members is also inevitable. This is a common observation that people want to work with those whom they like. Virtual organizations must try to create the atmosphere of trust, group prestige, empathy, satisfaction and loyalty towards other team members and must try to generate a philosophical rhythm of regular Face-to-Face (FTF) settings through emerging communication technologies.

This paper empirically tested the performance model (Fig. 1) in a multi-national organization MTBC to analyze the effects of technological (computer) mediation on the overall performance of teams which are geographically dispersed from each other. In this study, only one team process component i.e., "cohesiveness", (from the model depicted in

Fig. 1) has been studied and tested to analyze the impact of computer-mediated communication on performance. To extend this research, statistical analysis with the rest of team process variables should be performed before more specific conclusions about virtual team performance are made. On the other hand, within this limitation, the analysis being done in this paper suggests numerous interesting results.

The results depicted from the literature review above reveals the negative impact of technological mediation on team cohesiveness which in turn decreases team performance. However, the statistical analysis of virtual teams performed herein demonstrates the positive impacts of computer-mediated communication more on group pride and task commitment and less on interpersonal attraction components of team cohesiveness resulting in an increase in productivity of virtual teams.

On the whole, the findings of this study have reported an overall increase in the performance of virtual teams that communicate through computer-mediated technology as compared to non-computer-mediated technology. It is also safe to conclude that communication technologies do not do miracles in improving performance. Instead, teams should try to utilize these tools more efficiently to build loyalty, group pride and trust among themselves to achieve their goals successfully.

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