MANAGING INTERRUPTIONS IN VIRTUAL COLLABORATION:

AN EMPIRICAL STUDY IN THE TEXTILE BUSINESS

FANG SIYAN

Ph.D

The Hong Kong Polytechnic University

2013

THE HONG KONG POLYTECHNIC UNIVERSITY

INSTITUTE OF TEXTILES AND CLOTHING

MANAGING INTERRUPTIONS IN VIRTUAL COLLABORATION: AN EMPIRICAL STUDY IN THE TEXTILE BUSINESS

FANG SIYAN

A thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy

November 2012

CERTIFICATE OF ORIGINALITY

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it reproduces no material previously published or written, nor material that has been accepted for the award of any other degree or diploma, except where due acknowledgement has been made in the text.

___________________________________ (Signed)

Fang Siyan (Name of student)

ABSTRACT

This thesis explores and examines the interruption management issue in virtual collaboration in the textile and apparel business. Such virtual collaboration amongst or within organizations allows members to interact and collaborate regardless of geographic dispersion, as well as increase responsiveness and flexibility. Since interaction can be considerably intense among the collaborating partners such as designers, manufacturers, warehouses and retailers, one of the serious challenges is how to manage the interruptions to meet the increasing requirements of smooth interaction during virtual collaboration.

Interruptions amongst team members are inevitable during the course of virtual collaboration. Appropriate interruptions could bring important and timely information that is vital to adapt to the market while undesirable interruptions would cause disruptiveness to team members, decrease work efficiency or impede performance. Effective interruption management is expected to eliminate the negative effects of undesirable interruptions while maintaining the advantages of appropriate interruptions. Although the interruption's effect on individuals and virtual team performance has been studied a lot, empirical research focusing on the management of the interruption in virtual collaboration is still limited. This thesis aims to explore and empirically examine how to manage interruptions effectively through organizational and technological enhancement.

In view of the significance of managing interruption among virtual teams, the author reviews literature in organization science, management information science and other related research. The author concludes that intra-team awareness, virtual technology,

task interdependence of the virtual team members, and the team's motivating & governance system are determining factors of effective interruption management and virtual collaboration. Based on the literature review, a conceptual model of interruption management in virtual collaboration is built. The author adopts the combination of qualitative and quantitative methods to examine proposed relationships in the model. The exploratory qualitative interviewing approach provides us a preliminary test of the proposed causal relationships, from the points of textile industrial practitioners. The preliminary findings also enrich the knowledge about how individuals from today's textile companies manage interruptions and utilize advanced information technologies in their virtual teamwork. These serve as the contextual basis for the survey instrument development. The interview results support the proposed relationships and the underlying mechanisms: the enhancement of intra-team awareness and virtual technology helps to decrease undesirable interruptions and coordinate unexpected interruptions, high task interdependence among members and team-based motivating & governance system stimulate joint efforts for a shared goal, and encourage the dispersed individuals to be more cooperative in handling interruptions.

In the second stage of industry survey, the author collects 261 valid responses. The respondents are practitioners of textile and apparel companies who are currently involved in and have several years of experience in virtual collaboration. Structural equation modeling (SEM) analysis is employed to test the proposed hypotheses. The results suggest that the proposed antecedent factors (virtual technology, intra-team awareness, task interdependence, and motivating & governance system) are significantly associated with interruption management, and the interruption management mediates the relationships between the antecedents and the virtual collaboration effectiveness. In addition, task interdependence has direct effect on the virtual collaboration effectiveness.

Theoretically, this research is the first to construct an integrated framework to explore the antecedent factors of interruption management, and employ empirical study to examine the hypothetical relationships in the model. Besides, the author also puts efforts in developing the construct of interruption management. Practically, it puts forth systematic guidelines for improving the coordination of interruptions by means of technological aspect and organizational settings for management levels of textile companies; the author also offers individuals suggestions on handling interruptions appropriately and utilizing the virtual technologies to enhance effectiveness in their collaboration with co-workers, clients, suppliers, and business partners.

LIST OF PUBLICATIONS

Referred Journal Papers

- Fang, S., To, C.K.M., Zhang, Z.M., Chang, J.M.T. (2012). The Adoption of Information and Communication Technologies in Textile Virtual Collaboration. *Research Journal of Textile and Apparel* (accepted).

- Fang, S., To, C.K.M., Zhang, Z.M., Chang, J.M.T. (2013). Interruption in Virtual Context: A Framework of Interruption Mediation in Textile Innovation Team Management. *Journal of the Textile Institute* (to be submitted).

- Fang, S., To, C.K.M., Zhang, Z.M., Chang, J.M.T. (2013). Interruption Management and Virtual Collaboration: An Empirical Model. *Journal of Business Research* (Under draft, to be submitted).

Conference Papers

- Fang, S., To, C.K.M., Zhang, Z.M., Chang, J.M.T. (2012). Improving Cross-functional Collaboration in Global Business. *The International Journal of Arts & Science (IJAS) International Conference for Academic Disciplines*, May 27-31, Harvard University, Massachusetts, USA.

- Fang, S., To, C.K.M., Zhang, Z.M., Chang, J.M.T. (2011). Managing Communication Effectiveness in Virtual Teams. *Advances in Business-Related Scientific Research Conference 2011*, June 1-3, Venice, Italy.

- Fang, S., To, C.K.M., Zhang, Z.M., Chang, J.M.T. (2011). Interruption management in virtual team communication. *Fiber Society Spring 2011 Conference*, May 23-25, Hong Kong.

- Fang, S., To, C.K.M., Zhang, Z.M., Chang, J.M.T. (2009). Managing Interruptions: A Perspective of Virtual Team Collaboration in Production planning and Control. *The First Production and Operation Management Society International Conference-Hong Kong Chapter*, December 30, Hong Kong.

ACKNOWLEDGEMENTS

My heartfelt gratitude first goes to my chief supervisor, Dr. Chester K.M. To, who provided his time, guidance and encouragement to me for the last four years. He was the person first suggested me the topic of “interruption”, which I found a field with so much to explore. I would also like to express my sincere gratitude to my co-supervisor, Dr. Zhiming Zhang, who introduced me to the Hong Kong Polytechnic University. He encouraged me and concerned about me consistently throughout my study period. I am also thankful to my co-supervisor, Dr. Jimmy M.T. Chang, who offered me help during my study.

I would like to express my special appreciation and love to my parents. Without their understanding and consideration, this long journey would be too hard for me. Four years ago, I was so happy for going to a city far from home to lead an independent life. They let me know that wherever I am, their love is there for me all the time. Their great patience and unconditional love supports me to put the finishing touches to this thesis.

I would like to thank Peng Sixiang, who gave me invaluable support every time I was frustrated during the processes of exploring new knowledge. I am also very thankful to Krista Ko, who was my first friend in Hong Kong, and offered me help like a sister.

Of course, this thesis cannot be accomplished without those who assisted me in data collection and analysis. Prof. Eric Ngai offered me guidance on quantitative data analysis. Prof. Qingliang Gu and Prof. Dongsheng Liu cordially introduced me to the industrial practitioners in the textile and apparel companies. Without their help, I wouldn't be able to collect a high-quality set of empirical data. A considerable number of my friends helped me in seeking for respondents of interviews and industry surveys. Although I cannot name them all, I hereby deliver my sincere thanks to them.

Prof. Yi Li taught me *Quantitative Research Methodology*, Dr. Warren Chiu and Dr. K.F. Chan taught me *Research Methodology for Behavioral Research.* I would like to thank them for delivering me their profound knowledge and critical thinking about research.

Last but not least, I'm thankful to the Government of Hong Kong S.A.R., The Hong Kong Polytechnic University and Institute of Textile & Clothing for financial assistance and resource sharing.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. Introduction

This research in general observes the practices of virtual collaboration in today's globalizing textile and apparel supply business. In particular, it investigates and analyzes the collaboration issues of inter-member interruption. Interruptions amongst team members are inevitable during the course of virtual collaboration. Interruption, if not coordinated, can be one of the most vexing problems intruding into knowledge workers' task performance. Appropriate interruptions could bring important and timely information that is vital to adapt to the market while undesirable interruptions would cause disruptiveness to team members, decrease work efficiency or impede performance. In this research, the author asserts that enhancing organizational and technological maneuvers can help to achieve effective management of the interruptions. Effective interruption management is expected to eliminate the negative effects of undesirable interruptions while maintaining the advantages of appropriate interruptions. Although the interruption's effect on individuals and virtual team performance has been studied a lot, empirical research focusing on the management of the interruption in virtual collaboration is still limited. This thesis aims to explore and empirically examine how to manage interruptions effectively through organizational and technological enhancement.

This chapter gives an overview of the dissertation. The first section briefly introduces the research background and the research issues. Then the next section highlights the significance of this thesis from both theoretical and practical perspectives. In the following section, objectives of the thesis and research questions are put forth in an attempt to tackle the major issues identified. The outline of this thesis is presented in the last section.

1.1 Research Background

With the increasing complexity of cross-regional and multi-national commerce environment, today's textile and apparel companies are adopting a new way of doing business, which is called virtual collaboration. Virtual teams are composed of members who work and collaborate across spatial and temporal boundaries, cultural background, knowledge levels, and professionalism toward a common goal, with the mediation of various modern information technologies (Lipnack & Stamps, 2000). Virtual collaboration, which brings several areas of experts from different geographic locations together to work with shared purpose, provides a new prospect of cooperation among textile firms along the product supply pipeline. For textile & apparel industrial practitioners, such collaboration practice allows them to make more rapid and accurate decisions to respond to market fluctuation. The globalization of textile commercial activities drives tremendous companies to cooperate through the product chain, from design, manufacturing to merchandising and marketing. The relationship amongst teams can be business alignments, buyer-supplier, subsidiary companies of one group, or branches of a single organization, etc. For the textile companies, virtual collaboration helps in many aspects. For instance, it increases the efficiency of communication with suppliers and customers; team members can save a lot of time and costs from traveling to meet their business partners face-to-face. Team members can also contingently share important information, which is a salient advantage to win the market in today's volatile globalizing business environment.

Such contingent interaction among virtual workers becomes highly functional because it provides the dispersed individuals with the fresh, rich and coordinated information they need to refresh themselves. It is widely accepted that the modern communication technologies, including electronic mail, instant messaging, remote conferencing and mobile phones, have made communication more convenient and fast. However, these new and powerful information technologies increase the volume of important information delivered to interdependent virtual team-workers, intensifying the frequency of interruption among them (Dabbish et al., 2004). Interruptions that arise from large volumes of intensive communication would inhibit people from concentrating on the primary task, and consequently decrease the communication effectiveness of virtual teams. The cognitive demands of these context switches that arise from task interruptions can increase the user workloads and degrade individual information management capacity, which in turn increase the probability of mental mistakes in the mean time.

An interruption can be an externally-generated, randomly occurring, discrete event that breaks continuity of cognitive focus on a primary task (Bailey & Konstan, 2006; Gillie & Broadbent, 1989). Interruptions are pervasive in everyday life. A simple and common example in telephone calls: when it rings, the sudden noise can interrupt others' conversation or chain of thought. This kind of interruption might exert an undesirable effect to virtual workers. For another example, virtual team members would connect with each other for information or have discussion to settle some decisions through instant messaging such as MSN (Microsoft Network). In a project, a member wants to discuss some specific problems with a colleague who is in particular charge of it, he sends over an instant message for discussion (initiating an interruption) while the recipient is occupied in another task. Such circumstance is quite common in collaborative work. For interruptees (who receive interruptions), whether to start discussion immediately or keep interrupters waiting till he finish his ongoing work is a constant question. Improper interruption handling can bring converse effect to virtual teamwork.

Hudson et al. (2002) documents the managers' attitude on interruptions and finds that managers want to be accessible to those who need their attention during personal time, while they wish to maintain control over these interruptions at the same time. In other words, people do not mind being interrupted by necessary or worthwhile pieces of information, but they do prefer the interruptions happening at more desirable time rather than when there are some other tasks demanded at the same time. In addition, the relatively high interdependence of working tasks among virtual team members makes it hard to resist interruptions. It is almost an obligation to ascertain smooth interaction among virtual team members because of the changing market environment.

In light of such circumstance, the greatest concern is how virtual team members can temporarily maintain psychological concentration on important tasks while allowing interruptions to be properly fixed. Effective interruption management of the entire virtual team is critical for whole-team success. If the external interruptions cause less disruption to the normal performance of ongoing tasks, the efficiency and effectiveness of virtual teams is expected to be largely enhanced. Hence, it is vital to coordinate and regulate interruptions that naturally happen in the process of virtual work, instead of simply cutting off the sources of interruption. Interruption management involves appropriate regulation and coordination of interruptions using specific technologies and managing concepts to achieve lower disruption during virtual interaction.

The topic of interruption in organization science has been studied for more than two decades and has attained significant findings and breakthroughs. Succinctly, many studies concentrate on examining the various aspects of differences between virtual teams and collocated teams; a number of extant studies focus on examining the effects of interruptions on the virtual collaboration effectiveness, and the antecedents of virtual team performance under diverse settings. There are also substantial studies on establishing models that indicate the antecedent factors of effective re-design of traditional teams, yet such attempts in the context of virtual teams are rare.

The concept of interruption management has been brought into concern but the research progress is still limited. For example, Adamczyk & Bailey (2005) and Dekel & Ross (2004) develop intelligent computer systems to help users to manage interruptions under different contextual conditions. A body of research proposes practical methods and strategies of successful interruption management from several dimensions, such as proper adoption of modern technologies, promoting context awareness, and so on (e.g., Grandhi & Jones, 2010; Liebowitz, 2010; Minassian et al., 2004).

1.2 Current States of Research

Virtual collaboration is an effective way to keep the organizations and experts collaborating across geographical, organizational, functional and cultural boundaries. Controlling interruptions is a central issue of ensuring smooth virtual collaboration. Despite the growing importance of coordinating interruptions in virtual collaboration, relatively little is known about the elements that influence and determine interruption management and the success of virtual teams (Algesheimer et al., 2011). Studying the factors determining virtual team performance in an integrated model is difficult because of the diversity of this issue, and the difficulties in collecting effective data from virtual teams (Algesheimer et al., 2011).

According to the research in computer-supported cooperative work (CSCW), important contextual factors of the organization and team setting contribute to the regulation of interruptions during collaboration processes (e.g., Ackerman, 2000; Ljungberg, 1999). Human factors such as motivating systems largely affect a virtual team member's attitude in interruption treatment. Thus a proper motivating and governance structure would be an important determinant of the interruption management and the virtual team performance (Hertel et al., 2004). Also, task interdependence of the team members would impact the overall strategy of treating interruptions (Somech et al., 2009). On the other hand, human-computer interaction (HCI) researchers put much effort in investigating how the enhancement of virtual technologies helps appropriate handling of interruptions (Acosta & Selker, 2007; Crabtree et al., 2005; McFarlane, 2002). Interruption management has been proposed to promote effective virtual collaboration in the interruption-contingent environment of today's business (Liebowitz, 2010).

According to the current development of research in collaborative team interruption, the following concepts can be generalized:

- Many researchers have evaluated contextually the effects of different interruptions on individuals rather than on the holistic virtual team.

- Much work has been done in providing tactics of interruption regulation and management from the technological and engineering perspective, such as Human-Computer Interaction research. More attention has been put on developing the technologies to limit the damage caused by negative interruptions. This phenomenon reveals that there is a disparity between the technical applications and the theoretical analysis toward the issue. These previous research oversimplifies the interruption management process. A lack of research in this field suggests researchers to re-focus interruption management on more theoretical ground.

- The concept of interruption management is under developed. Interruption management could be a critical process in controlling virtual collaboration performance. Hence, it should be developed into a construct with clearer conceptualization and measurement scales that allow quantitative empirical studies. A construct is an abstract theoretical concept that is generated to explain a phenomenon. Such work is absent from previous studies, and this is an appropriate time to develop the particular construct.

- A large body of research has studies the determinants of effective virtual team collaboration from the organizational and technological perspectives, and has developed plausible frameworks that suggest how the virtual team performance could be enhanced. Yet, exploring the related issue with respect to the interruption phenomena is a very limited in literature.

- Most relevant studies are based on traditional laboratory experiments which oversimplify the natural contexts and social dimensions of teamwork, there are increasing number of studies show a bottleneck in laboratory exploration. The attempt of the research conducted in the real-world environment is considered necessary to produce more realistic results for the directions of textile companies.

In summary, little has been studied in interruption management to enhance textile virtual team collaboration within globalized and nomadic organizational work environment. This thesis aims to fill in this gap.

1.3 Objectives and Research Questions

The primary research objective is to identify the most influential determinants of interruption management in virtual collaboration and communication, and to investigate a theoretical framework to integrate the antecedents and consequences of interruption management effectiveness, as well as test it empirically. The ultimate aim is to provide insights into leverage points that help the practitioners in the textile & apparel industry to coordinate interruptions during virtual interaction in order to eventually facilitate smooth and effective virtual collaboration within and among the firms. The author believes the empirical study of the interruption issue in virtual collaboration shall yield strong theoretical and practical results to fill in this gap.

In detail, the questions to be explored are listed as follows:

- What are the primary factors in determining virtual collaboration success from the perspective of interruption management?

- How do organizational and human factors influence interruption management in today's mobile, nomadic workplaces?

- How do technological factors affect interruption management in virtual collaborative work?

- What role does interruption management play in the relationships between the organizational and technological factors of virtual teams and the collaboration performance?

- How is the construct of interruption management conceptualized and evaluated in virtual environment?

- What are the implications of better interruption management for interaction and collaboration within virtual teams?

To fulfill such research objectives and find the optimal answers for the research questions, the research was conducted as following: first, through literature review and in-depth field interview, the author provided a landscape of the problem context and identified the main constructs of the conceptual framework. The author also collected individual perceptions and experience of interruptions and their treatment methods from the virtual team practitioners. After that, questionnaire survey was employed to verify and detail it, in the mean time solicit better thinking to make it more comprehensive, objective, elaborate and generalizable. Finally, based on the analysis of the previous qualitative and quantitative data, the author applied structural equation modeling to analyze the proposed model. Some practical suggestions and guidelines in interruption management would be presented, which was expected to provide better understanding of this issue, and thereby facilitate effective collaboration for the textile & apparel firms to better adapt to the volatile market.

1.4 Significance

This research is expected to contribute in both theoretical and practical knowledge field. On the theoretical side, this research would fill in the gaps of the literature in interruption management for textile virtual teams and virtual organizations. The interruption management is a concept to be enriched in literature to-date: there is no systematic theory about interruption management such as what role does it play in coordinating virtual team performance, how to evaluate it, and how it can be realized through the setting on the team level. In this research, the author concludes related literature and explores extensive views from in-depth interview to develop the theoretical construct of interruption management, build the measures for this new construct, and test it through empirical processes.

A large body of literature has examined the factors influencing virtual team performance and the how interruption affect virtual interaction, but this research is the first attempt to construct an integrated framework of the factors determining virtual team effectiveness, particularly from the perspective of interruption management. In other words, the author investigates how interruption management, as a mediating variable, coordinates relationships between the antecedent factors and the virtual team output. It's novel that this work not only concludes and examines the influential factors of interruption management but also investigates how interruption management affects effectiveness of the virtual team or virtual organization. This framework maybe not comprehensive, but it makes significant contribution as a start in this field. In addition, the proposed relationships are examined through the empirical tests which collect data in the real world, rather than laboratory tests. The final validated model proves the hypotheses to be well-grounded and credible.

On the practical side, the proven framework would provide solid evidences of interruption management so as to assure efficient and smooth virtual communication, especially for the inter-organizational and inter-functional collaborative teams in the textile industry. The author believes that some practical suggestions would be raised for the large-scale and rapidly increasing group of people who participate in virtual interaction and collaboration. Ultimately, this research offers some practical guidelines for the design of virtual teams and the utilization of information technology, with attempt to ameliorate the interruption problems, to promote quality and efficiency of modern collaborative work.

1.5 Thesis Outline

This thesis is organized in a five-chapter format. Chapter one provides background information on the research issue and research gap. It also formalizes the statement of purpose and discusses the significance of the research. Chapter two reviews cross-disciplinary literature related to the research issue and identifies the most important antecedent factors of interruption management and virtual team performance. Thus, an integrated conceptual model is proposed and hypotheses are postulated in this chapter. Chapter three presents the qualitative method adopted as an exploratory research, as well as findings in this in-depth interview approach. Chapter four reports the methods of the quantitative study, including stage-one survey and the mass industry survey. It also discusses the findings in this approach and presents the final model built based on the empirical data. The result of hypothesis testing is also reported in this chapter. The final chapter summarizes the empirical findings, highlights the contribution of this research, and discusses the implications to real-world collaboration gained in this research.

2. Literature Review

This chapter reviews the extant understanding of the interruption issues in virtual collaboration, and how technological and organizational factors determine interruption management process and virtual team performance. In this chapter, the author also observes virtual teams in textile activities and summarizes how interruption could be coordinated in global environment. The first part introduces the research area and its context – the interruption issues in today's textile virtual teams. The causes of interruptions and their effects on virtual collaborative effectiveness are discussed from the perspective of management theories, psychological theories, and information systems. The literature provides advices and evidences of how organizations and individuals can adapt to interruption-contingent environment. The second part identifies critical factors that determine effectiveness of interruption management and virtual team success, and discusses the underlying relationships and mechanism of the identified factors. On such premises, the hypotheses and research model are also proposed.

2.1 The Context of Interruptions -- Textile Virtual Collaboration

As the market competition gets fierce, it is important to put the dynamic real-time global collaboration concepts into practice. It is evolving away from the post-industrial era to the current knowledge-based society (Rico & Cohen, 2005). Today's textile firms are faced with demanding competitive challenges due to their immersion to global activities. The virtual collaboration infrastructure allows activity-oriented, context-aware flexible communication among team members. Such virtual collaborating system allows proactive and coherent coordination of resources and decisions to respond agilely to capricious market. This research studies the processes of textile virtual collaboration, and the corresponding issues of interruption.

Collaboration by virtual means is gaining prevalence in the textile and apparel industry. For the textile supply operations, cooperation and collaboration amongst virtual teams contribute in many processes. Figure 2-1 depicts the close strategic collaboration among the apparel supply chain. The final apparel products are the joint effort of the companies: fibers, mills, garment manufacturers, brands, retailers, components like zippers and snaps, along with transportation providers, freight forwarders, export agents, and warehouse providers. Team members have to collaborate contingently anywhere, share real-time information and resources, which is a salient advantage in today's volatile business environment. Collaboration can now be perceived as business processes, leading to short lead time and increase sales revenue. This results in the burgeoning of virtual team (VT) collaboration.

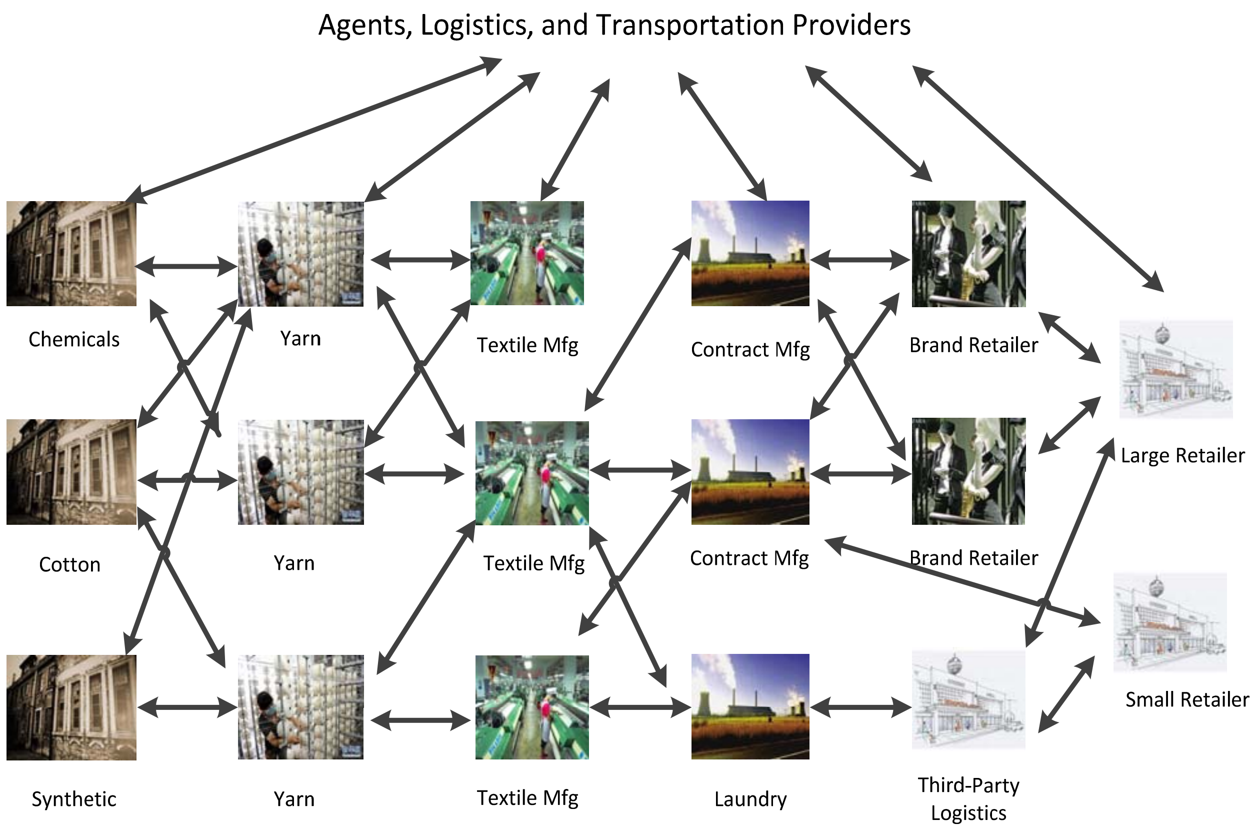


Figure 2-1: the Collaboration among Apparel Supply Chain

Today's organizations face growing challenges in turbulent business environment. The intensifying globalization of commerce and corporate activities stimulate inter-organizational cooperation. The increasing complexity of the market environment and the pace of organizational change require intensive interactions and interruptions among the collaborators. Many textile firms operate collaboratively as in a globally-networked virtual team to sustain their competitiveness. In order to better respond to the fast-changing market, there is a growing demand of cooperation and communication throughout all the organizational levels along the supply pipeline, from design, manufacturing to merchandising and marketing.

As shown in Figure 2-2, the model depicts how virtual team collaboration builds dynamic relationship among the core activity processes of textile and fashion supply system, from fiber spinning, weaving, knitting, dyeing, and finishing to garment manufacturing and retailing (To et al., 2002). Once the downstream market requirements and preferences are specified at end-marketplaces, all the processes within the upstream system could be informed contingently and operate concurrently and inter-supportively. Firms along the integrated process chain form a holistic virtual team that share one common goal. Advanced information and communication technologies promote such seamless collaboration along the supply chain. For an instance, a contingent customer preference change requested by the retailing part can be simultaneously shared with all other upstream processes to make aligned decisions. Textile virtual teams coordinate and integrate textile & apparel operations globally. The textile virtual teams can be inter-departmental teams from a single organization, inter-branch teams of a global company, business alliance teams which cooperate in activities such as product development, or supplier-buyer teams.

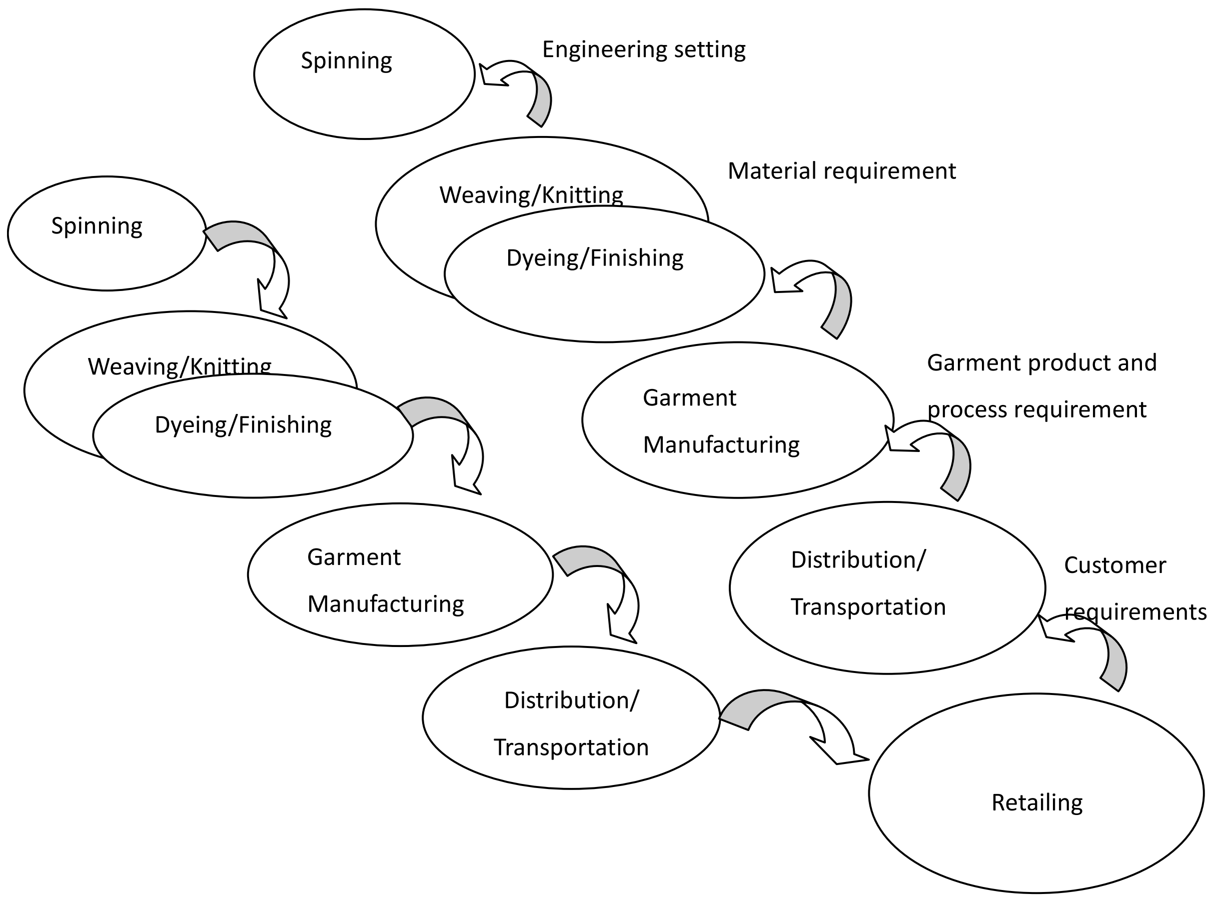


Figure 2-2: Integrated Process Chain for Textile Firm Collaboration

The work form of virtual team collaboration is gaining prevalence in the textile activities; however, little is known about how the interruptions among virtual collaboration team can be coordinated. Despite a relatively strong history of research on interruptions, interruption management in globalizing context remains a problem that still awaits further investigation and analysis. It is widely accepted that the modern communication and collaboration technologies, such as electronic mail, instant messaging, wireless information devices and smart phones, have made communication more convenient and fast. However, they also become significant sources of interruption against individual team worker tasks (Dabbish & Kraut, 2004). Unlike singular linear systems such as assembly lines, on which people cooperate with particular others on a routine basis, virtual team members experience many unpredictable events and interruptions from others requiring decision making or constant adjustments to planned work schedules (Ren et al., 2008). It is estimated that such unnecessary interruptions consume approximately 28% of a knowledge-worker's day, and bring companies tremendous extra cost per year (Sen, et al., 2006; Spira, 2005). An interruption can be an externally-generated, randomly occurring, discrete event that breaks continuity of cognitive focus on a primary task (Berry, 2011; Bjørn & Ngwenyama, 2009). This research focuses particularly on the external interruptions which are the interruptions caused by external sources, such as requests from colleagues or computers.

2.1.1 The Interruption Issue in Virtual Contexts

Virtual teams, also referred to as geographically dispersed teams, have their attributes, which are different from traditional teams. Such new form of collaboration is bringing both opportunities and challenges to modern organization management and globalizing business. These attributes make virtual team collaboration to a large extent rely on advanced functional requirements of communication tools. With a better understanding of how members in virtual teams collaborate, we could find ways to improve interruption management. Figure 2-3 depicts how this research topic was generated, as well as the related research fields. With the advancement of electronic information technology and the development of research on teams and organizations, a new pattern of collaboration among organizations appeared, which is called virtual collaboration. The well-developed theories in traditional team research and the efforts in the human-computer interaction (HCI), computer-supported cooperative work (CSCW) and communication information technologies provide sound bases for exploring virtual team theory development. The evolutionary working style or pattern of virtual collaboration expands quickly along the world. In spite of the fast prevalence of virtual teams gained worldwide, the research largely lag behind the practice, and there emerge an array of managerial and communicational problems. The unregulated interruption resulted from frequent virtual interaction is one of the most vexing problems. How to coordinate interruptions to assure effective collaboration of organizations is a central issue in textile collaboration research.

Scholars try to look into this problem from different perspectives. Some researchers try to incorporate the issues with organization structures and team design (e.g., Kirkman et al., 2004; Siegel et al., 1986; Sundstrom & Altman, 1989); some discuss human perception toward interruptions from psychological perspectives (e.g., Cohen, 1994; Gillie & Broadbent, 1989; Pearce & Gregersen, 1991); some examine how the technological advancement can mitigate negative impacts that are caused by interruptions (e.g., McFarlane, 2002, Adamczyk & Bailey, 2005; Dekel & Ross, 2004; Grandhi & Jones, 2010). While the findings of team research in traditional work environment providing useful pointers and valuable theoretical background for the start of virtual team research, interruption issues in virtual collaboration still call for specific attention because of the unique managerial, technical and social challenges.

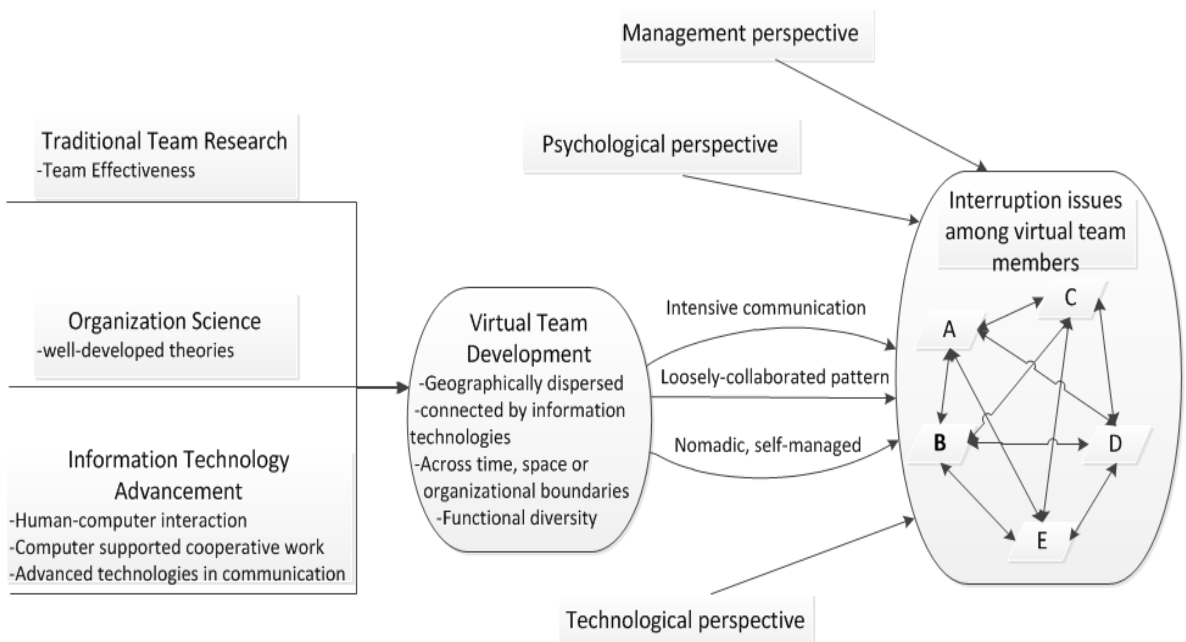


Figure 2-3: the Generation of Research Issue

To understand organizational issues in virtual teams, the author first reviews the concept of virtual teams (Bjørn & Ngwenyama, 2009; Martins et al., 2004; Townsend et al., 1998). Majority of them have considerable overlap on the core concept, i.e. virtual teams are the functional teams that rely on technology mediated communication; cooperation among members across geographical, time, and organizational boundaries.

According to Cohen & Bailey (1997), a team is a collection of individuals who are interdependent in their tasks, who share responsibility for outcomes, who see themselves and who are seen by others as an intact social entity embedded in one or more larger social systems, and who manage their relationship across organizational boundaries. Both the terms “team” and “group” are used to describe a collection of people working together, and in most literature they are used interchangeably. The key characteristics of “virtual” refers to the relationship that is built and reinforced by electronic technologies or sometimes even refers to that members in the team never meet face-to-face (Daft & Lengel, 1984; Potts & Jones, 2011).

In the research, virtual teams are confined to a group of people who interact through interdependent tasks guided by shared purposes, and work cooperatively across time, space, and organizational boundaries, supported by information and communication technologies (Algesheimer, et al., 2011; Bjørn & Ngwenyama, 2009; Hertel et al., 2005; Naik & Kim, 2010). Those virtual teams can be composed of individuals from different departments within one organization, or different branch offices across the world within an organization, or even people from several organizations that are linked by ad hoc relationships such as partnerships, alliances, and outsourcing contracts. Professionals who work remotely at home or from other non-headquarter locations using networks and other information technical applications are also involved as virtual work (Raghuram et al., 2001).

Recent literature focuses on understanding the functioning of virtual teams rather than simply comparing virtual teams to face-to-face teams. Concerning the functioning of virtual teams, several key characteristics of virtual teams help one to understand the generation of interruptions in such context. Figure 2-4 depicts why interruptions are intensive and inevitable in such contexts. On one hand, geographic dispersion of team members, unstable membership and loose coupling structure make it hard for virtual team members to have sensitive and accurate understanding of their team context and task environment. On the other hand, due to flat hierarchy structure, virtual team collaboration enables more informal interaction, which allows for rapid feedback, sharing local context, and simultaneous conversations (Olson & Olson, 2000). Virtual team members are well-partitioned in their expertise, but their tasks are interdependent on each other. The completion of a project requires the collaboration of their indispensible knowledge or resource inputs. In addition, the environment of virtual team-working is very uncertain and fast-changing. Such working environment would increase the volume of important information delivered to interdependent team-workers, intensifying the frequency of interruption by dispersed team members.

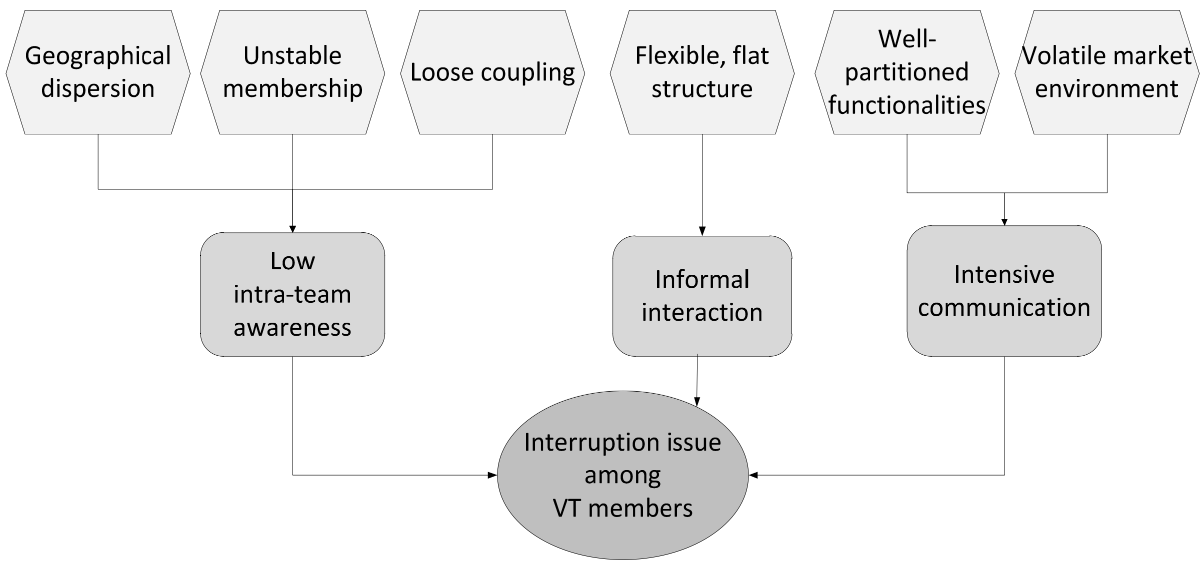


Figure 2-4: the Causes of Interruptions in Virtual Team Collaboration

The following paragraphs explain the causes of the interruption issue in detail. These characteristics of virtual teams result in distinguished behavior pattern during team member communication. Firstly, virtual team talents may differ in cultural background, knowledge level, professionalism and skills, and may be dispersed in different regions of varied time zones. This allows organizations to hire people with specific skills regardless of the concern of where they actually locate. Due to rare chances to meet face-to-face, decreased sense of connectedness for individuals in a team becomes a problem. More, time zone difference of team members has led to the asynchronous communication, which means people do not interact easily on “real-time” basis. Such characteristic makes interruption hard to be anticipated.

Secondly, some researchers indicate that textile virtual teams have more unstable memberships such that contingent expertise can be added or removed as tasks change (e.g., Kirkman et al., 2004). Some virtual teams are designed to perform ad hoc projects in which everyone takes charge in a specific functional part. Unlike in traditional teams, relationships within the virtual form are tenuous, and more likely to be contractual. In such ad hoc projects, the membership mobility can be quite high. Such teams would probably skip the team building process and the “warm-up” period which bring members sense of belonging and commitment to the team. The absence of relationship building results in team member’s lack of awareness to other members and the entire team.

Thirdly, the virtual team members are also mostly loosely coupled and nomadic, without much sense of supervision. Higher extent of autonomy is allowed in the virtual team members. Their working style is significantly different from that of traditional office workers. They may work at home, in the coffee shop or anywhere; they may work at anytime, even at mid-night to interact with people across the globe. The nomadic working style allows for greater adaptability because team members are not partitioned by vertical hierarchies. The strong sense of leadership is replaced by self-management. This is also supported by Sproull & Kiesler (1986) and Dubrovsky et al. (1991), who conduct empirical research and find that status effects are reduced in virtual communication.

The geographical dispersion, the unfixed membership and the nomadic working style can cause low intra-team awareness for virtual members. Low intra-team awareness can be the underlying reason for some reported traits of virtual teams. For example, virtual team's communication tends to be more task-oriented than that of face-to-face teams (Hiltz et al., 1986). In face-to-face teams, people would sometimes talk about non-task related topics like friend's chat, but these chats decrease dramatically in virtual interaction. McLeod et al. (1997) reports that some virtual team members are more likely to express their opinions in anonymous conditions. Interaction through information technologies makes it easier for anonymous view expression. Also, it is reported that it may take longer for virtual teams to accomplish tasks or reach consensus (Graetz et al., 1998; Siegel et al., 1986).

Fourthly, virtual team workers may be functionally or culturally diverse, connected via lateral relationships. As a result, the virtual teams are expected to handle tasks in a more flexible way, especially when facing a turbulent and changing environment. Baker

(2004) claims that virtual network is designed to handle tasks and environments that demand flexibility and adaptability. Unlike a bureaucracy, which is a set of fixed relationship for processing all tasks the network organization molds itself to each task, virtual relationship is more tenuous and ad hoc. Gutwin & Greenberg (2004) also indicates that communication relationships are not vertically or horizontally bounded, because the internal network structure in a virtual organization is emergent rather than imposed.

Fifthly, structure in virtual team also tends to be flat. Reduction in hierarchical levels allows the virtual team to be more configurable, but the boundaries are considerably more blurred in virtual teams (Escriba-Moreno & Canet-Giner, 2006; Suchan & Hayzak, 2001). A flexible and flat structure enables virtual teams to dynamically adapt to the changing market environment and customer needs by keeping informed of the latest information over time, modifying the business processes, and rearranging the relationships among components.

Sixthly, the team elites are well-partitioned by their functionalities, knowledge required, or work pattern. Members may vary substantially in their education background, expertise, organization, and culture (Gunawardena, 1995). The pursuit of a common project goal makes these professionals interdependent on their tasks and knowledge, which lead to frequent interactions (Shachaf, 2008).

The flexible, flat structure, well-partitioned functionalities and volatile market environment has give rise to more intensive, informal interactions among team members in the courses of collaboration. Intensive, unregulated communication is one of the most important characteristics of virtual teams. Virtual teams usually communicate more frequently than conventional teams. A large amount of communication is delivered as electronic text documents, web meetings, or e-chats through information technologies. In addition of the intensive and frequent interactions, informal communication can also be a result of the flat structure. Monge & Fulk (1999) indicates that more extensive informal communication is required due to the lack of formal rules, procedures, clear reporting relationships, and norms. In contrast to formal communication which structure information channels facilitating downward transmission of orders and upward transmission of information, the informal communication can be more personal peer-oriented and interactive (Staples et al., 1998). Informal communication, which is more interactive than formal communication such as report and structured meetings, allows for rapid feedback, sharing local context, and contingent conversations (Feldman, 1984).

Under the globalizing textile business environment, interruptions are pervasive during inter-organizational or intra-organizational communication processes. Group work may require highly intensive interaction among group members, and the interdependence of the members' jobs gives rise to a great extent of task progress uncertainty as problems in a member would inflict additional problems to other members in repercussive way. Modern information and communication technologies are becoming more advanced and accessible while their cost declines. Thus frequent interruptions during work time become inevitable. Increased synchronicity of communication makes the interruptions even more intrusive.

2.1.2 The Psychological Perspective of Interruptions

A large body of previous psychology research investigates how interruptions affect human behavior and team performance, and some interpret interruptions as intrusive, extremely disruptive like "constant, constant, multitasking craziness", and would cause "time famine" and other negative effects (González & Mark, 2004; Perlow, 1999). It is very common that people perceive difficulties in resuming interrupted tasks. Interruptions are something to be avoided in user interface design wherever possible. According to Minassian et al. (2004), communication technology design should follow a simple principle of "avoid interruption if possible → handle interruption if necessary → recover previous activity".

Nevertheless, in most cases, interruptions are found having a mixed and complex effect on individuals, depending on task complexity and relevance to the ongoing work, execution time, and so on. Some researchers have demonstrated that people have some natural abilities to dynamically adapt their behaviors to accommodate interruptions. For example, Woods et al. (1995) holds the view that people have a natural ability and predisposition to multitask. But such ability can be unreliable and highly vulnerable to external influence. Mark et al. (2005) also reports that information workers manage on average 12 different projects concurrently; each project may involve unique set of contacts: colleagues, customers, vendors, etc.

Without appropriate regulation, interruptions might exert negative effects on the task performing and emotional state of the team members. For example, Cohen (1994) finds that unpredictable and uncontrollable interruptions induce personal stress in performing tasks, especially the tasks requiring higher mental load. Interruptions on unsuitable timing can cause people to make mistakes, reduce their efficiency, or both (Gillie & Broadbent, 1989). According to the study of O'Conaill & Frohlich (1995), in 41% of interruptions the recipients do not resume the work they were doing prior to the interruption.

One of the key questions for understanding how to coordinate interruptions is to identify the factors in deciding the disruptiveness of an interruption. Disruptiveness refers to a state that the person being interrupted is affected emotionally or on task performance by the interruption. Prior research has evaluated task complexity (Bailey et al, 2000; Cutrell et al., 2001), the similarity between ongoing and interrupting task (Gillie & Broadbent, 1989), the time of interruption (Cutrell et al., 2001), and the methods of coordinating interruptions (McFarlane, 2002). In general, the higher the cognitive load of the primary task when interrupted, and the more irrelevancy of the secondary task to the primary task, the more a user will be vulnerable to an interruption; also more likely that interrupted task performance will decrease.

Gillie and Broadbent (1989) conducts several experiments to study the phenomenon of everyday experience that some interruptions are disruptive while others are not. The results suggest that the nature of the interruption (in terms of similarity to the concurrent task) and the complexity of the interruption (in terms of the amount of information processing or memory storage required) seem to determine whether the interruption will be disruptive or not. People would experience a task re-orientation period called “latency” to resume the interrupted task. Normally, people would need a couple of seconds or several minutes to get the chain of thoughts back after being interrupted by a new email.

Zijlstra et al. (1999) indicates that interruptions facilitate performance on simple tasks while inhibiting performance on complex tasks. From the psychological perspective, human tend to use their unoccupied mental effort on interruptions when performing non-challenging jobs. The occurrence of interruptions requires them to focus more deeply on the primary task and this results in better overall human performance. Speier et al. (2003) also finds, however, that this phenomenon does not hold for complex or cognitively demanding tasks. When people are cognitively engaged in demanding tasks, interruptions decrease their performance. People also have individual differences in their ability to accommodate interruptions during their multitask working period, in their ability to recall information about interrupted tasks, in their performance on interrupted tasks, and in how they handle interruptions in human–human communication (Spink et al., 2008).

Current literatures are mostly dealing with the effect of interruption on individual and task performance (e.g., Adamczyk & Bailey, 2004; Czerwinski et al., 2000). Cohen & Bailey (1997) finds that unpredictable and uncontrollable interruptions induce personal stress that can negatively affect performance after interruptions. Bailey & Konstan (2006) conducts an experiment to measure the disruptive effect of an interruption on a user's task performance. The results of the experiment demonstrate that a user performs slower on an interrupted task than a non-interrupted task, and the disruptive effect of an interruption differs as a function of task category. So, it is suggested by them that an application should avoid interrupting the user's current task whenever possible.

According to the psychological view of Human-Computer Interaction, task structure generally affects mental workload (Card et al., 1983; Monk et al., 2002). Task structure refers to the subtasks and boundaries within the task decomposition. This is why interruptions in earlier stages of a task when people are not fully immersed in the task usually considered as less disruptive. In further research on this problem, another experiment by Bailey et al. (2001) demonstrates that an interruption has a disruptive effect on both a user's task performance and emotional state.

Psychologically, the structure of human information processing system can be divided into two classes: conscious and subconscious; and memory into two classes: short- and long- term memory. In practice, working memory is usually short term memory. We can also assume that only a single task can be under conscious control at one time because of the resource limits. Other tasks can be performed subconsciously without pre-occupied resource, so that those tasks can be done simultaneously. Only routine, well-learned tasks that have already been developed specialized procedures can be done under subconscious control.

There can be two states in human information processing system: task-driven and interrupt-driven. When people are deeply engrossed in a task, they are task-driven (Miyata & Norman, 1986). However, people seldom keep themselves constantly in a task-driven situation because of the changing environment. They need to frequently interact with one another and are apt to be interrupt-driven. In a task-driven situation when people are deeply engrossed such as in the middle of a programming job, it is very costly to interrupt. It is suggested to use a signal to make people be aware of the incoming request, instead of an immediate interruption. They will detect gross signals, but not the message details. Even so, the abrupt sensory signals such as flashes of light or twinkling windows or auditory tones can cause some degree of disruptive effects.

Hence, interruption does not always cause people to make errors. People are able to successfully perform multiple tasks concurrently under particular conditions. Although it is claimed that people ordinarily perform two or more activities during the same time frame, it does not mean that people do it easily, neither is the reliability ascertained (Preece & Shinghal, 1994). Such human cognitive limitation in handling interruptions makes it hard to switch between tasks without a decrease in task performance or extension in completion time.

2.2 Interruption Management

Ljungberg (1999) tests collaborating workers' attitude toward interruptions and surprisingly finds people want to be accessible constantly, but never for all kinds of communication. The similar attitude has been found by other researchers. Although many people find interruptions disruptive, most of them tend to open to others in their lull time. In an observational study conducted by O'Conaill & Frohlich (1995), interruptions are seldom resisted by recipients. For another example, Hudson et al. (2002) investigates the managers' attitude on interruptions and finds that managers want to be accessible to those who need their attention during personal time; at the same time, however, they wish to maintain control over these interruptions. They do not mind handling interrupting tasks at leisure time, but they want them to fit into the holes in their personal schedule rather than disrupting it. Hudson et al. (2002) collects a manager's opinion about interruptions:

> *"I would not mind being connected all the time, but more on the email side than on the phone mail side. … It's probably more in a pull-mode connected than in a push-mode connected."*

In today's apparel manufacturing, the product specifications are delivered through emails, faxes, phones, which are almost the same as a decade ago, except virtual workers use web-conferencing a lot more. Such plain methods of conveying important information would cause data loss, and more importantly, the interruptions when interactions among the partners are not coordinated. The production processes are complex and involve many parties. An apparel item can be subject to more than fifty modifications or enhancement before production is complete. As a result, ensuring everyone in the collaboration network get an accurate and up-to-date description of the garment is vital. In such process, providing updated information to the right person at right time is the biggest challenge, and this is the core purpose of interruption management. Without effective interruption management, the collaboration would probably turn into finger pointing because there is always a disparity between those who get disturbed by interruptions and who gets the benefit. For instance, an apparel shipment arriving at the brand distribution center or even the retail points is discovered with off-spec defect, owing to a manager in the supply chain has missed an important interruption message for new specification change. If the critical changes in product design or distribution cannot be coordinated throughout the supply and distribution cycle, confusions and mistakes can be repercussively growing along the year-long supply chain operations.

People do not mind being interrupted by necessary or worthwhile pieces of information, but they do prefer the interruptions happening at more desirable time. Since more intensive, informal and contingent communication is required in virtual collaboration, interruptions become essential, as a double-edged sword to industries and business. While some interruptions bring new and helpful information, some of them cause disruptive effects to people's work. The relatively high interdependence of working tasks among textile virtual team members makes it hard to resist interruptions. Nevertheless, when people deeply concentrate on work that requires highly cognitive effort, any external interruption can distract them, especially the irrelevant information.

Research indicates that the feeling of being disrupted led by unfavorable interruption could be mitigated through better coordination of interruptions via taking good advantage of modern technologies in diverse contexts (e.g., Basoglu et al., 2012). The concern is how people can maintain the mental concentration while allowing interruptions in the current work. If the external interruptions cause less disruption to the normal performance of ongoing tasks, the efficiency and effectiveness of virtual teams is expected to be largely enhanced. Under such circumstance, it is vital to coordinate and regulate interruptions that naturally happen in the process of virtual work, instead of simply cutting off the sources of interruption.

For sakes of effective virtual collaboration, positive interruptions are desirable, and should be treated with due attention while negative interruptions should be taken under control. This approach is critical, yet difficult in virtual team practice, and there are no agreed answers to-date. Thus, how to make the interruptions controllable is the central issue of the present research. Extant literature has examined the various differences between virtual teams and collocated teams, and the effects of interruptions on the task performance and individual emotional state under diverse settings. Also, substantial studies have established models that indicate the antecedent factors of effectiveness for virtual team communication. However, very few of the team studies concentrate on managing interruption management issues, which plays an incredibly important role in promoting virtual innovation team effectiveness.

As figure 2-5 shows, the effect of interruptions on both task performance and individual emotional state is complex. Some interruptions can exert positive influence to interruptees (persons being interrupted) while some bring negative effect. The interruptions, which, for example, are anticipated, or bring important information to accelerate mutual understanding between the parties of virtual collaboration, can be recognized as positive. These interruptions can provide people with rich information and some refreshment as stated by the subjects from the interviews; the critical information exchange could facilitate timely problem solving during the course of managerial decision making. Such interruptions which can bring a new perspective, or update operational requirements can prescriptively adjust mutual understanding and sustain the virtual collaboration.

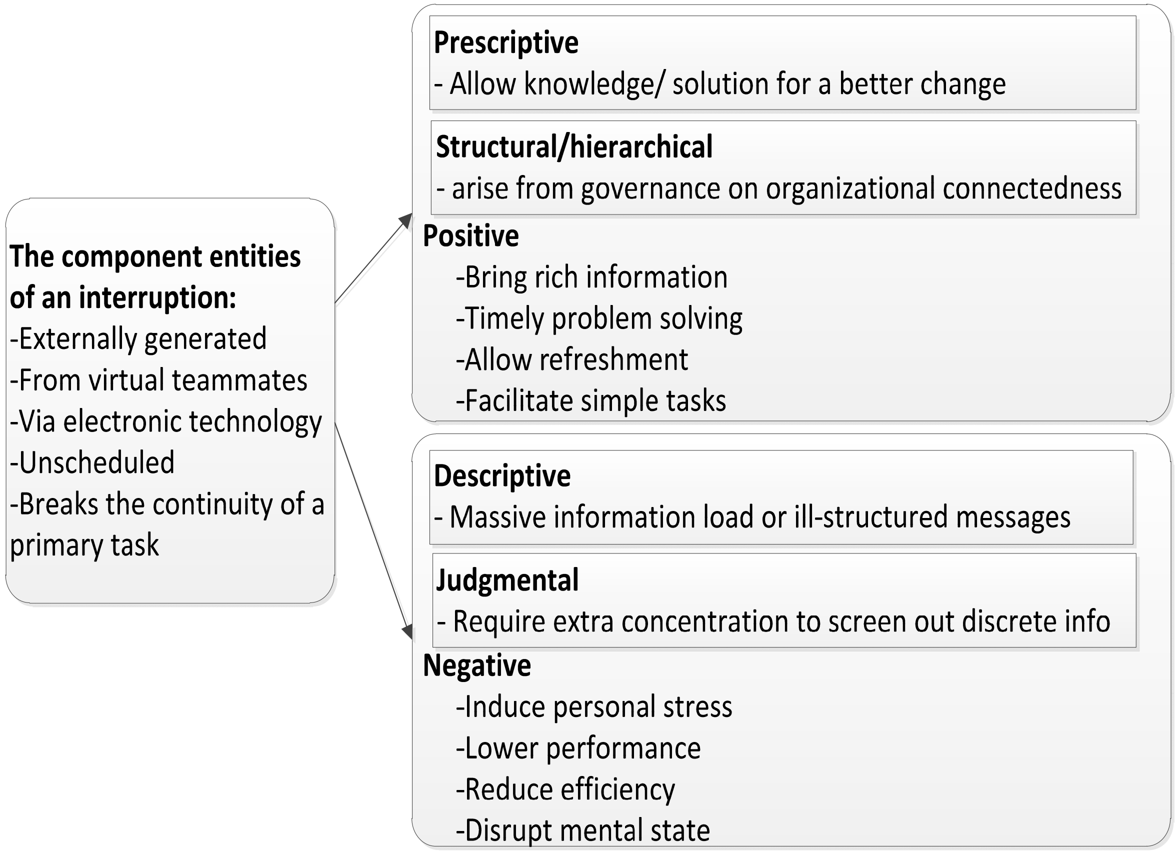


Figure 2-5: Types of Interruptions

Again virtual team members or units are often nomadic and autonomously monitored. They are characterized by diverse expertise and work pattern, exercising their own sense of professions and judgment. Conventional hierarchical structures seem not appropriate for monitoring their activity progress and results. However, autonomy and control are inseparable, especially in innovation activities (Feldman, 1989). Perhaps autonomy in individual team units would demand different extents of authority and resources, tending to over-emphasize individual own interests. As they do not congruously align with each other, excessive autonomy leads to a prevailing culture that takes collaboration away from organizations, particularly built on the basis of virtual structures. Therefore interruption resulted from hierarchical governance can exert a function like a sort of switching station to regulate team interaction and set forth inter-team priorities and commitment to common goals.

Contrarily, some unpredictable or uncontrollable interruptions would bring unfavorable, reproachful effects. Virtual innovation team workers may perceive unpredictable and sudden interruptions as personal stress and negatively affect performance after interruptions. For example, when some tasks demanding intensive mental occupation are being performed, such as calculation, writing, and conception, the interruptions will probably break task work continuity and inflict disruptive effect. In most cases, such interruptions are simply descriptive in nature, stating massive or levels of factual messages in ill-constructed format, such as special terms of references or discrete appendices. Virtual innovation team members cannot handle such interruption off-hand, and need laborious efforts to judge and discern the significance and values of interrupting message contents. Such interruptions induce negative attitude toward virtual communication and interaction. In controlling the communication efficiency of virtual work, interacting team members shall have employed multiple communications technologies to anticipate and alleviate the undesirable impacts of interruptions.

Succinctly, the literature provides views of virtual team collaboration management, merely under the rubrics of interruption research in organization science and information processing. On these premises, the author posits that effective interruption management helps virtual innovation teams to regulate various sources and types of interruptions, alleviate negative effects caused by interruptions, and increase the effectiveness of team collaboration. The author attempt to extend the concepts and model the antecedents of interruption management within today’s globalizing textile virtual collaboration contexts.

2.3 Integrated Management Model to Coordinate Interruptions

This section puts forth a hypothetical model of the organizational and technological characteristics of virtual team’s interruption throughout the collaboration process. The hypotheses and constructs are developed based on extensive review of related research and theories. The hypothetical relationships in the research model and the rationales of postulating these hypotheses are described first, followed by the conceptual model that shows the hypothesized relationships. The conceptual model sets up the framework for empirical test of the hypothetical relationships of the proposed constructs.

Dabbish & Kraut (2004) puts forth that three principal aspects that need to be emphasized in controlling the disruption associated with contingent interaction: (1) imposing information displays or norms to synchronizing interruption attempts with the recipients' lull periods (when they are not intensively engaged in some tasks); (2) technological: provide the target of interruptions with advanced technologies such as filtering systems to control the volume and nature of interruptions; (3) motivational: increase selectivity of initiating interruptions through economic or other incentives. In light of the discussion of this research and other related efforts, the author develops four antecedent factors of interruption management: intra-team awareness, virtual technology, task interdependence, and motivating & governance systems.

2.3.1 Intra-team Awareness (ITA)

Increasing positive interruptions and decreasing negative interruptions is a plausible way of managing interruptions and making interruptions less disruptive. As described earlier, interruptions that bring rich, constructive information to resolve current problems are positive while interruptions that bring disruptiveness to the recipients yet without much benefit to teamwork can be negative. Developing intra-team awareness could help to control the interruptions with undesirable timing, and increase the chances to initiate interruptions at desired timing. Fostering higher levels of intra-team awareness within the virtual team could help to avoid interrupting people concentrating on important tasks, and that in turn decrease the number of disruptive interruptions. As Dourish & Bellotti (1992) describes, awareness is an understanding of other team members' activities, which provides a context and guide in performing their own tasks. In this research, intra-team awareness for members in a virtual team refers to team members' understanding of their task context, project environment, and other members' activities, which provides a context and guide in performing their own tasks.

According to literature, timing of an interruption plays an important role in its effect on individual and the interrupted task performance. Bad timing can make interruptions very disruptive. With higher intra-team awareness, individuals are more aware of the virtual shared workspace and other members. Badly timed interruptions can affect task performance even it is motivated by good intention. Researchers (e.g., Adamczyk & Bailey, 2004; Bailey & Konstan, 2006; Iqbal & Bailey, 2005) report that interrupting tasks at random moments can cause the interruptees to take up to 30% longer to resume tasks, commit up to twice the errors, and experience up to twice the negative effect than interrupting at proper moments. Even it does not cause mistakes, it lowers task efficiency as the interruptee needs a long period of re-orientation to resume the primary task (Bailey et al., 2000). Iqbal & Bailey (2006) empirically demonstrates that interrupting at subtask boundaries results in much lower cost of interruption than non-boundary moments. Adamczyk & Bailey (2004) puts forth that different interruption moments have different impacts on emotional state of the recipient.

As interrupting members with high mental occupation is what we are trying to avoid in interruption management, awareness display provides indications of whether it is appropriate occasion to initiate interruption to the team members. Thus, the chances of interrupting high mental load teammates can decrease by the utilization of awareness display technology. Awareness display is a technique provided by virtual technologies to show the mental status and availability for external interruptions. It sometimes reflects the user's willingness to accept interruptions at the moment. Awareness display offers information required for virtual team members to decide the proper opportunity for interruption. Checking awareness and availability status of the recipient before initiating interruptions could help to prevent negative interruptions which cause intrusion to the recipient's ongoing demanding work. Lack of such regulation of interruptions may lead to constant disruptions to virtual knowledge workers' task performing in some highly interdependent teams, and may cause adverse effect on the interruptees, such as make errors, decrease efficiency, change emotional state, or even lower the whole project progress (Cohen, 1994; Hudson et al., 2002; Tang & Birnholtz, 2010). As a result, awareness display is a simple and effective way to help manage interruptions by providing contextual information for interrupters to judge the interruptees' readiness for interruptions (Dabbish & Kraut, 2008).

Awareness display can provide contextual information about the activities of group members. It enables other team members to be aware of teammates' availability for interruption or readiness for interaction (Dabbish & Kraut, 2008). For textile firms, it is important to use awareness tools to indicate availability of remote workers and to increase their sense of presence across virtual teams (Koehne et al., 2012). Tang & Birnholtz (2010) demonstrates that awareness display lowers the disruptiveness that interruptions caused to the interruptees: among the 76% of people who check the other party's awareness prior to interruptions, 19% of their partners are performing high load tasks. Within the 19% interrupters, 2% still insist on interrupting while 17% stop the attempts of exert immediate interruptions, which would prohibit people from concentrating in highly demanding work.

As interrupting members with high mental occupation should be avoided, awareness-check provides indications of when is appropriate to initiate an interruption. Within the internal collaborative systems, awareness display which exhibits whether the user is busy or currently away or available (like the status display in MSN) is one of the ways to enable intra-team awareness. For instance, when help from colleagues are needed, most people would like to reach the most available teammate for assistance; but when they do not have the access to their awareness status (like who is available and who is occupied with which task) via communication technologies such as internal integrated systems, they probably would randomly choose one to interrupt. If team members have more information about each other's status, the chances of making intrusions to the deeply committed ones will be smaller.

There are also some risks in showing personal availability within virtual team; privacy protection is one of them. Activities like listing the performing tasks online, showing the project progress, sharing teamwork calendar do provide context for teammates to distinguish appropriate time for interruptions, except they may expose too many details that are not supposed to be exhibited in face-to-face teams. Erickson & Kellogg (2000) presents the idea of social translucency (instead of transparency, the term translucency is used to account for the tension between privacy and information availability). The social translucency has three facets: visibility, awareness, and accountability, which are expected to provide availability information so that interrupters can self-regulate their willingness to interrupt others' work.

Succinctly, intra-team awareness is found to diminish the barriers caused by spatial distances in virtual interaction and collaboration. Some information technologies could improve intra-team awareness by availability display, personal task progress sharing, or schedule sharing, etc. Intra-team awareness can, in turn, regulate and alleviate inter-member interruptions. When team members are more aware of each other's mental status, the negative interruptions are more likely to decrease. Although checking awareness status increases the cognitive workload on interrupters, it reduces undesirable interruptions, and encourages the synergistic effect of team member collaboration.

Based on the contextual and empirical support stated above, the following hypothesis is postulated:

H1: the development of intra-team awareness has a positive effect on interruption management.

2.3.2 Virtual Technologies

Communication is an essential function in the practices of textile virtual teams. Therefore, during the course of project collaboration, there is a reliance on computer-mediated communication to provide adequate contextual discussion as well as knowledge sharing. Hence, how the collaboration and communication technologies are deployed to ensure smooth remote communication is a central issue to virtual teams. The author explores the role technology plays in virtual collaboration under the rubrics of active theories in the past three decades, and discusses how these technologies can support interruption management and effective virtual collaboration under various circumstances.

- **Theories Regarding Virtual Technologies**

The author analyzes and synthesizes the theories regarding virtual communication technologies so as to understand the rationale of proper utilization of technologies under diverse circumstances. Virtual teams are facing more challenges than face-to-face teams. When virtual collaboration first came to application, it was deemed to be more difficult to attain effective interaction due to the "weaker" capability of conveying social context cues than face-to-face contacts. Media richness is the communication medium's ability to carry data and symbol, i.e. the ability to transmit information and related cues about the individuals who are communicating. According to media richness theory (also known as information richness theory), for equivocal issues, ambiguous messages or complex contexts, richer media is generally more effective than the simple, restricted content media, which are also known as "lean" media (Daft & Lengel, 1986). For virtual communication, video conferencing is relatively richer media while text-based chats and emails are leaner media.

Short et al. (1976) establishes social presence theory. Although this theory was actually developed to highlight differences in the use of the telephone and face-to-face media, it has influenced much computer-mediated communication research over the years. Social presence describes the degree to which the media allows users to feel psychologically close or present (Fulk et al., 1990). Weisband et al. (1995) demonstrates that people usually project their own personal styles, previous experiences, and social norms of past interpersonal interaction into electronic communication. This theory posits that the communication effectiveness is not only determined by the intrinsic content richness of the medium, but also largely affected by interacting persons' characteristics and inner states.

More, Walther (1992) presents social information processing theory, which is an interpersonal communication theory, holds that intra-team personal relationship in virtual teams might require more time to develop than that in traditional face-to-face teams. The researcher proposes that despite the lack of nonverbal communication inherent in virtual interactions, people can seek out and interpret cues that serve as substitutes of nonverbal communication, such as use of emoticons and time stamps. In this theory, people are conceived as being capable of adopting and interpreting alternate methods to form impressions of others in the absence of social cues.

Extending these ideas even further, a structuration perspective is taken into the virtual organization communication research, by acknowledging the reciprocal and co-evolutionary dynamics between organization and technology. DeSanctis & Poole (1994) builds Adaptive Structuration theory, which is a viable approach for studying the role of advanced information technologies in organization change. Groups and organizations using information technology for their work dynamically create perceptions about the role and utility of the technology, and how it can be applied to their activities. These perceptions can vary widely across virtual teams, and influence the way how technology is used and hence mediate its impact on team outcomes.

The series of theories concerning the social aspects of technology are called social dynamic media theories, which emphasize the social and contextual aspects in virtual communication. Those social aspects include the organizational culture, relational contexts, competitor's environment, etc. Compendiously, while the richness of interaction channel may promote the development of awareness, rapport, and trust within the virtual team, user experience of a specific interaction tool also influences technology effectiveness in supporting virtual collaboration.

Concluded from these theories, virtual technologies are becoming more and more effective in conveying social contextual cues and creating shared interpretive social context among team members. Collaboration technologies facilitating effective communication should enable: (1) the continuity and accuracy of communication, (2) the conveyance of nonverbal and social cues, (3) the atmosphere close to face-to-face interaction, and (4) individual involvement to the team. In addition, the choice of virtual-communication-supportive technologies should be in line with the task nature, project stage, and experience. For unstructured tasks, rich media would be more suitable to be employed in interaction while leaner media can be used in certain and routine tasks. The ability to allow people to be more "present" through a technology is also required, especially in the early stages of a project when the team members are not familiar with each other.

- **Advanced Technologies to Coordinate Interruptions**

The advances in information and communication technologies have increased the number of ways one person can interrupt another within a virtual team. In view of heavy information load among the members, the onset of an external activity that requires immediate attention can interrupt their current tasks. Therefore, some filtering systems and negotiating systems to coordinate interruptions are reported by researchers (e.g., Acosta & Selker, 2007; Liebowitz, 2010). Filtering systems can control the volume of the incoming interruptions. For example, when others approach the user who is deeply committed to his own task through the Internet, the negotiating system would ask the initiator to display the most important feature about the request (what is it about, how urgent and important it is for the whole team, how long it takes to complete, etc.). Then they will automatically filter the tasks with higher priority to immediate interrupt the user, while negotiating another time for interaction for tasks with lower priority.

This kind of filtering system decreases the opportunities for discrete issues to cause disruptions to people under high mental workload, thus increases effectiveness of interruption management within virtual collaboration. Horvitz et al. (2005) develops a system called “Bestcom Enhanced Telephony”, which is being used at Microsoft to manage interruptions from phone calls, instant messages and emails. The system has a wide range of sensors to evaluate the availability of a user such as microphones to detect if there is a conversation underway and the use of inexpensive web cameras that can determine if the user is having conversation with others. The system can also use e-calendar of the interrupter and the recipient to schedule interaction for a mutually convenient time.

Some mediating systems are also available for coordinating interruptions. They are like secretaries, which can determine whether, when, and how to contact the user when it receives the request of interruption. The negotiating systems can be a comparatively more complex system based on the filtering technique. This kind of system is usually referred to as communication agents or notification managers. For example, Tang & Begole (2003) explores the feasibility of automatic availability management system based on activity monitoring. Wiberg & Whittaker (2005) develops a negotiator system, which can automatically negotiate with interrupters of a better opportunity interaction when their human users engaged in other activities. In a somewhat more complex approach, Milewski & Smith (2000) builds on a telephone system that allows a caller to preview a recipient's self-declared state before placing a call and discovers that users of the system never seem to remember to change their availability state. In spite of the differences in effectiveness of managing interruptions, various kinds of technologies are invented and put into application for the purpose of interruption regulation. Individuals experience a revolutionary shift from a pattern of accepting all interruptions into interaction utilizing smart and autonomous technologies based on human supervision (McFarlane & Latorella, 2002).

To summarize, the feeling of being disrupted led by unfavourable interruption could be mitigated through better coordination of interruptions via virtual technologies. Coordinating interruptions should be an important lesson to be learned for textile virtual teams. The textile & apparel firms collaborate as virtual teams in order to increase dynamic capability to win the market, rather than get redundant information. While synchronous technologies such as remote conferencing, telephones, instant messaging, electronic rooms, e-brainstorming can support contingent communication and immediate feedbacks, asynchronous technologies such as emails, groupware, shared file centers are favourable if the user is mentally occupied. Some more intelligent technologies are also available. The filtering systems are used to filter unfavorable interruptions by key words, so that only interruptions related to the primary task and the interruptions with higher priority can be delivered to the recipient, and the other incoming tasks would have to wait until the completion of the ongoing task. With these technologies, the virtual collaborators should pay attention on when and how to use different technologies, in terms of media richness, synchronicity, and functionality, etc.

Based on the evidences from literature, the following hypothesis is postulated:

H2: the appropriate utilization of virtual technology has a positive effect on interruption management. Various techniques and functionalities offered by modern information and communication technologies largely enhance the quality of interaction, and are helpful in coordinating interruptions at the same time.

2.3.3 Task Interdependence

During the past two decades, researchers concerning interruption issues have laid particular emphasis on the technology progress. However, without the understanding on human factors of the textile virtual teams, the coordination methods of interruptions might be limited and unilateral (Harr & Kaptelinin, 2007). Without taking into account a broader social context, interruptions cannot be even judged as negative or positive (Burmistrov & Leonova, 2003; Hudson et al., 2002). Ackerman (2000) also argues that technological systems are rarely able to independently deal with this sort of social construction.

Task interdependence, which refers to the degree to which team members depend on each other (in terms of information, materials, and support) to accomplish jobs, is often the reason that virtual teams are formed in the first place, and it defines team characteristics (Campion et al., 1993). In collaboration, work can be designed to be highly interdependent; requiring members to be highly involved to pursue their shared goal. For branch offices across the globe of one single company, there is a shared goal of achieving organizational interest. When individual organizations collaborate as business partners, task interdependence is the result of direct and indirect alliance or buying relationships in the collaboration network. Collaboration involves not only aligning the economic goals of the partners in the network, but also the social dimensions, such as task interdependence and management structure. Figure 2-6 delineates how close the tasks of two parties of a collaborating team can be, using the interaction between the brand and the mill in the fabric development process as an example. There are frequent interactions and documentary exchange between them during the collaborating activities from sample enquiry, specification change, testing, to fabric approval. Especially in the traditional industries like textile and apparel, the interaction processes can be very detailed and trivial. The task interdependence can be considerably high among all parties involved in the supply chain.

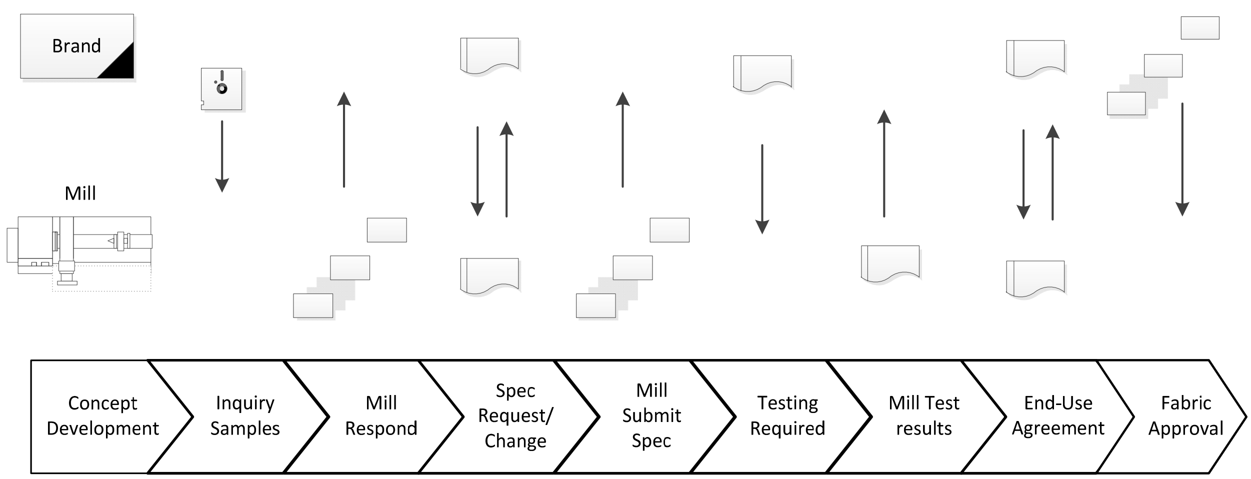


Figure 2-6: the Collaboration between the Brand and the Mill

A body of research states that task interdependence influences team process of interruption management and team outcomes (e.g., Kozlowski & Bell, 2003; Wageman, 1995). Interdependence is an important aspect in organizational work teams. Maynard et al. (2012) and Kozlowski & Bell (2003) suggest that interdependence remains an important antecedent in virtual team model; it's a structural team-level input that imposes specific demands on interactions to support effective team performance.

The degree of task interdependence of virtual team can be positively related to team members' sense of responsibility and the feeling of being needed. Task interdependence may influence the motivational properties of treating external interruptions in virtual work because it enhances the sense of responsibility for others' work (Kiggundu, 1983). Similarly, Gundlach et al. (2006) suggests that task interdependence affects the communication process due to its enhancement on collective planning. Higher levels of interdependence create the incentives for 'facilitative behaviors' that are needed for performing tasks (Wageman, 2001). It is similar with the finding of Somech et al. (2009), which indicates interdependence encourages communication, support and cooperation among team members. In addition, Rico & Cohen (2005) also finds that teams with higher task interdependence could be most effective, and these teams are always associated with a higher frequency of communication between team members, a higher level of complexity of decision making process, and richer communication channels. That indicates interruptions and intensive interactions due to higher task interdependence can have positive effects on collaboration effectiveness when the teams are under proper control and management.

Previous research provides insight into the mechanism of the relationship between task interdependence and virtual team process (Johnson & Johnson, 1989; Van de Ven et al., 1976). The main underlying reason that task interdependence affects interruption management is that interdependence creates the incentives of cooperation in performing tasks and interaction. Interdependent team members would have much higher sense of responsibility for helping others to complete shared duties. Under such context, members would feel more obligated to avoid disruptions caused by interruptions (as interrupter), and cooperate with others by answering incoming interruptions (as interruptee). Responding to the interruptions in the premise of not disturbing own work is an important way of keep the whole-project moving forward. As such, task interdependence imposes specific demands on the smooth interaction to support effective interruption management.

Traditional teams can accomplish their jobs more independently. For instance, product design team spends a lot of time discussing product features and technical requirements while sales team puts much implementation effort on coordinated marketing and distribution operations. Once coordinated, they can run their own tasks concurrently without much concerns of processing details of dependent tasks. However, virtual teams comprise many different functioning parts and specialists; they integrate the upper and downstream of the product supply chain. Members in virtual teams depend on each other for new information exchange and professional idea sharing to cope with uncertain market environment. Responsive and intensive interactions are thus required. Virtual teams tend to work more collaboratively with higher task interdependence, because their tasks are sometimes structured sequentially dependent, demanding accurate outputs from preceding tasks as key inputs for succeeding tasks. With higher interdependence, team members tend to plan, strategize and prioritize the tasks that help the entire team become ready to perform their tasks (Kozlowski & Bell, 2003; Maynard et al., 2012; Saavedra et al., 1993).

Based on the above discussions, the following hypotheses are postulated:

H3a: task interdependence within the virtual team determines the significance of interruption management. If the members are more dependent on each other for task completion through the aspects of authority, resources, opinions or technical support, they are more likely to open to interruptions, and deal with interactions during their working time.

H3b: well-strategized task interdependence within the virtual team is positively related to the virtual collaboration effectiveness. High levels of task interdependency can increase in the interruption volume, yet stimulate collaborative mind and collective behavior among members. Higher interdependence would prompt team actively in interaction and would help interruption management, thus facilitate team performance.

2.3.4 Motivating & Governance System

The motivating system of the virtual team refers to how performances of team members are motivated and stimulated. It is associated with the standards and criteria of allocation of benefits and compensation (both monetary and non-monetary) to the members. The motivating system for a virtual team provides criteria for members in evaluating and coordinating team behavior. The motivating and governance system indicates how reward and other incentives are allocated and how team members are motivated to achieve better performance. The structure and allocation of rewards might affect the motivation of team members, and the motivating system is central to many models of work team effectiveness (Hackman, 1990).

The motivating and governance system of a team considerably influences team members' attitude toward interruptions, while technology system impacts people's ways of coordinating interruptions. The motivating system is important particularly in interruption management in virtual teams because how to treat an interruption is not solely a matter of two people (the interrupter and the interruptee), but influences output of the entire team.

There is incongruence between traditional reward system and the requirements of emerging form of virtual teamworking. Traditional reward allocation system is based on the principles of organizational management. It emphasizes functional division of labour, hierarchical differentiation in authority, and direct standardization of work routines. In virtual teams, the context and organizational settings have changed, and such motivating system might no longer be suitable. Virtual teams emphasize collaboration, less routines, loose coupling, with simple hierarchy and not much sense of supervision (Agarwal & Singh, 1998).

Various kinds of reward (bonus, raise in salary, etc.) and other incentives (promotion, award, vacation, recognition by management, etc.) in encouraging better work performance compose the motivating system of a team. There exist several distinct motivating systems. For virtual teams which have less hierarchical structures, the position based incentives are obviously not good ways for managing team members. In contrast, performance based motivating system is more suitable for the achievement of the shared goals. The collective and individual based motivating systems are two principal ways of allocating rewards, and the argument of the comparative advantage of the two principles has been long-standing. For example, DeMatteo et al. (1998) introduces two types of reward allocation procedures. Equity norms and equality norms: Equity norms disburse the team's reward in proportion to the contribution of the individual team members, while equality norms divide the team's reward equally despite the varying degrees of contribution among the team.

Although team-based approach has been criticized because people are not recognized for their specific work, the team-based motivating and governance system helps to regulate and coordinate interruptions within virtual team and grows in popularity in worldwide organizations. To summarize, appropriate team-based motivating and governance system (includes monetary and nonmonetary incentives) facilitates interruption management among virtual collaboration. In the volatile textile business environment, interaction among virtual innovation team members is intensive and intractable. The common goals and awards can promote and assert the values of their interaction and shared efforts, and encourage them to focus on their big picture by inter-supportive means. A team-based reward system stimulates the motivation for altruistic behavior (considering not only individual convenience but also whole-team benefit when dealing with interruptions) of the team members, which facilitates the interruption management in virtual collaboration. Lawler III (1995) also reports that collective based systems perform better in supporting cooperative behaviors among members than individual performance based systems.

The incentives based on individual performance are extrinsic motivators, which could have temporary impact on people's behavior. However, in the long run, they have no ability to change people's attitude toward work (Kohn, 1993). More importantly, extrinsic motivators would damage the collaborative atmosphere among the virtual collaborators. In contrast, team performance based motivating system is intrinsic motivator, which provides conditions of performing creative or challenging jobs.

Individuals in a team have to tackle both team goals and individual goals. Individual-based incentive system encourages members to pursue their individual performance goals, while team-based incentive system pay more attention to the team's shared goals. For many virtual teams, members of different functionalities collaborate to achieve shared goals. The collaboration among the members is especially crucial to achieve the team goals, and this makes the accomplishment of individual goals useless without reaching team goals.

Team-based motivating system supports interruption coordination and management in virtual team collaboration. On one hand, interrupters will probably decrease initiation of interruptions at random time. Sharing interest of team members makes them consider more about the entire team. For instance, before initiating an interruption, people would check the recipients' availability for external interruptions instead of interrupting whenever they are in need of immediate interaction. For the selection of mediating technology, they would also choose more appropriate ones under specific contexts, rather than choosing one without deliberate consideration.

On the other hand, interruptees would also treat interruptions from the perspective of whole-team-success. Under individual-based motivating system, team members would pursue individual performance and see personal task performing overwhelmingly important. In that case, other's need for interaction is something with low priority when their own tasks are unsettled, and this could result in efficiency loss in virtual collaboration because the team atmosphere seems to be more competitive than cooperative. There is always disparity between who does the work and who gets the benefit within the individual-based motivating system: the initiator of an interruption gets the benefit while the interruptee needs to afford extra work. This is supported by the study of O'Conaill and Frohlich (1995) that the individual-based systems tend to benefit the initiators with the recipients having little control over the interactions, and that overtime they may become self-defeating. In contrast, under team-based motivating and governance system, the highest priority always goes to team overall effectiveness.

The motivating system is also found to affect collaboration effectiveness of virtual teams. For example, Cohen & Bailey (1997) reports that a nonmonetary reward (e.g., recognition by management) is positively related to team's rating of performance. Kerrin & Oliver (2002) suggests that most problem-solving and improvement activities rely on team-based motivating mechanisms in which ideas are openly offered. For an effective motivating and governance system in virtual innovation teams, one of the most important principles is rooted in the recognition and reinforcement of excellent team performance on collective basis (Hackman, 1987). The reward system should adapt to specific characteristics of the team such as team task interdependence, and organizational structure. As organizations move toward team-based reward system and eventually into it, performance would become the result of how well members leverage skills into products or services.

A team-based motivating and governance system is the fundamental and basic reason for allocating reward and resource in line with team performance. In most virtual teams, members are from different professional aspects and their tasks are well-partitioned; the responsibility of every job is clearer and the team success relies on success of each progress. Such system is more like “collaborating mode” instead of “competing mode”, within which members perceive higher equality of team-based reward allocation. Bal & Foster (2000) regards team-based motivating structure as very important component in managing virtual collaboration effectiveness, and virtual team members are rarely directly rewarded by individual contribution. The reason is that dispersed individuals are connected and managed under nomadic working and collaborating pattern, so cooperation is much more demanded than competition. Such structure makes it ineffective and inappropriate to adopt the individual performance-based motivating system. Thus, the team-based motivating and governance system would be more suitable in managing virtual teams.

As organizations continue to adapt their structures to team-based governance, the interdependence level of team tasks would be increased because it’s getting increasingly harder to separate and distinguish the contribution of individuals (Nickel & Oneal, 1990). However, people have a natural ability to behave in certain ways based on the rewards they receive. Honeywell et al. (1997) finds that under a team-based incentive system, top performers incline to decrease their performance when their earnings are shared by poor performers, while poor performers continue to perform poorly because they benefit from others’ work outcome. In such situation, an effective governance system which goes with the collective motivating structure is vital to stimulate and sustain individual work performance and efficiency, because individual task performance is an indispensible part for the whole team in team-based motivating system. Virtual teams should consider appropriate governance methods to inspire individual team members. The governance system concerns how to motivate members so as to be more fair and encouraging, rather than using personal contribution-based reward as the only incentive. For example, the most effective members and the members with outstanding contributions would receive promotions and more responsibilities. Members who fail to fulfill task requirements constantly may no longer have the opportunity of being a part the virtual team. Besides, the average performers should be awarded with certain affirmation to strengthen self-esteem, which would be helpful in attaining members since they feel more demanded and fulfilled. The remaining members should be all contributive and indispensible, and would obtain the tools, skills, information, support, and freedom to innovate as they need. This ensures the fairness of reward attribution and sustains the competitiveness of virtual team members. Under such member performance governance, people might have higher sense of responsibility to the team, which helps interruption management.

In light of the above discussion, the following hypotheses are postulated:

H4a: team-based motivating & governance system positively affects interruption management. Team-based motivating system encourages members' open attitude toward interruptions. Under such structure, interrupters will probably decrease initiation of interruptions at random time regardless of the recipient's availability, and choose less disruptive mediating technology for interaction rather than choosing one without deliberate consideration. In the mean time, team-based governance system would ensure and encourage individual contribution under nomadic and dispersed collaborating environment.

H4b: team-based motivating & governance system positively affects the virtual collaboration effectiveness. The common goals and rewards can promote and assert the values of team member's interaction, as well as fully open discussion and shared efforts, which provide a sound basis for effective virtual collaboration.

2.3.5 Effective Virtual Collaboration

Owing to the intensive interaction and cross-functional collaboration, simply stopping interruptions from happening is not an ideal way to improve collaboration efficiency. Virtual team members are facing a dilemma to deal with interruptions. For the interruptees, the incoming interruption messages may be valuable and need immediate attention. For instance, some latest information from business partners can be important for decision making; and information about the changing environment is crucial to response quickly to the market. Missing these kinds of interruptions can be extremely costly for virtual teams as well as the firms. For the interrupter, there might be some trouble caused by this non-response because there are chances that the interrupter can do nothing before he gets reply on this issue. There is a continuing conflict between the need to concentrate upon one thing at work so that full processing capability can be gained to assure work quality, and the need to be alert for the unexpected, especially relevant and important external events and thoughts.

Since virtual team members may benefit from some interruptions, it is not appropriate to turn down all the communication requests. Some researchers try to reduce the degree of disruptive effect of an interruption, taking less account of the number of interruptions (Dabbish & Kraut, 2004; Dekel & Ross, 2004). Regulating and coordinating interruptions in proper ways are useful management approaches to eliminate problems caused by negative interruptions while enhancing work performance prompted by positive interruptions (Dabbish & Kraut, 2004; Jett & George, 2003; Spira, 2005). In addition, some researchers attempt to explore more fine-grained interruption management techniques to reduce the damage caused by interruptions, in order to facilitate virtual collaboration (e.g., Fogarty et al., 2005).

Hence, the author argues that improving the interruption management could help to mitigate the negative impacts while maintaining the positive effects in virtual collaboration. In the integrated conceptual model which identifies the relationship between organizational attributes and team effectiveness, interruption management is hypothesized to play a mediating role between the antecedent variables and virtual collaboration effectiveness. In other words, on one hand, interruption management is influenced by the organizational and technological factors; on the other hand, it exerts an effect on virtual collaboration effectiveness.

In light of the above discussions, the following hypothesis is postulated:

H5: interruption management positively affects the virtual collaboration effectiveness.

2.3.6 Proposed Conceptual Model

A series of contingencies that influence virtual collaboration effectiveness have been identified. In today's volatile textile business environment, interruption management process would largely mediate the effect of these contingencies on virtual collaborative effectiveness. Hence, the author proposes a model of interruption management in order to integrate the factors contributing to the enhancement of interruption management in virtual collaboration. The extant collaboration-driven model focuses exclusively on those geographically dispersed teams in organizations. This means that the model mainly applies to teams playing specific roles in virtual structures, with each member having a differentiated commitment and job duties respectively. The scope of both technological and social factors should be taken into consideration when looking into interruption problems. The author chooses interruption management as team processes because it is a central issue in prompting interaction effectiveness in virtual team collaboration, since the textile market continues to be volatile, elusive and competitive.

The author organizes and assesses the components using the inputs-processes-outcomes (IPO) framework which is the dominant theoretical lens used in the study of teams. The conceptual model draws upon Hackman's normative model of group effectiveness (Hackman, 1987) and is applied to the virtual team context. In the model, the author reports organizational and technological antecedent factors of interruption management in virtual teams. Effective interruption management helps the virtual teams to regulate various sources and types of interruptions, alleviate negative effects caused by interruptions, and increase the efficiency of team communication.

Based on extensive literature review, the theoretical model is developed to drive further analysis (shown in figure 2-7). The proposed model describes the antecedents (intra-team awareness, task interdependence, virtual technology, and motivating & governance system), mediating variable (interruption management), and consequence (virtual collaboration effectiveness) of this research. The objective of the model is to identify and examine the major determinants of successful interruption management in virtual team collaborations. Through the conceptual model, the author hopes to understand what should be present for a virtual team to better manage interruptions and promote effectiveness. The present framework focuses exclusively on virtual teams (geographically dispersed teams) in organizations. Besides pure virtual teams, there are also hybrid teams in which members pursue independent projects and, in the same time, collaborate on other projects or tasks to meet specific requirements.

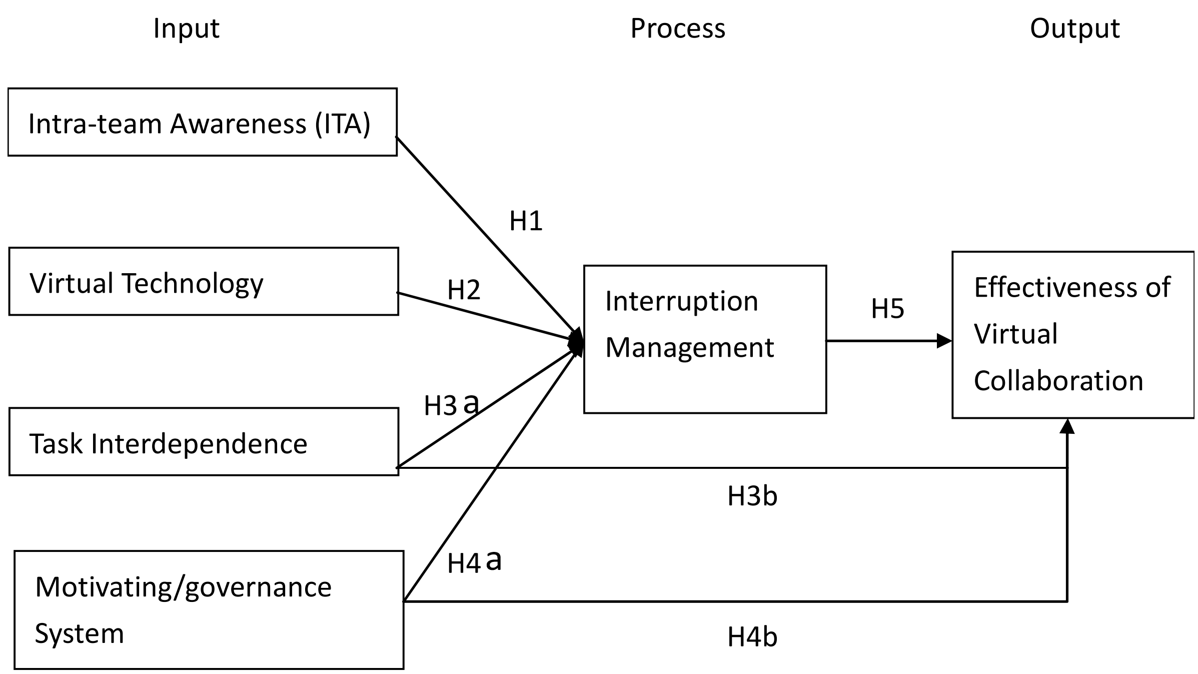


Figure 2-7: the Conceptual Model on Interruption Management and Virtual Collaboration Effectiveness

2.4 Summary

This chapter reviews the prior research that relates to the interruption issue within virtual collaboration, particularly in a textile & apparel business context. Extant literature has studied virtual collaboration and the interruption issue from various perspectives such as organizational science and information systems. Although the interruption effect on virtual team performance has been studied a lot, empirical research focusing on the coordination and management of the interruption in virtual collaboration is yet to be explored. In the research, the author seeks to identify the antecedents of interruption management, and its effect on virtual collaboration effectiveness.

The development of interruption management concept is relatively limited, without well-developed theories. The management of interruptions among virtual interaction is a critical issue in obtaining successful cross-functional virtual collaboration. The interruption management involves appropriate regulation and coordination of interruptions using specific technologies and managing concepts to achieve lower disruption and more effective virtual collaboration, which helps to improve competitiveness under the volatile market environment.

To assert the relationships among the constructs, the author proposes the conceptual model of the research interest and the hypotheses for empirical test. The proposed model is composed of inputs (the organizational and technological factors: intra-team awareness, virtual technology, task interdependence, and motivating & governance system), process (interruption management) and output (virtual collaboration effectiveness). The relationships among the antecedent factors, the interruption management and virtual collaboration effectiveness are presented in research model (see figure 2-7). The proposed hypotheses are drawn with evidences concluded from literature.

3. Qualitative Study

This chapter explains the qualitative research methods adopted in the exploratory stage of the research and its findings. The first part outlines the research design. The second part describes the qualitative in-depth interview approach that the author adopts in the preliminary stage of the research. The third part describes insights gained from the interviewing. Figure 3-1 depicts the research approach for this research.

3.1 Research Design Outline

The intent of this research is to explore the most influential factors that determine interruption management and virtual collaboration effectiveness in today's globalizing textile business environment. From literature review, the author puts forth four antecedent factors which are considered the most critical, namely, intra-team awareness, virtual technology, task interdependence, and motivating & governance system. The author attempts to use empirical data to examine the relationship among interruption management, virtual collaboration effectiveness and these antecedent factors. Such attempt is innovative since extant research in this field mostly focuses on interruption's effect on virtual team performance instead of constructing frameworks that guide interruption management. To accomplish such research objectives, the author conducts the research in the real-world context and adopts multiple methods to complete the empirical investigation. The author believes that such a methodology could achieve a high authenticity and generalization, and most importantly, objectivity.

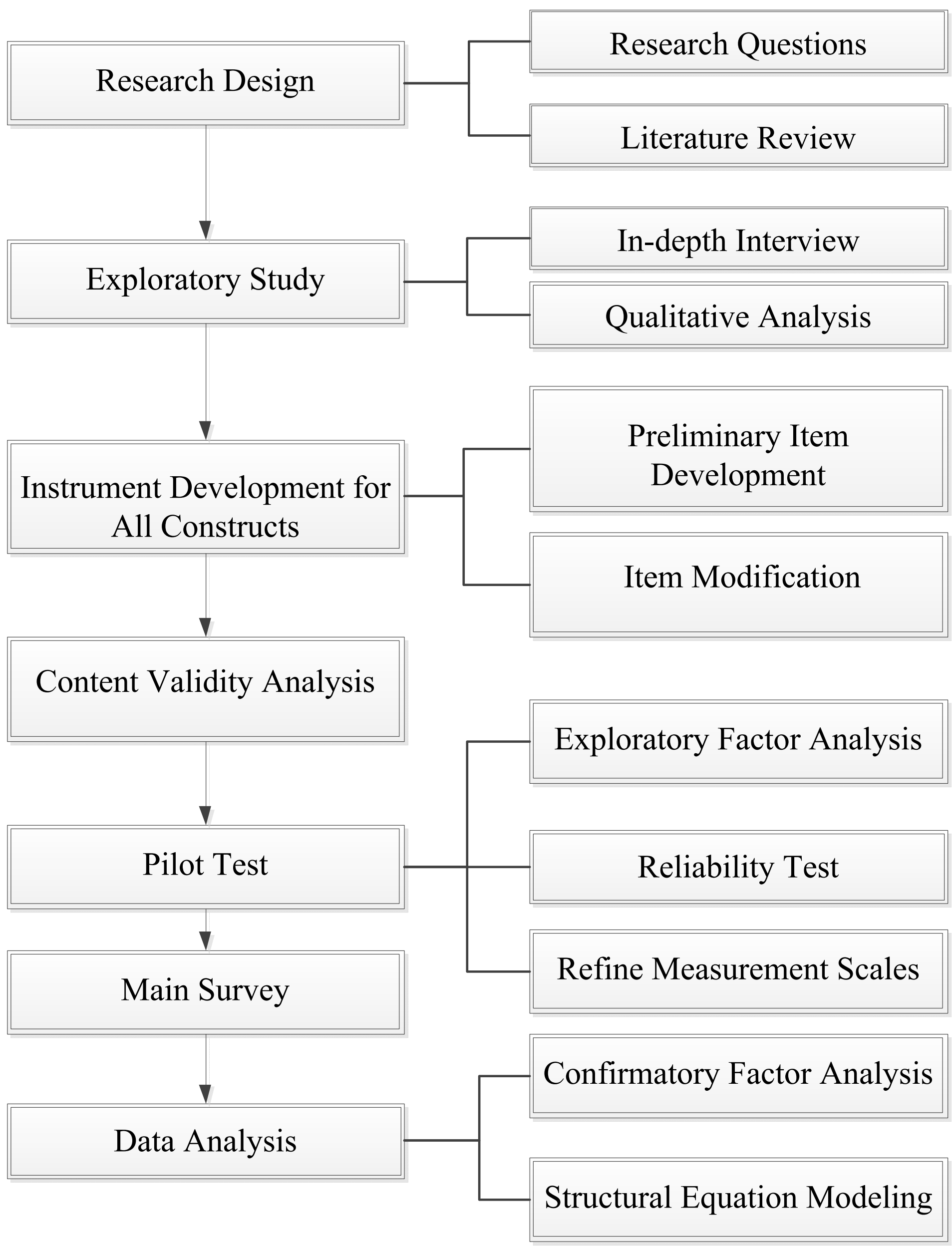


Figure 3-1: the Research Approach

3.1.1 Empirical Research in the Real-world Context

Despite a burgeoning interest on virtual team research, studies in the context of real world settings are relatively inadequate. Martins, et al. (2004) reviews 93 empirical articles on virtual team studies and discovers that of the 93 articles, 66 are lab studies while only 13 use "real teams" and 14 are case studies. In spite of a large body of literature and various findings of research regarding interruption, there is a common limitation in the existing studies: Most are based on laboratory experiments conducted in artificially controlled environments (e.g., Adamczyk & Bailey, 2004; Bailey et al, 2001; Burmistrov & Leonova, 2003; Cutrell et al, 2001; Zijlstra et al, 1999). Studies based on real work environment are rare.

Research regarding interruptions is always carried out in a technology- rich environment. As a result, most studies investigate interruption issue without taking much the social dimension into account. However, the author argues that an accurate and comprehensive grasp of the problem context is a prerequisite of a successful problem solving process. The author attempts to achieve research outcomes more applicable to real situations, as the tasks and environment of the real-time virtual teams are evolving and complex. Hence, rather than one-time laboratory approach which is criticized with its inherent artificiality, the present research is conducted in the real-world setting.

3.1.2 Adopted Research Methods

In order to establish and evaluate the proposed framework of interruption-contingent virtual collaboration, the author employs a multi-phase study. The triangulation process of literature review, qualitative interview study and quantitative analysis allows cross check of the validity of one another (Jick, 1979). The cross-disciplinary literature involves classic theories on team performance, managerial issues in remote communication in modern fast-changing environment, technical aspects on virtual interaction, psychological issues on human mental capability of handling external interruptions and how organizational and technological factors affect virtual team members' interruptions. The author develops initial hypotheses based on literature review, followed by the process of in-depth interviews for further evaluation and verification.

The objective of adopting the qualitative approach is twofold. One is to provide a preliminary test of the proposed causal relationships using narrative data collected from industrial practitioners. Literature on interruption management and virtual collaboration effectiveness in the textile and apparel industry is particularly limited to-date. The other is to offer a contextual basis for the quantitative measurement design, because three of the constructs (i.e., intra-team awareness, virtual technology, interruption management) are not well-debated in previous empirical studies. With the findings in this stage, the author explores the underlying mechanism of the constructs and generates measurement items for quantitative tests of hypotheses.

3.2 Qualitative Approach - In-depth Interview

As a matter of fact, practice is ahead of research in the research topic. A large number of organizations have participated in virtual collaboration with other organizations, and also a considerable number of organizations have formed virtual teams to intensify the interaction among the branch offices across the world. The author adopts qualitative method to explore how the textile practitioners coordinate interruptions in their work, how the proposed organizational and technological factors actually influence interruption management, and how interruption management could be conceptualized during the processes of virtual collaboration.

3.2.1 Data Collection

The exploratory qualitative study was undertaken to collect people's perception toward interruption management issue and the fundamental factors that contributed to interruption management and virtual collaboration success. As there were no validated measurement scales for quantitative tests that have been developed by previous studies, the author conducted in-depth interviews with virtual collaboration practitioners.

The interviews were semi-structured. While structured interview has higher face validity, unstructured interview allows the freedom to display the credentials positively (Campion et al., 1997). Semi-structured interviews allow certain flexibility on the premise of assuring control over the main topic. The questions of interviews were assessed by a group of academics including three professors and three PhD students. The final protocol of interview was confirmed after several rounds of revisions and amendments. After respondents were assured of confidentiality and protection of their privacy, the interviews began with comparatively restrained questions (structure and composition of the virtual teams, communicative technologies adopted for interruption coordination, organizational context, relationships among team members, types and frequency of interruptions encountered at work, team tasks, etc.), followed by questions more open to allow free expression that may lead to some inspiring ideas. In the interviews, primarily the same questions were asked, but the author allowed some flexibility to tailor the interview to different interviewees. The respondents were encouraged to describe in detail the personally experienced phenomenon and perception. According to Campion et al. (1997), standardization in sequence and group of interview questions might be advantageous in reliability and validity of interview results.

Questions asked in the interview are listed in the following, of which the sequence was kept the same:

1) Introduce the organizational settings and some background information of your team.

2) How frequently do you receive interruptions? How do you feel when you are interrupted?

3) How are the virtual technologies adopted in your team? Do they help coordinating interruptions? What do you think are the most essential functions of the technologies for interruption management purpose?

4) To what extent you are aware of the external contexts including availability and progress of others in virtual environment?

5) How are the team members motivated and governed? Does such motivating/governance system affect your attitude and behavior towards interruptions?

6) Do you feel independent on task performing during virtual collaboration? How does the independence affect your attitude and behavior to interruptions?

7) What are your strategies in treating different interruptions?

8) For virtual collaboration among the textile companies, what are the criteria and standards for effective interruption management?

9) Elaborate on the effort your team made in order to better coordinate interruptions,

and its effects on final performance of the project.

10) Do you think good interruption management among team members would influence the virtual collaboration effectiveness?

The interview prototype is presented in appendix A. Twenty respondents from 15 textile & apparel firms were interviewed during the period of December 2009 to August 2010. Each interview lasted for about 1.5 to 2 hours. Each of the selected respondents was a member or supervisor in a collaborative virtual team, and had considerable experience in dealing with interruption issues in intra-team virtual communication.

3.2.2 Data Analysis

Each interview was tape-recorded and then transcribed. The interpretation of the text was performed using the methods of content analysis. Content analysis is a summarizing analysis of messages that relies on the scientific method (including attention to objectivity, a priori design, reliability, validity, generalizability and hypothesis testing) and is not limited as to the types of variables that may be measured or the context in which the messages are created or presented.

After transcription of the texts, the content was reviewed by a panel of researchers several times to identify and describe phenomena found in the texts. This panel includes four academics of textile business, who were invited by the author to read the interview transcript and provided their own categorization. Discrepancies among the reviewers were resolved through further discussion. Such process was essential to assure reliability when human coder was used in content analysis, because it enabled the researchers to assume the respondent's viewpoint and to set aside personal preconceptions of a situation or experience (Neuendorf, 2002).

Firstly, a corpus of texts was identified, and then unit of analysis was selected. The contents were categorized according to the themes of responses to every question. For example, when the author collected the data concerning perceptions about interruptions in their current work, the analysts looked particularly for the descriptions such as "annoying", "unplanned" (indicating they might feel intruded by interruptions), or "efficient", "connected"(indicating they might feel interruptions desirable). Relationships among the concepts were summarized through examination of the sorted data. This interpretive process was fine tuned along the analysis until all the transcriptions from all interviews were coded. An iterative interpretation process was applied in data coding until it reached saturation (Miles & Huberman, 1984). The propositions of this research were formed after the content analysis.

3.2.3 The Profile of Interview Participants

The business of the participating 15 companies covers fibre and apparel manufacturing, dyeing, home textiles, fashion retailing. Among these companies, there are also firms which integrated the activities along the supply chain (profile of organizations and interviewees are shown in Table 3-1). These participants mainly work in offices located in Hong Kong and Shanghai, with requirements for interacting with overseas offices. Of the 15 organizations, there are four American firms, two European firms, one Canadian firm, six Chinese firms, and two Chinese universities. Of the 20 interviewees, 11 are male and nine are female, consisting an even distribution of gender. Seven are team leaders while 11 are team members, and the other two are team advisors. Nine of the interviewees are members of ad hoc virtual teams which are created particularly to pursue unique projects. The other 11 are employees who need to cooperate with remote members as part of their daily work, although they have a wide range of expertise and job specifications such as marketing, R&D, sales, accounting. Notably, some respondents communicate with their teammates both by virtual means and face-to-face through business travel. Some are simultaneously involved in several other non-virtual projects.

Table 3-1: the Profile of Interview Participants

	Organization	Business Scope	Team Role/Expertise
1	Private firm (American)	Fashion market research	Project manager
2	State owned (Chinese)	Integrated	Administrative
3	Private firm (American)	Apparel retailing	Technical manager
4	Private firm (Canadian)	Textiles retailing	Retail manager
5	Private firm (American)	Fashion retailing	Marketing
			Project coordinator
6	Private firm (Chinese)	Dyeing	R&D
			Project leader
7	Private firm (Chinese)	Home textiles	Merchandiser
			Secretary
			Advertising
8	State owned (Chinese)	Manufacturing & trading	company general manager
9	University (Chinese)	Textile material	Research team leader
10	Private firm (French)	Branded apparel	Designer
11	Private firm (Chinese)	Children's wear	company general manager
12	Private firm (English)	Branded apparel	Sales
13	Private firm (American)	Fiber manufacturing	Technical manager
14	Private firm (Chinese)	Integrated	vice general manager
15	University (Chinese)	Textile economic research	Research team leader
			Researcher

3.3 Findings of Exploratory Studies

Cross disciplinary literature review combined with in-depth interviews of virtual team players was adopted in the present phase of research. During the courses of interviewing, the author explored people's perception toward interruptions, examined people's behavior pattern of interruption treatment in virtual collaboration, and how they believed interruptions could be managed effectively. The author took a step further, by also testing preliminarily the antecedent factors of interruption management and virtual team performance.

Collaborating as virtual teams is prevailing in today's globalizing textile and apparel business, so interruptions among members are frequent and becoming an increasingly significant issue in most companies.

> *Currently, nearly all the textile companies have their own business alliances, which collaborate closely to form a win-win relationship. Some of the upstream companies collaborate with retailers to analyze customer needs and preference; some of the material companies collaborate with universities to develop new fibers. All these collaboration needs a great deal of interaction, especially computer-aided communication. I do encounter a lot of interruptions every day. Even in the*

companies that do not have alliances, they have to communicate frequently with their vendors. A number of companies have branches across the country or even the world. In such a globalizing environment, it's not possible all the communication are scheduled, there ought to be plenty interruptions. (Organization 9)

Textile operations and activities along the supply pipeline can be very trivial. Interruptions can be especially frequent yet significant.

In the textile business, there are many small details, which are indeed very important. As management level, I have to make very specific work arrangements to all the departments. I am used to be interrupted very frequently and I never turn off my cell phone. (Organization 8)

3.3.1 Intra-team Awareness

The participants in interviews agree with literature (e.g., Garrett & Danziger, 2007) on the significant influence of intra-team awareness on interruption management. Results show it is important to mitigate disruptiveness through awareness display function, which decreases unfavourable interruptions in many cases.

- Availability display

Most people would like to alert others that they are concentrating on some demanding work and do not want to be disturbed. Existing technologies for awareness display allow work status sharing, personal task progress sharing, or schedule sharing, etc. For example, some software applications that integrate instant messaging with scheduling system allow availability display and timely update, showing whether the targeted person is performing mental-demanding tasks or the extent of his availability for interruptions. When sufficient and appropriate information (e.g., task type, complexity, expected completion time, etc.) about the ongoing task is shown, the team members could suffer less from undesirable interruptions.

The contents of display vary, depending on specific needs of each project or team. The participants suggest that traditional availability display (simply showing whether the user is available or not) can be improved by providing more information about their awareness status so that the interrupters can make appropriate decisions.

> *If he's simply showing "busy", I don't know exactly what he is busy with, and whether it's related to the issue that I'm about to discuss with him. If they are not related, I prefer not to interrupt him right away. If I'm able to get all the*

information about his status (including mental load, project progress, the task currently working on, his schedule for future tasks) before initiating an interruption, I would re-evaluate when and how to interrupt him for the benefit of both of us. (Organization 13)

- Connectedness of members

The interview result shows that connectedness among members is an important component of intra-team awareness, which receives little emphasis in literature. Developing intra-team awareness through appropriate virtual technologies encourages the sense of involvement for members, even without deliberate team-building activities. On one hand, designing activities to build inter-member awareness and acquaintance may facilitate interruption management because it provides adequate contextual and environmental information for members to be aware of the external situation. On the other hand, building interpersonal relations helps members to develop the sense of belonging to the team; thus will tend to behave altruistically in the interruption-contingent environment. In other words, with higher awareness to the team and other members, one would grow responsibility to the team, which makes him think more about the integrated team instead of considering solely himself when treating incoming interruptions or initiating interruptions.

From discussions with interview participants, the author finds that with high levels of intra-team awareness, virtual team members could perceive sense of belonging and involvement to the team. Intra-team awareness is considered inadequate in virtual teams because team experts seldom or never meet in person. Interaction is often realized through the networked computer systems. Unlike those in co-located teams, members in virtual teams have little chance to develop personal relations. The development of awareness and sense of connectedness among members could encourage altruistic behavior within the virtual team interaction. Respondents report that certain activities and experiences shared by members within the same team can help to develop the sense of connectedness and collaboration among them.

Virtual team members are professionals from different backgrounds and locations, even different organizations who rarely meet face-to-face, and have little time spent together to build interpersonal relationships, trust, cultural adaptation, and rapport. The lack of development of such awareness may result in absence of connectedness among members and sense of belonging to the team. When treating interruptions, team members without sense of belonging would probably behave selfishly.

The author also finds an interesting phenomenon. If people have built personal relation with an interrupter in the past, they tend to answer the interruptions more actively. This might be partly attributed to the experience in dealing with that person, and people would feel it easier solving the problems similar to previous tackled ones. Knowing the person makes people to have an approximate estimation about the purpose of interruption, and it might lower the disruptiveness caused by the interruptions.

> *If I know this person well and we have past cooperation experience, I would like to give him higher priority on the premise that it will not jeopardize the whole-team interest and not delay others' important task. (Organization 2)*

> *If I'm doing tasks on one project, and then there comes an interruption or request from a colleague who is not totally relevant to my ongoing project, I may ask him to wait until I have a break, unless his request is extremely urgent. (Organization 12)*

Through the discussion and analysis of this issue, the author finds that deep conversation and interaction among a small group using synchronous technologies such as instant messaging (IM) can develop certain degree of awareness among virtual team members, due to its informal communication structuring. Instant messaging is also a text-based tool to convey information without nonverbal cues. It is often used to discuss minor matters or have brief conversation to supplement other activities that users are engaged in, such as audio conferences. Sense of connectedness among team members is also required in small-group informal virtual interaction. While e-mail is the most popular in international or inter-cultural interaction, instant messaging is preferred in communication with people of the same nationality or culture. Instant messaging is preferred among people of small groups as their interacting method. According to the respondents, instant messaging is usually adopted within a social circle, which means that the tool represents higher social proximity. People will probably use instant messaging to contact the most familiar, people of inner circle they work with. Cultural differences, varied time zones and language boundaries make it hard for people outside the particular circle to interact through instant messaging. It is the way that team members develop connectedness through instant messaging – by building the sense of intimacy within a relatively fixed circle group.

> *For interactions among the three branch offices (Beijing, Shanghai, Guangzhou) in China, we use instant messaging (like MSN and QQ) and telephone conference; no big problems are found in interaction. But for interaction between a China branch and the Canada office, Email is the primary tool we use. (Organization 4)*

The opinion is shared by some other participants. For example, another Chinese worker in an American firm reports:

> *I always chat with my colleagues and teammates online for work arrangement, decision making, etc. I feel it's convenient, and efficient. There are also e-rooms for group chat. Of course, I know these people well because we meet face-to-face from time to time. Otherwise, I will not use instant messaging, because it feels weird. I mean, we not so familiar, and I will use e-mail or other tools. Instant messaging is just too informal. For example, there is no way I will report to my boss in Boston through instant messaging. Time difference is one problem, but the most important is that using instant messaging makes me feel more intimate to the other side, more like a friend. (Organization 3)*

Awareness among virtual team members can be nurtured in the processes of such informal communication, which is frequent in virtual teamwork. In contrast to formal communication which happens as patterns of downward transmission of orders and upward transmission of information (such as report and structured meetings), the informal communication can be more personal peer-oriented, interactive, and allows for rapid feedback and local context sharing.

To conclude, the improvement of intra-team awareness among members is positively associated with the development of individual involvement and sense of belonging to the virtual team; hence stimulate altruistic behaviour (helping others) in collaboration. The advancement of virtual technologies makes it easier for team members to be aware of the availability of others, which helps to regulate interruptions. The availability display allows the interruptees to show their readiness for interruptions, while interrupters can show the key information (urgency, importance, issue, etc.) of their interrupting requests so that interruptees could determine the time and method of answering the interruption.

Succinctly, three dimensions are important in evaluating the ability of a virtual team to nurture intra-team awareness: level of convenience for a member to be aware of others' availability for interruptions, the ability for a member to develop a coherent mental picture of project status and external activities, and the sense of connectedness of the team members.

3.3.2 Virtual Technologies

- **Technologies in Current Textile Business**

Virtual teams use multiple information and communication technologies to share information and perform collaborative work. In additional to the most traditional communication methods such as phones and emails, there are group-based remote conferencing technologies, and the latest and more innovative intelligent technology including shared electronic workspace and integrated tele-collaborating systems. Each technology is designed for specific purposes, with its own features and advantages.

Participants reach consensus that synchronous communication encourages the exchange of latest information and opinion while asynchronous communication gives people chances to continuously focus on their primary work even when others try to approach them. The interview result shows that many textile firms still use synchronous communication technologies like telephones, instant messaging, and video conferencing, as well as the asynchronous technologies such as emails and shared database. For remote conferences, mostly they use audio conferencing, web conferencing which combines audio conferencing with document sharing, desktop video conferencing; only a few companies use room-based video conferencing. The questions and opinions raised through synchronous technologies could have immediate answers or feedbacks. One of the respondents from a Chinese home textile firm shares her experience of using synchronous tool to solve a complex customer complaint. When her client complained about the colour aberration of the sample, she timely called together her colleagues from different departments (sales department and customer service in Shanghai, manufacturing plant in another city) for a video conference so as to identify the underlying reasons of the problem, discuss probable remedial actions to take, and finally reach a set of optimal solutions.

> *In such urgent cases, I have to use the communication tools that allow me collect information quickly so that I can identify where the source of the problem is and how we can prevent from happening hereafter. I also want to know the opinion of other departments on how to fix such problem to make fair decision. Calling a tele-conference is the best method under that condition. (Organization 7)*

Participants conclude that higher synchronicity usually causes higher disruptiveness to individuals because it allows simultaneous communication and immediate feedback. For instance, instant messaging and telephones would probably cause higher level of disruptiveness to the interrupted person because they require immediate attention whether or not the person is in the right status of answering them. On the contrary, asynchronous technologies provide members with information without an intention to intermit other's work, and could lead to lower levels of disruptiveness. For remote conferencing, notwithstanding the synchronous nature of interaction it supports, it usually causes less disruptiveness because it needs pre-scheduling and people will get their preparation (both on their mental status and task arrangement) for that. Unlike other simultaneous communication tools, the remote conferencing rarely initiate extemporaneous interruptions.

> *We usually use tele-conferences in regular issues such as remote training, brainstorming about a new product or an encountered problem, or the routine reports from different branch offices around the world. (Organization 3)*

In contrast, asynchronous communicative technologies cannot effectively support tasks requiring real time coordination. They allow interrupters to send out messages at their convenience while offering receivers the freedom to choose the location and the time for reply, they have little control over the timeliness of feedbacks.

> *In my company, we (Asian team members) sometimes have to wait for whole day to receive reply from Americans because of the time zone difference. (Organization 5)*

The textile & apparel firms collaborate as virtual teams in order to increase dynamic capability to win the market, so it is important for them to prevent being overwhelmed by trivial interruptions during virtual collaboration. These technologies can support positive interruptions, regulate negative interruptions, and limit the disruptiveness an interruption may cause to virtual collaborators if adopted appropriately. The advantages that modern technologies bring to interruption management are recognized by most participants. However, it is not easy for them to adopt these technologies. Some companies hesitate to adopt more intelligent technologies as they consider that it is not the best time to adopt them, due to a series of reasons such as costs, staff training on new devices, and business collaborator's opinions.

A general manager in a Chinese company states that the manipulation difficulties have prohibited them from using a more intelligent system.

> *We once imported an advanced device to facilitate virtual collaboration. But I'm afraid the biggest problem was its user-friendliness. It had very complicated user interface. Manipulating it may be not problematic for senior technical staff, but some of the staff just prefer not to use it. And they still use emails nowadays. (Organization 8)*

Another company shares their problem of adopting advanced technologies: their business collaborator cannot afford such devices.

> *Even if we have the demand and capability of investing in the information systems for improving interruption issue, some of our collaborating companies would not, such as the factories in which most textile and apparel products are manufactured. Then there is no true two-way, effective collaboration. (Organization 8)*

Cost is one of the most critical and paramount considerations for textile firms. Although it is not discussed intensively in literature, it is mentioned by interview participants frequently. The author considers it necessary to briefly discuss this issue as what is revealed here is not discussed substantially in literature. Cost-sensitive might be a characteristic of the textile industry, which is different from several other industries, and it is reflected saliently in the adoption of virtual technology in virtual teams. The respondents report that few companies would invest a large amount of money in the software or hardware to support virtual interaction unless the improvement on team effectiveness can be seen in near future. Understanding the relative advantages and costs of each collaborative technology helps organizations to utilize technologies that would not cause large financial burdens to the organization while pursuing the great communication enhancement.

Unlike some other industries that are dominated by several giant companies, this industry is highly dependent on the small-medium sized companies. So many firms are doing mass production, although they are eager to make differentiated products and introduce high value-added products. Buying high-tech software to solve problems in communication is important to them theoretically, but they just don't have the financial capability. (Organization 1)

During the financial tsunami in 2007/2008, a lot of companies asked their virtual team employees to communicate through text-based tools such as emails and e-chats in order to cut the expenses caused by overseas calls. In contrast, room systems for video conferencing are relatively more expensive because they require special cameras, hardware, a specialized meeting room, and high-speed integrated services digital network lines. One example of these systems is a product of Cisco Company called Telepresence. The equipment itself is expensive; while it needs one office room exclusively served as remote conference room and it show images with high resolution.

Nearly every participant in the interview process has encountered the problem of unexpected intermit due to technical immaturity during the remote conferences. The effectiveness of the web conference is affected by a considerable number of factors such as the IT development of the city, the level of equipment advancement, the internet maintenance, etc. The service and maintenance costs are also prohibitively high for many textile and apparel companies.

> *We adopt tele-conference for regular training programs. In fact, I think broader bandwidth of internet is needed for smoother interaction. Take our office for an example, we have to use WebEx (online meeting software) instead of other devices that can provide clearer image and stronger remote support. Of course, cost is an important aspect considered by the company. In addition, less noisy office environment is required to increase the conference quality. (Organization 5)*

Hence, textile companies should choose communication devices flexibly based on their own organizational characteristics and financial capacity. Large companies which have requirement for high quality of communication are more likely to adopt expensive web conference equipment to facilitate remote communication. Most small to medium organizations observed are struggling to grow or even to survive, with cautious budget for extra equipments. Since a considerable number of textile corporations are cost sensitive at current stage, capital is usually spent on issues that are directly associated to profit making such as marketing. Nevertheless, the author suggests that proper investment on virtual technologies can be constructive to the business and organization development in the long run.

- **Components of Virtual Technology Construct**

Interview results indicate that appropriate adoption of communication technologies with proper functions should be an important aspect in interruption management. Thus the author discusses what components of virtual technologies can facilitate effective interruption management according to the interview output.

- Awareness display

The participants suggest that one way to mitigate disruptiveness is awareness display, which decreases unfavorable interruptions. When sufficient and appropriate information (e.g., task type, complexity, expected completion time, etc.) about the ongoing task are shown, the team members could suffer less from undesirable interruptions. They also suggest that showing something more specific than working status (available/busy/offline etc.), such as effort level and priority or other necessary details about the ongoing job would be helpful in coordinating interruptions.

For instance, showing the effort level (which represents the degree to which one is occupied to the primary job) would help my teammates know how urgent and important my ongoing job is, compared to the interruption. Another method is to present user's priority, which shows what kinds of tasks one is dealing with and what kinds of incoming related tasks one prefers, to prevent from feeling intruded by discrete interruptions. (Organization 3)

- Ability to decrease negative interruptions

Negative interruptions are mostly the disruptive interruptions, which break the train of thought when the interruptees are occupied in other activities. Participants agree that the tool with ability to reduce such unfavorable interruptions is a good virtual technology. Some communication technologies allow users to simultaneously work on documents, analyze data, and share ideas on white boards. Within these intelligent systems, asynchronous ones are mainly used to support information exchange (e.g., bulletin boards, video-conferencing, electronic data interchange and group e-calendar), while synchronous ones facilitate cooperation to avoid unfavorable interruptions (e.g., group decision systems, electronic brainstorming systems, ranking or voting tools, group authoring software, electronic meeting systems).

Participants reveal that negative interruptions would be probably decreased when essential information is stored online and the members in all involved partners have access to the electronic data center. Such data center should have the ability of updating the progress of any member, storing the shared files and tracking the changes. It is like a centralized data warehouse, with a reliable, scalable, highly available storage infrastructure to solve the problem of data integration. In the textile industry, it has always been detail-oriented.

We have an internal system or "write board" for particular projects. Such an information sharing system can provide information required by all links of the supply chain. Issues like pattern changing of the products can be released through this means, instead of sending emails or making phone calls. This simple feature could decrease many interruptions. To make sure that everyone knows about the changes, the system requires each reviser that changes cannot be made without being visible to all parties and no changes can be made outside the system. This method regulates the interruptions related to product or market changes, which is one of the main sources of the unscheduled interruptions. (Organization 1)

- Ability to regulate unnecessary interruptions

To lighten the burden of overloaded people, most participants think that to let the system take charge of incoming interruptions is a good alternative. Therefore, using the filtering technologies to regulate interruptions is reported to have control the nature and volume of the incoming communication. Such system is able to automatically filter the tasks with higher priority to immediately interrupt the user, while negotiate another time for interaction for tasks with lower priority. In the previous designed application systems, targets are forced to make decisions about communication based only on how busy they are, without knowing the urgency, importance or the content of the incoming communication. The advanced filtering system decreases the opportunities for discrete issues to cause disruptions to people with high mental load, thus increases the overall communication efficiency and task performance.

> *We use mail filters and machine receptionists to regulate unnecessary interruptions. For example, when others approach me when I'm deeply committed, the system would ask the initiator to display the most important feature about the request (what is it about, how urgent and important it is for the whole team, how long it takes to complete, and so on). I think it's quite effective. (Organization 12)*

- Ability to convey social cues

The participants agree that the communication technologies characterized by high level of interactivity and social presence are appropriate for building a shared interpretive context within the team, while leaner electronic communication means is more suitable for maintaining interaction within an established context in which people can make inferences based on understanding of each other. Compared with face-to-face communications, virtual interactions in the observation are perceived to be less effective in conveying social context cues and creating shared interpretive social context among team members. The ability to convey social cues on one hand decreases the opportunity for future interruptions; on the other it nurtures the intra-team connectedness, and thus facilitates interruption management.

> *There are fewer greetings in my communication with virtual teammates. I think it's better to come straight into the point when I approach others with phone calls or emails because I have a particular issue to talk about. It's not like collaboration with my office colleagues, with whom I have a lot of chances to meet face-to-face and talk about weather and footballs. But I think such phenomenon is not that good for collaboration because social cues are still very essential in business conversation. (Organization 11)*

To conclude, interview results show that the ability to regulate unnecessary (unconstructive, with inappropriate timing) interruptions, negotiate for interaction time, and show availability for interruptions are crucial functions in supporting positive interruptions and prompting virtual collaboration effectiveness.

3.3.3 Task Interdependence

Higher task interdependence for virtual teams is mainly due to the flat team structure and simple hierarchy. In the structure of traditional teams and organizations, interaction is more formal and bureaucratic. For example, the frontline manufacturers report to the directors, and the directors report to a general manager. Under such structure, manufacturers are dependent on those along the same command line within the organization. The structure of virtual teams is flatter than that of traditional teams. In a flat structure, such bureaucratic reporting system is no longer effective, sense of supervision becomes weak. People from different hierarchical levels become teammates, who need to interact with each other for shared purposes. For instance, participants report that designer teams in an apparel company have simple hierarchy:

Our virtual team consists of French designer team, American designer team and Chinese designer team, to take charge of all the apparel design in Chinese market. From the organizational perspective, there are usually three to four hierarchical levels (designer, senior designer, design director, manager, etc), each team with more than 10 persons. From the perspective of virtual teams, there are only two levels: the designer and the team leader (or coordinator). The designers do not often interact with their virtual teammates because design job is relatively independent. We may work at home, at coffee shop or anywhere else, and interact whenever there is a need for problem solving. For instance, after pre-sale period, there are feedbacks from Chinese customers. If there are some issues (sizes, colour, details, etc.) that need to be revised, we have to communicate intensively on problem identification and making agreement of solutions, in order to respond quickly to the market and prevent loss of loyal customers. Interruptions in this period are relatively frequent, but team members do not consider them annoying because such reciprocal interaction is the faster way to solve problems. As one of the virtual team coordinators, I'm responsible for regular collaboration and irregular discussion with other coordinators on an array of issues. (Organization 10)

Flat structure could bring more frequent interactions among team members, because the reduced hierarchies force every member to deal with more sources of information. As a result, people face more challenges in communication, such as knowing what and how to coordinate information, learning more techniques in handling interruptions.

> *We are trying to reduce hierarchy, to achieve more flat management structure. I think the efficiency is certainly improved by decreasing hierarchies for virtual collaboration, although it increases requirement to the employees. For example, there were 3 levels before, the top management, the middle management, and the frontline. Now we are turning to 2 levels, team leader and team member (the frontline). The team leader has to coordinate more people, and the frontline has to filter the necessary information, because they cannot impose heavy burden (extra interruptions) on the management. (Organization 2)*

Another company also shares their experience that higher flexibility enabled by flat structure enhances the efficiency of virtual collaboration, although the task interdependence may also increase.

Within our sales team, high flexibility is what we strive to achieve because it's important if we try to respond quickly to the market. For instance, generally speaking, a sales person cannot access the general manager or chairman of the board directly; in our virtual team, under special circumstance like negotiation with clients, I once called the general manager directly to ask for resource support according to the client's requirement. This certainly increases the rapidity of reaction, and in the same time increase the interruption volume for the leaders. (Organization 14)

Most participants agree on that the task interdependence of virtual team members made them treat interruptions more carefully and have more sense of interruption regulation.

We have four standing departments: the executive office, financial office, investment department, and general counsel to the board. I'm in one of the standing department. Members of these departments may disperse at different branch offices. We have to work collaboratively and interrupt each other from time to time because we are interdependent. The more frequently we communicate, the more sense of interruption management we develop. I will check the availability before interrupting other members in standing departments because I know they are interrupted often, just like me. There are also other non-standing *departments such as Board of directors (including investment committee), broad of inspectors, and Committee of stakeholders, but they do things relatively independent to us and we do not interact frequently. Those people usually interrupt me randomly; they don't concern much about whether I'm busy doing my own work. (Organization 2)*

3.3.4 Motivating & Governance System

The motivating & governance system considerably influences people's attitude toward interruption under most circumstances. Participants agree that virtual teams that perform better are able to motivate talents more effectively. A participant complained about losing spirit for teamwork because of the ineffective motivating system.

I don't know what kind of reward allocation system the teams adopt. They never let us know clearly. If we can get paid according to project benefits, I would be more inspired. The reward structure is not transparent; as a result, I don't see much stimulation to promote our performance. I think this is just not good for the team. Our wage is set, according to position in the team. Our bonus might be determined by the team performance, but I'm not sure because they never made these things clear. (Organization 6)

An appropriate reward system is the key of motivating team members in most companies investigated. What is of the same importance is an appropriate governance structure, which is critical to the management of interaction process within virtual teams. However, with regard to the reward allocation mechanism of virtual teams, participants do not have consensus. The author distinguishes the pros and cons of the two motivating systems based on participants' opinions. Collective motivating system motivates team interactions for interdependent tasks while individual rewards provide incentive for those teams with tasks reflected purely individual responsibilities.

Most people consider team-based system to be more helpful in cooperation and collaboration for virtual members, although it might not easily come into practice in real world. Team-based motivating system in virtual collaboration makes virtual team members feel like an entirety, and connected to each other. Interruption management becomes essential to interaction among team members because everyone is equally responsible for the output.

> *Human being is self-interest. I will behave altruistically only when our profits are related and dependent on each other. The team-based structure can make people*

more cooperative. Members would more likely to spend their time on helping others and collaboratively complete tasks. When facing interruptions, they are also more willing to respond with the most appropriate way. This would be absolutely beneficial to the whole team performance. (Organization 15)

Some interviewees also consider team-based motivating system effective particularly in virtual teams. When team members have a shared ultimate goal, it's much easier for them to collaborate.

Actually, for virtual teams, there is not so much to compare because we all have our contributions. We have our personal goals and a shared goal, and we have to realize both. It is true in most virtual teams, no matter for inter-departmental teams, inter-organizational teams, or multi-national company teams. We collaborate because we have shared interests and benefits. (Organization 3)

This opinion is also shared by another interviewee who insists individual performance is hard to measure. Where team members are interdependent and share goals, it is more appropriate and much easier to measure team performance than individual performance. The performance advantage comes from team problem solving, communications and self-direction. Team members give each other feedback so that overall performance and their shared goals could be achieved. As such, people would treat interruptions in a way that benefits the whole team, when individual members in the team shares accountability. Especially for small virtual teams, the collective motivating structure works better and can be governed more easily than in large virtual teams.

> *From my point of view, a solely individual-based reward system is not realistic. Team members' performances have to be measured by a series of criteria, including quality, profit, revenue, apparel delivery time, customer satisfaction, etc. (Organization 11)*

Participants share their thinking about the reason to abandon individual motivating system. When rewards are decided based on some individual based "objective" measurement (such as sales volume, task quantity) or even supervisor judgments of individual contribution, there will often develop rivalry and conflict within the team. What's more, members are more likely to show egocentric behavior in collaboration process, like completing their own tasks disregarding the entire collaborative situation, or denying interruptions without careful thought.

I think it (individual-based structure) inhibits the collaborative progress. I would certainly put aside other's requests when I'm busy, regardless of how important or urgent this is to my teammate. Sometimes even if I'm not very busy or focused, I still don't want to respond to other's interruptions because we are in a competition. If they get more resource, I would be the one who lags behind in the team. Actually, I don't think it seems like a 'team' because we are not so cooperative. Individual performance and the projects on our own are things we care most. (Organization 8)

In addition, individual-based system is believed to jeopardize creative thinking.

Allocating rewards by individual performance forces the members to focus solely on their present output. This would probably lead to lack of creative thinking, risk taking, and eventually the lost of inner motivation for work. (Organization 5)

Participants also put forth that a good team-based motivation system can stimulate and motivate performance of team members, and an appropriate governance system is a critical condition for the motivation mechanism to have its full effect.

It seems that the individual-based structure can stimulate and encourage team member's contribution to the team, I think so can the team-based system. The prerequisite is good supervision mechanism. If the supervision is ineffective, members who pay more efforts would feel unfair to share their achievement with others who pay less effort. If this persists, no one would strive for success because everyone wants to 'reap without sowing'. Nevertheless, with a good supervision system, there are plenty of ways to stimulate people. For example, members who fail to successfully perform their own tasks are asked to receive more training. Another supervision method is investigation on member's team spirit; the less collaborative team members would subject to some kind of punishment. (Organization 9)

Some interviewees share another reason of the ineffectiveness of individual-based motivating structure. Although people care about how much they get paid for their work, few regard financial rewards as the only important incentive. Providing better environment for collaborating is valued by the virtual team members. A number of participants view team-based motivating system as more appropriate in sustaining team member relationships and encouraging individual contribution as well. Collaborating, instead of competing, is the most important thing for virtual team members.

People would be competitive when they are forced to compare. Once rewards are based on individual performance, people would strive for good performance to win the rewards or compliments from superiors. Such good individual performance may not be actually excellent quality of tasks, but quantity or rapidity of finishing tasks. It might actually not help total performance but harm the entire team work. When a limited number of people are rewarded with financial incentives, others may see these people as obstacles in their path to success. This situation is opposite to a collaborating environment that team-based system leads to. (Organization 10)

In contrary to the majority interviewees in favour of the team-based motivating system, there are a few agree with the individual-based structure. They consider the individual-based system to be simple and straightforward to follow, and fair to people that work hard.

I think the individual contribution based motivating system we are using is fairer to people who make more efforts. At least what they are paid is in proportion with what they have done. It's an effective way to keep motivating members to make progress. (Organization 12)

These interviewees consider that reward based on individual performance is an effective way to motivate team members because the steady growth of the company is closely relevant to every member's effort, although they may compete fiercely. From their point of view, the managers or team leaders should consider the trade-off between motivating the team as a whole and stimulating individual passion to make contribution.

> *It (individual-based reward) is the most straightforward method to motivate members, I presume. In current stage of business development, we have to use this strategy. The system should go with the actual situation of company. We will consider about a bit of change when the business is more stable. I think the company needs to form a win-win relationship with the work force. We employees and team players receive rewards that we value when they add value to the company's business proposition. This certainly leads to a degree of competition inside the team, but there is a balance between the self-interest thinking and responsibility to the team. After all, the members that cannot deal with interruptions properly would be complained by others, and eventually kicked out. (Organization 7)*

Based on the viewpoints shared by participants, the author concludes that team-based motivating and governance system is effective in motivating and encouraging collaboration among team members in most circumstances, thus facilitates interruption management. Notably, there will be some complexity in the implementation of the team-based motivating system. A knowing-doing gap exists in most organizations. When it comes to a fundamental change in the organizational structure, especially when it is related to a fundamental change in reward allocation, the organizations usually become excessively precautious. Nevertheless, some virtual teams are taking their steps.

> *It takes time to get employees used to team-based pay; however, when it has been implemented in a true virtual team, it works better than individual pay. (Organization 14)*

In addition, the author also suggests that the reward structure should be transparent, clear and standard for the members. Transparency is important since only a clear reward allocation method can stimulate people, and they believe every effort they pay has rewards. Such appropriate design and implementation of a team-based motivating system is believed to enhance interruption management in virtual environment.

3.3.5 Interruption Management

Participants agree that it is crucial that interruptions are coordinated and managed during the processes of collaboration among the partners of the supply pipeline. Cooperative efforts should be made in the forecasting, purchasing, production and inventory management, synchronization of delivery and distribution schedules. Collaboration not only improves a firm's credibility, but also increases the sources from which one company can gain knowledge about the market. When one company can concentrate on its strength and do things extraordinarily well to form its unique advantage, other channel members can focus on their own value-adding activities. Such virtual network collaboration is applied widely in the textile and apparel industry. The importance of interruption management during collaboration has been realized by a considerable number of textile firms.

> *The textile industry is facing fierce competition and the companies that stop innovate are losing their competitiveness power. We need to deliver innovative and quality products with low costs and shorter lead time to win our customers. In doing so, we first need to coordinate effectively the activities with our partners. Interruptions with good intentions do not always lead to good consequences. What really help are the interruptions that bring the important issues without intervening in my planed work. So I think interruption management is important.*

The problem is just that not so many people pay great attention to it. (Organization 3)

In the textile industry, interruptions are to a large extent inevitable because a great number of small details are actually significant to the final products. Virtual collaborators need to interact with each other from time to time on activities from design and development, manufacturing, eventually to distribution in end market places. Participants suggest that some guidelines for team members to follow are helpful in regulating undesirable interruptions whilst maintaining teamwork efficiency.

As brand designers, we decide the styles and discuss with the fiber producers and mills: the texture, weight, elastic qualities, colour, associated strength, etc. There are always plenty of interruptions for all the details and modifications that have to be made. I have my own rationale of handling interruptions, but I think it is best that the team should discuss about it and set agreed guidelines on interruption management. (Organization 10)

With higher task interdependence, the management level and the executive level have to develop their own ability to coordinate interruptions.

All the departments work closely so that important information is not missed or delayed. So, cooperation between team leaders and team members is needed. Team leaders should give instructions on communication details, such as "I prefer not to be interrupted in the middle of remote conferences", "for the details of XXX project, please refer to my secretary", "do not call me except for emergencies", or "I read e-mails every half hour", etc. Team members should obey these rules so that their interruptions can be received in time, and in the same time, not intrusive to team leaders. (Organization 14)

- **How to manage interruptions**

A majority of participants, despite they are from different virtual teams, share surprisingly similar strategies in treating interruptions: mainly according to the relative urgency and importance compared to the concurrent task. Only urgent and important interruptions are answered immediately and personally.

If I receive an interruption, I will first identify its urgency. If it's very urgent, I will then check the importance of this task; for important tasks, I'd like to handle it as soon as possible if it's not complicated and not time-consuming. (Organization 1)

- Urgency

Urgency is a characteristic that is easy to identify for the interruptees. For example, phone calls are often deemed as urgent requests among virtual team members. In today's textile and apparel business, market environments changes rapidly; this requires virtual team to formulate methods of coping with urgent interruptions.

> *Urgency is an important consideration in our business. Sometimes the clients ask us to fix an emergency in several minutes. It's very time-sensitive dealing with the changing market environment. (Organization 3)*

> *From our (apparel exporter) perspective, if the apparels are not shipped in right time, then the delay will increase the cost in production. So when production deadline is coming up, I would be very concerned about the incoming interruptions because it could be very costly if any unexpected happening is not timely and properly fixed. If we have any delay on the date of finishing production, the buyer may ask us to ship the goods through air or may ask for discount or cancellation of the order. And repeated delays might affect the long term business relationships. From the buyer's perspective, they make promotional plan based on*

the delivery dates of the particular orders and inform the retailers that apparels will be in the stores on the particular dates. The delay of the production or shipment will cause their loss. Especially for virtual collaboration among the supply chains, the appropriate way of treating urgent interruptions can be sometimes crucial for the firm. (Organization 8)

Some companies create critical event notification systems so as to respond quickly to the emergencies and resolve them with proper manner.

Urgency is the first thing I will consider when interruption happens, and this may be attributed to the fierce competition of this (textile) industry. We have policy called critical event notification system in our company, for example, at the happening of some critical events, the urgent message goes to the team leader, if he is not available then, it goes to his assistants, and they will take care of these kinds of emergency first. (Organization 2)

- Importance

For textile companies, information about raw materials, competitors, downstream partners, and customer requirements are all crucial to their business development and maintenance. Attitudes toward such important interruptions also affect collaboration.

> *Some interruptions can be quite informative and important to the company's business development as well as decision making. For example, phone calls or emails about cotton price fluctuation or forecasting price variation of the raw materials. Timely receiving such key information would make us respond more quickly than our competitors, and it also enables us to be advantageous in negotiating with our customers. (Organization 14)*

Respondents also share their opinions on how to distinguish which interruptions are important. Some virtual teams have consensus on the important issues, like particular projects and key clients.

> *Tasks from our key clients are considered as important interruptions. I will deal with them personally and with great patience. If two or even more requests are waiting for me to answer, I have to respond to things related to the biggest client first, I'm afraid. (Organization 11)*

Some virtual teams have a system to indicate the important issues, by using exclamation marks or other symbols.

> *Take e-mail as an example, I will glance the subject and the sender, whether it's from a main client or key contact, and whether it's important shown on the subject (important ones will show an exclamation mark). I will read the urgent ones immediately while put the less urgent ones aside for a moment if I'm busy right now. But I read all the emails within about half an hour in most time to guarantee I miss nothing important. About 70% of the interruptions at my work are from emails. If the issue is very urgent, I'll reply in 30 minute; less urgent, reply in 4-6 hours; if not urgent, I may reply in a day. When new emails come up, mostly I don't check them immediately, because sometimes "looking", even not replying brings some disruptive effect to the concurrent work. In addition, I check email every 30 minutes, it becomes a routine. In our team, we have golden rules like "never let something urgent happen, let something important happen. This means that do things that will prevent emergencies from happening is a good method of interruption management. (Organization 1)*

Mcfarlane (2002) puts forth four distinct ways to treat different interruptions: immediate, negotiated, mediated, and scheduled. In this research, the author identifies the most popular interruption strategy to cope with different situations in current textile business environments: immediate, delegated, negotiated, and scheduled. The four ways of coordination methods are appropriate in coping with different situations.

When I found myself constantly involved in the interruption situations, I thought I had to conclude a system of interruption handling strategies. Mine is developed based on the Eisenhower method. The basic principle is to treat interruption based on the urgency and importance of the interrupting task (see Figure 3-2): when the incoming task is more urgent and important than the primary one, to reach the best overall team efficiency, people should handle the interruption immediately before resuming their primary one; if the interruption is important but not so urgent, we can make an appointment with the interrupter to deal with it; if the interruption is an trivial urgency, then we can get it delegated to less occupied others; and if the interruption is neither important nor urgent, it's appropriate that we postpone it and get the tasks in hand done first.(Organization 6)

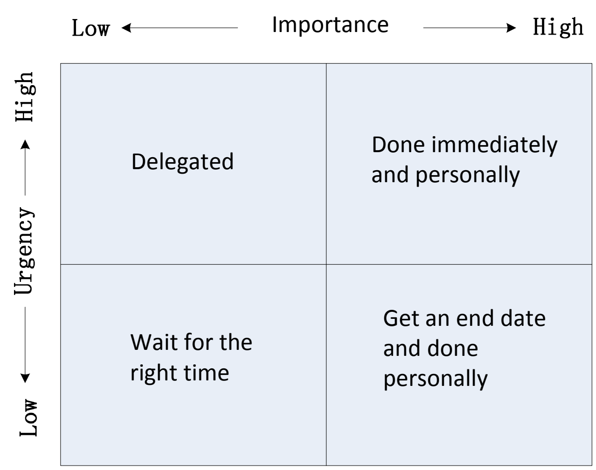


Figure 3-2: the Basic Rationale of Choosing Handling Interruptions

- Immediate

The "immediate" way is to let the interruptee come up and talk over the problem, promptly stop the documentary work at hand and resume it after settling the problem. The immediate way of responding to interruptions will benefit both parties if the interruption is positive and helpful. If the interruption happens at inappropriate timing, the interruptee may experience a troublesome "orientation" period in resuming task performing. This orientation period can be very long or even make the interruptee unable to resume. Hence, only under specific context, people would choose the immediate method to fix interruptions.

- Delegated

When the interruption recipient is occupied, delegating the incoming task to another responsible team member is a good way to coordinate resources in one team. According to our interview output, “delegated” can be a practical method of balancing disruption and efficiency in collaboration.

> *For the tasks involving high levels of concentration (e.g., programming, writing papers, etc.), tasks approaching deadline, and situations involving higher degrees of etiquette (e.g., conducting an interview), incoming interruptions are better regulated or delegated. (Organization 1)*

- Negotiated

If the recipient is not available for interruptions, the “negotiated” way is recommended to respond the incoming requests. The “negotiated” way would have the incoming problem stated and let the recipient negotiate with the interrupter for a better opportunity to deal with the problem.

- Scheduled

When the interrupting task is neither urgent nor important, the Eisenhower method tends to neglect such trivial issues. However, participants suggest that “scheduled” is a better method in treating such interruptions, in order to avoid them turning into big problem. The "scheduled" approach would restrict interruption from all sources until a prearranged time period such as one hour. This method may involve some assistant devices such as reminders to realize such function. If an incoming activity is suspended because the recipient is deeply concentrating on another task, a reminder indicates that a message is still pending for processing when the interruptee comes to subtask boundaries. A reminder can be a signal (to indicate that there is still something to be done) or description (to help retrieving what should be recalled).

> *An ideal reminder should meet the following criteria: 1) inform me of the suspended tasks in right situation; 2) clearly and immediately remind me when something urgent comes up; 3) do not distract me from the current activity; 4) provide a list of suspending tasks whenever I need to see it. (Organization 2)*

- **Components of Effective Interruption Management**

Through the qualitative approach, considerable insights have been gained for instrument development of interruption management. The experience of choosing interruption handling strategies based on an array of external conditions that shared by the interview participants provide sound basis for developing measurement items for the construct of interruption management in the next step of research. The scale of interruption management should include the following aspects:

- Whether the interruptions are treated based on its urgency and importance. As explained previously, the urgency and importance of the interruption largely decides how it is treated.

- Whether the interruptions are treated based on task priority. The task priority is another criterion for measuring comparative urgency, importance and other characteristics of the interrupting task. Task priority can be set at team level for the members to understand which tasks are preferred. For example, more prior tasks can be the more urgent requests, the requests from important clients, or the time-sensitive tasks. For the highly interdependent teams, high priority might also goes to the tasks that related to a lot of team members. Tasks with higher priorities should be paid extra attention and responded with possible immediacy. Tasks with relatively lower priorities should be controlled when the recipient is occupied in mentally demanding tasks. These less prior interruptions could be mediated or negotiated for a better timing.

- Whether the negative interruptions are regulated while the positive interruptions are treated properly. As described earlier, some interruptions are positive, bringing much latest information for refreshment and instructions for decision making. Some are negative interruptions, which would cause considerable disruptions to the recipients and have no instructive meanings to the team collaboration. For the sake of better coordination of the team process, the positive interruptions should be treated properly and the negative interruptions should be regulated in order to assure the quality of team performance and the efficiency of the team collaboration.

3.4 Summary

This chapter introduces the qualitative approach – in-depth interviewing with the textile industrial practitioners, and the findings in the exploratory research. The narrative data collected in this phase provide rich and illuminating evidence that helps us to understand the phenomena. Twenty participants shared their virtual collaboration experience, including how they treat interruptions in their collaborative work, how textile firms utilize the information technologies to deal with the interruption problems, and how they reckon our hypothetical factors influence interruption management. The interview results are summarized in table 3-2.

Table 3-2: Summary of Interview Results

Proposed Relationships	Supported?	Reason
Intra-team Awareness → Interruption Management	Yes	Intra-team awareness helps to know other's availability, workload and status; it also increases connectedness among members.
Virtual Technology → Interruption Management	Yes	Proper utilization of technologies can help regulate undesirable interruptions and facilitate desirable interruptions by diverse means.
Task Interdependence → Interruption Management Task Interdependence → Virtual Collaboration Effectiveness	Yes	People show higher sense of responsibility to other's requests when their performances are correlated.
Motivating & Governance System → Interruption Management Motivating & Governance System → Virtual Collaboration Effectiveness	Supported by majority	A majority of supporters insist that people will behave more cooperatively when their rewards are based on team performance. A minority of opponents state that individual-based motivating system is the most effective way in stimulating performance.
Interruption Management → Virtual Collaboration Effectiveness	Yes	Better coordination of interruptions help smooth interaction among collaborators.

The participants agree that the collaborative parties should develop intra-team awareness in several aspects: access to others' availability for interruptions, workload, current priority for tasks, the degree they feel connected to other parties, and the awareness to external environment. Higher awareness allows the dispersed individuals have knowledge about when and how to interrupt others when there are interaction requirements. The virtual technologies adopted by the participants facilitate interaction to some extent, but are not satisfactory in meeting increasing requirements of adapting to the changing market. This is partly because technological advancement can be slow in the traditional and cost-sensitive industries like textile and apparel. Ideal technologies are able to decrease undesirable interruptions, display availability, mediate interrupting requests, and filter interruptions. Task interdependence in the textile industry is relatively high for the collaborators, and this promotes people's willingness to coordinate interruptions. Current textile virtual teams adopt different motivating & governance systems, but most participants agree that a team-based joint reward system with effective monitoring and governance can motivate team members' shared effort in controlling interruptions. Participants also shared their experience of managing interruptions. The discussions contribute significantly to the next stage of research.

4. Quantitative Survey

Questionnaire-based survey was employed in this research to collect information of the respondents, including organizational and technological characteristics of their virtual team, issues of interruption management and their collaboration performance. After the interview process, a multi-stage questionnaire survey was employed to test the hypotheses. The initial stage of the survey was to evaluate the measurement development as well as questionnaire design, and to collect feedback from subjects for refinement of items. Since the measurement items of the constructs intra-team awareness, virtual technology and interruption management were developed especially in this research, the author used data in the first stage to evaluate and purify the statements of items. Stage-two was the mass industry survey to collect adequate qualified data for further analysis and hypotheses testing.

This chapter explains and justifies the quantitative approach to test the hypotheses. The chapter is composed of five parts. The first part describes the processes of survey instruments and questionnaire design. The second part introduces the method and result of the preliminary test in the first stage which provides evidences for the justification of the instruments. The third part describes data collection method, sampling strategy and data cleaning method for the mass survey; and delineates the preliminary data analysis which proves that the data do not suffer from some statistical bias such as non-response bias and common method bias. This part also introduces the demographic characteristics of the sample, and decribes descriptive analysis for the exogenous and endogenous variables. The following two parts provide a detailed quantitative analysis pertaining to the proposed conceptual model using the main survey data. The fourth part provides the processes and results of the measurement model building, and also concerns reliability and validity of the measurement model. The fifth part presents the methods and results of structural model validation and hypothesis testing.

4.1 Survey Instruments

This research investigates how interruption management in virtual collaborative work can be realized through organizational and technological design of the virtual teams, and how it influences virtual collaboration effectiveness among the textile industrial practitioners. The development of scales for measuring the constructs in this research (shown in Figure 4-1) follows the paradigm for constructing scale measures suggested by Hinkin (1995). The suggested main steps for scale construction are: (1) generating a sample of measurement items, (2) collecting data, (3) purifying the measures, (4) assessing reliability and validity. These steps and the associated calculations work well for the scale development in the present research.

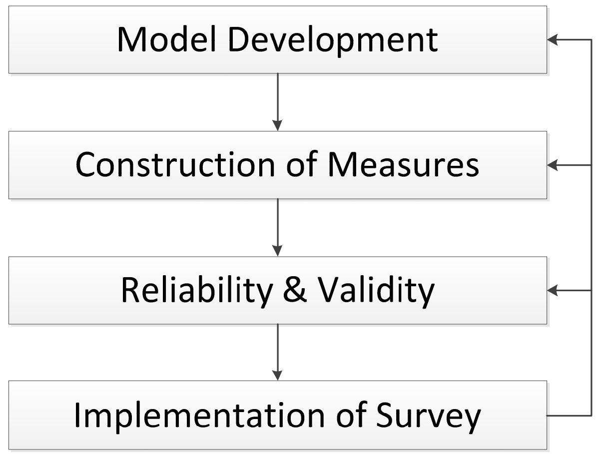


Figure 4-1: the Approach of Questionnaire Development & Modification

Through extensive literature review, a series of organizational and technological antecedents that affect interruption management as well as virtual collaboration effectiveness were yielded. A tentative empirical test of the outlined relationships was undergone through the in-depth interview process. The next step was to develop reliable and valid scales for quantitative measurement, and use these measurement scales to examine the hypothesized relationships among the constructs. First, constructs of the research were derived in line with the outcome of interview content analysis and literature review. Second, the content validity was pretested among a group of professionals in organizational behavior and business studies field. The preliminary questionnaire was designed to have a pre-test for the measurement scales. Third, the construct reliability of the scales was examined through preliminary test. Because three constructs were developed originally in this research, the items under these constructs were created and evaluated following the procedures of Bearden et al. (2006) and Ding et al. (2011). Based on the evidences found in stage-one, the author modified the measurement items and questionnaire design. Fourth, the mass questionnaire survey was carried out in several cities. Finally, confirmatory factor analysis (CFA) and structural equation modeling (SEM) analysis were performed with the data collected from the main survey, to test the proposed model of virtual collaboration and the hypotheses.

4.1.1 Item Development for Variables

The instrument of this research comprises six constructs, namely, the intra-team awareness, virtual technology, task interdependence, motivating & governance system, interruption management, and virtual collaboration effectiveness. Each dimension is composed of several items since multi-item measures are adopted in scale development. According to DeVellis (1991), multi-item measures tend to yield high reliability and less measurement error. Each construct in the conceptual model was developed into a section correspondingly in the questionnaire. The development of scales for measuring the constructs in this research followed the paradigm for constructing scale measures recommended by Hinkin (1995).

In this research, both deductive and inductive methods of item generation were adopted to develop appropriate measurement scales. In deductive scale development, the theoretical definition of the construct to be measured was drawn from literature and used as a guide to generate items. The constructs of motivating & governance system, task interdependence and virtual collaboration effectiveness were developed in deductive way, since theories on these variables were adequate enough for us to adopt these validated measurement scales. In inductive approach, the pattern generated from questions answered by interview respondents was used as indicator in developing items, rather than exclusive theoretical evidence. In contrast to other constructs in this research, measurement scales of the intra-team awareness, virtual technology and interruption management were especially developed for the study.

4.1.1.1 Intra-team Awareness

Previous literature describing intra-team awareness were reviewed (e.g., Bailey & Konstan, 2006; Dabbish & Kraut, 2004; Dabbish & Kraut, 2008; Dekel & Ross, 2004; Dourish & Bellotti, 1992; Gutwin & Greenberg, 2004; Tang & Birnholtz, 2010). This construct was developed based on literature and evidences collected from interviews. Without the validation processes of previous researchers, development of this construct should receive particular attention. According to Churchill Jr. (1979), the scale development process consists of item generation, scale development, and scale evaluation. In item generation phase, the author developed a pool of candidate items generated through literature review, interview results, and domain experts' input, in conjunction with the assessment of content validity of the candidate items (Boudreau et al., 2001). The scale development phase required selecting and grouping the candidate items a subset of items with satisfactory reliability and validity. The final stage of scale evaluation was to examine the remaining items thoroughly to ensure psychometric properties.

The literature suggests measurements of intra-team awareness should include the following items: the awareness of other's availability and workload (Dekel & Ross, 2004; Gutwin & Greenberg, 2004) and sense of connectedness of team members (Nunamaker et al., 2009). The participants in the interviews also suggest that the following items should be parts of the measurement: awareness of other's task priority, awareness of the project progress, awareness of external environment, and access to the related information that helps individuals to have wise judgments about the time and method in connecting others. Initially nine items were generated in this construct.

The next stage was instrument purification process by examining the content validity of the initial statements. Content validity refers to the extent to which elements of a research instrument are representative to its construct (Haynes et al., 1995). This stage involved the identification of the items that best present the dimensions of each construct and the elimination or revision of the other items. Seven textile virtual team leaders individually discussed whether they agreed on the statements. The criteria for retaining a statement was at least four participants agreed on the measurement item for the construct. Based on their comments, the statements were modified. To ensure content validity, the double-barreled, ambiguous, leading statements were eliminated or revised, and the redundant items that tapped the same facet of a focal construct were removed.

A panel of five academic experts on textiles and organization science were also invited to evaluate the content validity of the measurement items. They were asked to assess the degree to which each item represented the targeted construct ranging from 1 (very unrepresentative) to 7 (very representative). The author retained the items with average score greater than four, which were assumed to have good content validity. After this process, the number of intra-team awareness items deduced to five (see Table 4-1).

Table 4-1: Initial Items for Intra-team Awareness (ITA)

Code	Item
Ita1	I am aware of my virtual teammates' availability for interruptions.
Ita2	I am aware of my virtual teammates' priority for interruptions.
Ita3	I am aware of the project progress of my collaboration work.
Ita4	I feel connected to my virtual teammates.
Ita5	I am aware of the external environment of my virtual collaboration work.

4.1.1.2 Virtual Technologies

Virtual technology is a construct that reflects the extent to which the adopted virtual technologies performs in managing interruptions and virtual collaboration. Such attempt in literature is lacking because most of the previous research focuses on technologies that facilitate merely virtual interaction. This construct was also developed in this research, following the steps explained in the construct development of intra-team awareness. A body of research regarding virtual technologies (e.g., Acosta & Selker, 2007; Basoglu et al., 2012; Bélanger & Allport, 2008; Fry & Slocum, 1984; Grandhi & Jones, 2010) provides theoretical support for developing measurement items of virtual technologies: they should decrease negative interruptions, have the ability of filtering unnecessary interruptions, negotiating and mediating interruptions. Interview participants suggest that they should also be more "present" and expressive to facilitate mutual understanding, show availability and other key information required for the classification of interruptions, etc. Initially 10 items were generated and five items remained after justification (see table 4-2).

Table 4-2: Initial Items for Virtual Technology

Code	**Items**
Vtech1	Remote technologies adopted in our team are able to help decrease negative interruptions.
Vtech2	Remote technologies adopted in our team are able to negotiate for interruption time.
Vtech3	Remote technologies adopted in our team are able to show user availability for interruption.
Vtech4	Remote technologies adopted in our team help us to be more “present” in interaction.
Vtech5	Remote technologies adopted in our team help to filter unnecessary interruptions.

4.1.1.3 Task Interdependence

Task interdependence conceptualized by Thompson (1967) is considered seminal among the research of task interdependence in team collaboration: interdependence encapsulates the extent that team members need to provide information, materials, and support to one another to accomplish the team’s task. Campion et al. (1993) and Wageman (1995) also identify similar conceptualization of task interdependence and develops measurement scales for the construct. Based on such conceptualization, Pearce

& Gregersen (1991) develops measurements for the construct, and they are further modified and proved reliable by Liden et al. (1997). This construct is also employed by Hertel et al. (2004) to test task interdependence in virtual teams and proved to be statistically valid. The author adopted the items of Liden et al. (1997) (see Table 4-3).

Table 4-3: Initial Items for Task Interdependence

Code	**Items**
Dep1	Team members work closely with each other in doing their work.
Dep2	Team members frequently must coordinate their efforts with each other.
Dep3	The way individual members perform their jobs has a significant impact upon others in the team.

4.1.1.4 Motivating & Governance System

The motivating & governance system is an organizational factor of virtual teams, indicating the mechanism of how team members are motivated and how the performance of the team is governed to ensure smooth collaboration. This construct focuses on how reward and other incentives are allocated in virtual teams. It is conceptualized the same as the reward structure in traditional teams. A large body of research suggests the measurement scales for the reward structure and incentive system (Bamberger & Levi, 2009; Cohen & Bailey, 1997; DeMatteo et al., 1998; Hackman, 1987; Hertel et al., 2004; Kerrin & Oliver, 2002; Koehne et al., 2012). Virtual collaborators cooperate as a holistic team; as a result, the members are governed under the same motivating system and rules.

The development of this construct was based on the construct of evaluation and rewards suggested by literature. Mot1 “My rewards depend primarily on how the entire team is doing” and Mot2 “My rewards are strongly influenced by my contribution as a team member” were adopted from Campion et al. (1993). Mot 4 “The motivating and governance system in my team is able to stimulate and reinforce individual performance” was adopted from Hackman (1987). The measurement items in the literature were employed to evaluate motivation systems in traditional teams, so the author added another item that particularly focuses on the motivating system in interruption-contingent virtual environment: Mot3 “the motivating and governance system in my team encourages me to consider more about the whole team in treating interruptions”. Besides, another item is strongly recommended by the interview participants, i.e. Mot5 “My rewards depend primarily on my position”. Mot5 is a reverse scale. The internal consistency of the construct would be tested to see whether the added items are suitable in this construct. The developed items are listed in Table 4-4.

Table 4-4: Initial Items for Motivating & Governance System

Code	Items
Mot1	My rewards depend primarily on how the entire team is doing.
Mot2	My rewards are strongly influenced by my contribution as a team member.
Mot3	The motivating and governance system in my team encourages me to consider more about the whole team in treating interruptions.
Mot4	The motivating and governance system in my team is able to stimulate and reinforce individual performance.
Mot5	My rewards depend primarily on my position. (reverse scale)

4.1.1.5 Interruption Management

The interruption management variable reflects the virtual team members' perceptions of the extent to which interruptions during their virtual collaboration are effectively coordinated and managed. The literature suggests that the quality of interruption regulation largely affects collaborative performance. This construct was also developed in this research, following the steps explained in the construct development of intra-team awareness.

Literature toward the concept of interruption management mostly focuses on the potential approach adopted by virtual team members to help effectively manage interruptions (eg., Bailey & Iqbal, 2008; Grandhi & Jones, 2010; Liebowitz, 2010), and the information technological developments on the systems to help regulating interruptions (eg., Adamczyk & Bailey, 2005; McFarlane & Latorella, 2002). Some guidelines of interruption management can be concluded from the literature: positive interruptions should be treated properly while negative interruptions can be regulated, urgent interruption should be handled immediately. In the in-depth interviews, the concept of interruption management in virtual collaboration was discussed and the components of criteria for effective interruption management were collected, including: interruption should be treated by their priority; interruptions with high priority should be handled promptly while interruptions with lower priority should be regulated if the recipient is occupied; and important interruptions should be handled properly, etc. Thirteen initial items of the interruption management construct were generated. The statements were reviewed and discussed by the interviewers then, attempting to acquire a deepened understanding of the participants' insight into this construct. Interruption management items reduced to eight after justification (see table 4-5).

Table 4-5: Initial Items for Interruption Management

Code	Items
InMgt1	Interruptions of high priority are usually handled first.
InMgt2	Interruptions more urgent than ongoing tasks are usually fixed immediately.
InMgt3	Interruptions more important than ongoing tasks are usually fixed immediately.
InMgt4	Positive interruptions are usually properly fixed.
InMgt5	Negative interruptions are regulated.
InMgt6	Interruptions with high priority are usually fixed timely and properly.
InMgt7	Interruptions with low priority are seldom received during high mental load period.
InMgt8	Overall, I think our team has good interruptions management.

4.1.1.6 Virtual Collaboration Effectiveness

The variable of virtual collaboration effectiveness reflects team members' self-reported perceptions of how effective their virtual collaboration is. The author derives measurement items of this construct from the scale of self-reported team performance developed by Hauptman (1986), which was further modified by Ancona & Caldwell (1992). The adopted scale includes: adherence to schedules, adherence to budgets, efficiency, task quality, ability to resolve conflicts, and overall work excellence. This research aimed to measure virtual collaboration effectiveness rather than the effectiveness or performance of the entire virtual team. Hence, the author put more emphasis on evaluating team collaboration. The author made minor amendments on wording so that the adopted items can adapt to the virtual collaboration context.

In addition, the author followed the instruction of Hackman (1987) to add member satisfaction in the scale of the virtual collaboration effectiveness. A number of studies report that higher level of frustration and lower degree of satisfaction is found in virtual team members (Graetz et al., 1998; Thompson & Coovert, 2002). This is possibly because people in virtual teams experience an amount of mental demands and greater efforts in computer-mediated collaborative work. However, for decision-making tasks, members experience a high level of satisfaction toward the processes and in decision-making tasks such as electronic brainstorming (Valacich & Schwenk, 1995; Gallupe et al., 1992). The measurement items of this construct are listed in table 4-6.

Table 4-6: Initial Items for Virtual collaboration effectiveness

Code	**Items**
Effe1	I think the remote collaboration projects of our team are completed on time.
Effe2	I think the remote collaboration projects of our team are completed within budget.
Effe3	I think the remote collaboration of our team is of high quality.
Effe4	I think my collaboration and interaction with teammates is efficient.
Effe5	I think our team is able to resolve conflicts.
Effe6	I'm satisfied about the being a member in the team.
Effe7	Overall, I think collaboration of our team has good performance.

4.1.2 Questionnaire Design

In order to collect opinions from Chinese-speaking participants, the measurement items in the original questionnaire were translated into Chinese following the blind translation-back-translation method of Brislin (1970). As some measurement scales were adopted from literature and translated into Chinese, the accuracy of wording requires special attention. The initial Chinese version of questionnaire was first reviewed by four Chinese native speaking academics. The structure of sentences, the wording, and expression of professional terms were emphatically checked. Some wording was revised according to the reviewers' advice. Additionally, the questionnaire was pretested using the sample of a small group of Chinese. After the completion of the survey, the respondents were asked about the Chinese expression of the statements, and some minor changes were made to form the final Chinese version of questionnaire. For example, the term *virtual team* was replaced with *remote team,* and *virtual technology* was replaced by *remote technology* in the main questionnaire. A number of respondents stated that the term *virtual team* was too academic and might get the respondents confused. They also suggested that many of the virtual team members in industry named their teams as remote teams. So the author made this minor revision on wording to keep our questionnaire as clear as possible to the respondents.

The final questionnaire is composed of eight sections. Each construct in the analytical framework would be developed into a section correspondingly. Section one includes screening questions that help to select qualified respondents, concise explanation of the definition of terminologies such as “remote team” and “interruption”, and the assurance of confidentiality. Sections two to five are the items measuring the independent variables: intra-team awareness, virtual technology, task interdependence, and motivating & governance system. Sections six and seven concern the dependent variables in the conceptual model: interruption management, and virtual collaboration effectiveness. The last section collects demographic information of the respondents and the virtual teams or organizations they work in, including business types of organization, types of virtual team, virtual team size, team virtuality (the degree of how a team’s tasks depend on virtual collaboration), respondent's team role, virtual collaboration experience, functional area of the respondent, gender. The English and Chinese versions of questionnaire in stage one are recorded in Appendix B and Appendix C respectively. Information related to characteristics of the virtual teams and organizations are also collected because the author attempts to test whether there are differences among the different groups of virtual teams.

Concerning types of virtual teams, Sundstrom & Altman (1989) uses integration and differentiation to identify four types of work groups: (a) advice and involvement groups;

(b) production and service teams; (c) project and development teams; and (d) action and negotiation teams. Sundstrom et al. (2000) extends this typology into six types: production (R&D), service (IT), management, project, action and performing, and advisory (consulting). In this research, the following six categories of virtual teams are to be chosen in the questionnaire:

- R&D teams: include all kinds of research, innovation, new-product development teams.
- Service teams: include maintenance, technical support, pre and post-sales service teams, etc.
- Action teams: the teams that are responsible of conducting the complex, time-limited performance events which might be self-regulating or delegated by the senior, examples are sales, marketing, customer survey, front-line production teams, etc.
- Management teams: executive teams, usually consist of one senior manager and several managers or supervisors that directly report to him or her. These teams coordinate the work unit through joint planning, policy making, budgeting, staffing, and logistics (Cohen & Bailey, 1997).
- Consulting teams: teams that provide solutions or solve problems, usually work outside of or parallel to production teams.

- Project teams: integrated teams that carry out specialized, time limited projects with cross-functional expertise, and disband after finishing.

Size of virtual team might be also influential to the proposed relationships. Martins et al. (2004) states that too large size may cause process losses and production blocking although the increase on team size may result in more ideas generated. Riopelle et al. (2003) argues that the increased size makes it difficult for participants to interact effectively through IT tools such as videoconferencing or message group. This research divided the virtual teams into five categories by number of its members: 1-5, 6-10, 11-20, 21-50, above 50. In addition, regarding the gender difference of the virtual members, Lind (1999) finds that women are more satisfied with their virtual communication process, and they also perceive more inclusive and supportive as a member of the team compared to men. The author put these demographic variables in the questionnaire to test whether they have impact on other variables in the model.

Five-point Likert scale was used to indicate the respondents' perception and judgment about each item. The format of the scaling in the questionnaire was:

1. Strongly disagree

2. Disagree

3. Neutral (neither agree nor disagree)
4. Agree
5. Strongly agree

Before the survey started to implement, a final evaluation of the questions was conducted. Any ambiguous or repetitive question was avoided, the probable annoying wording or formatting was improved, and the length of whole questionnaire was constrained to five pages.

4.2 Stage-one Survey

The objective of the stage-one survey was to collect the feedback from subjects about the questionnaire. This feedback would be considered for the refinement of items for the main questionnaire survey. Especially for the scales developed in this research, results in the first stage survey provide important evidences for measurement validation. Another objective of the stage-one survey was to collect and analyze data, providing initial outcome of the test, in order for us to predict problems and prevent mistakes that result from questionnaire design. Scale reliability and validity was tested in stage-one survey, and it provides us with evidences on questionnaire refinement (e.g., if there was any statement of items can be further improved or eliminated). It also gave us a preview of how long the subjects were expected to complete the questionnaire and how difficult items could be finished. This helped us to control the mass survey process.

4.2.1 Data collection

The stage-one survey was conducted from September to November 2010 in Hong Kong, Shanghai and Beijing. Participants were invited with the criteria of virtual collaboration experience in textile and apparel firms. The reason for selecting the three cities is that they are first-tier cities and trade centers in China; collecting data in the three cities assures both sample adequacy and efficiency for the questionnaire survey. The data were screened and cleaned first, following instructions of Hair et al. (1987). Missing data were examined and cases with missing data were deleted from the database, because non-random missing data would cause bias to statistical result. After 25 questionnaires were excluded from the sample in the data cleaning and screening procedure, a total of 89 valid questionnaires were collected and analyzed. Within the respondents, 64% are male, 11% are virtual team leaders. Concerning the business scope of the participant firms, 20% are manufacturing oriented, 20% are marketing oriented, 22% are research and development oriented, 16% are integrated, 15% are innovation oriented, and 7% are branding oriented. Regarding to the functional area of the respondents, 40% of them are professional/technical, 20% are administrative, 16% are marketing/sales, 15% are managerial, and 6% are production (see Table 4-7).

Table 4-7: Demographic Information of Participants in Stage-one survey

Demographic items		**Percentage**
Business type	Manufacturing oriented	20.2
	Branding oriented	6.7
	Marketing oriented	20.2
	Research & development	22.5
	Integrated	15.7
	Innovation oriented	14.6
Participant's team role	team leader	11.2
	team member	86.5
	Advisor/Supporter	2.2
Participant's functional area	Managerial	14.9
	professional/ Technical	40.2
	Sales / Marketing	16.1
	Manufacturing / Production	5.7
	Clerical / Office	19.5
	others	3.4
Educational level	Bachelor	53.9
	Master	42.7
	Doctoral	3.4
Gender	male	64.0
	female	36.0

4.2.2 Scale Reliability

Researchers must ensure the instrument to measure constructs is reliable and valid (Churchill Jr., 1979). Reliability and validity are both indispensable criteria in measuring the quality of empirical design. As Flynn et al. (1990) notes, empirical data are of little use without good reliability and validity. The reliability of the measures was first assessed in this stage. Reliability refers to the degree to which all the items in the scale measure the same concept and yield the same result each time. Reliability indicates the consistency of a measure, and it concerns the relative absence of error in measurement.

Scale reliability is the proportion of the variance in a latent variable that is attribute to the true score of the latent variable (DeVellis, 1991). Reliability test was employed in both the pilot and main survey, in order to test the internal consistency of each dimension. Although there are a number of ways to test reliability of the constructs, the most widely used method is calculating the coefficient alpha. Cronbach's standardized alpha for each dimension of the questionnaires was computed to check the consistency level of all the items in each dimension.

Generally, higher correlation alpha indicates higher reliability of the items under one construct. Peterson (1994) considers the construct of measurement to be satisfactory when Cronbach's alpha exceeds 0.7. However, this figure can be lower in the some special occasions, for example, when there are relatively fewer items in one dimension or the items are newly developed (Kim & Mueller, 1978). In this research, most constructs are relatively new and await further validation. Therefore, the author set 0.6 as the satisfactory level of reliability test in this research. To secure the internal consistency of the set of measurement items in a construct, items with coefficient alpha below .60 were eliminated.

The item-total correlations were also tested to identify and discard items which did not well represent the construct. If the Cronbach's alpha for the dimension when a particular item is deleted is higher than that for the dimension with all the items, then that item should be deleted to achieve a more meaningful and interpretable set of constructs. For example, the item "Ita4" was excluded because α without this item was 0.807 which was higher than the original α 0.735 of this factor. For the cases that more than two items should be eliminated to achieve good internal consistency of a construct, the items were excluded one by one. For instance, the "Mot4" item should be deleted because α without this item was 0.768 which was higher than the original α 0.737 (see Table 4-8); after "Mot4" was removed, α increases to 0.768, however, α can be even higher (0.773) if the

“Mot5” was deleted, so the “Mot5” was deleted then. In addition, corrected Item-Total Correlation value should be greater than 0.3 (Field, 2005). The corrected item-total correlations for the items and the coefficient alphas are shown in Table 4-8. After the examination of scale reliability, several measurement items were eliminated to achieve higher internal consistency of the constructs. Table 4-9 shows the coefficient alphas before and after reliability tests, as well as the deleted items.

Table 4-8: Coefficient Alphas and Item-Total Correlations of the Variables

Item code	Item	Item-Total correlation	α if item deleted	α
Intra-team awareness				0.735
Ita1	Awareness of other's availability	.603	.653	
Ita2	Awareness of other's task priority	.640	.632	
Ita3	Awareness of project progress	.584	.657	
Ita4	Sense of connectedness	.201	.807	
Ita5	Awareness of external environment	.537	.673	
Task interdependence				0.773
Dep1	Close cooperation	.615	.687	
Dep2	Frequent coordination	.670	.622	
Dep3	Individual job dependency	.542	.765	
Motivating & Governance system				0.737
Mot1	Team-based motivation	.576	.660	
Mot2	Contribution as team member	.607	.651	
Mot3	Team consideration	.600	.653	
Mot4	Reinforce individual performance	.273	.768	
Mot5	Position-based motivation (reverse scale)	.458	.707	
Virtual technology				0.731
Vtech1	Decrease negative interruptions	.513	.678	
Vtech2	Negotiate for interruption time	.564	.656	
Vtech3	Show availability	.574	.656	
Vtech4	Increase social presence	.291	.762	
Vtech5	Help filter unnecessary interruptions	.550	.664	

Interruption management				0.652
InMgt1	Handle interruption by priority	.441	.597	
InMgt2	Handle interruption by urgency	.495	.579	
InMgt3	Handle interruption by importance	.394	.609	
InMgt4	Proper handling of prior interruptions	.096	.683	
InMgt5	Regulation of less prior interruptions	.250	.647	
InMgt6	Proper handling of positive interruptions	.499	.579	
InMgt7	Regulation of negative interruptions	.382	.610	
InMgt8	Overall interruption management	.236	.645	
Virtual Collaboration Effectiveness				0.839
Effe1	Adherence to schedules	.422	.842	
Effe2	Adherence to budgets	.494	.832	
Effe3	High quality communication	.680	.803	
Effe4	Assured collaborative efficiency	.612	.814	
Effe5	Ability to resolve conflicts	.584	.818	
Effe6	Member satisfaction	.654	.809	
Effe7	Overall good performance	.703	.799	

Table 4-9: Improvement of the Coefficient Alphas

Factor	Coefficient alpha		Number of items		Items deleted
	Before adjusted	**After adjusted**	**Before adjusted**	**After adjusted**	
Intra-team Awareness	0.735	0.807	5	4	Ita4: Sense of connectedness
Task Interdependence	0.773		3		
Motivating & Governance System	0.737	0.773	5	3	Mot4: reinforce individual performance Mot5: Position-based motivation
Virtual Technology	0.731	0.762	5	4	Vtech4: social presence
Interruption Management	0.652	0.704	8	5	InMgt4: Proper handling of positive interruptions InMgt5: Regulation of negative interruptions InMgt8: overall interruption management
Virtual Collaboration Effectiveness	0.839	0.856	7	5	Effe1: Adherence to schedules Effe2: Adherence to budgets

4.2.3 Factor Analysis

After ensuring internal consistency of the scales, exploratory factor analysis was conducted to evaluate the validity of each construct using SPSS 18.0. Exploratory factor analysis was used to identify tentative dimensions of a scale and determine the items to be deleted. The criteria for retaining a factor was eigenvalues greater than 1 (Kaiser, 1960), with factor loadings at least 0.4 or higher (Stevens, 1992). Eigenvalues rule is that only the factor explain more variance than the average amount explained by an original item can be retained. To avoid cross loading, items with factor loadings greater than 0.4 in more than one component were omitted (Hair et al., 1987). Principal component factor analysis with varimax rotation was applied to the exogenous variables (the antecedent organizational and technological variables). Table 4-10 illustrates the result of exploratory factor analysis of the antecedent factors. Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is 0.711, indicating sampling identify in this research is satisfactory for factor analysis to proceed; and the value of Bartlett's test of sphericity is 461.020 at significance level of .000, suggesting the presence of correlation (Hair et al., 1987). These values indicate the adequacy of the data for exploratory factor analysis. The EFA result suggests a four-factor solution based on the eigenvalues, which explains 67% of the variances, and the factor solution is the same as conceptualized. After this purification process, the scales can be used in the main survey.

Table 4-10: EFA Results of the Antecedent Factors

Factors and items	**Factor loading**	**Eigenvalues**	**% of variance**
Intra-team awareness		3.645	26.036
Awareness of other's availability	.864		
Awareness of other's task priority	.903		
Awareness of project progress	.773		
Sense of connectedness	.630		
Virtual technology		2.519	17.992
Decrease negative interruptions	.675		
Negotiate for interruption time	.827		
Show availability	.821		
Help filter unnecessary interruptions	.673		
Task interdependence		2.054	14.673
Close cooperation	.815		
Frequent coordination	.805		
Individual job dependency	.710		
Motivating & governance system		1.165	8.323
Team-based motivation	.809		
Contribution as team member	.787		
Team consideration	.799		
Accumulated Variance Explained	Intra-team awareness: 26.036 Virtual technology: 44.028 Task interdependence: 58.701 Total: 67.024		
KMO's MSA	0.711		
Bartlett's Test of Sphericity	461.020 at .000		

In the exploratory factor analysis of the construct interruption management, Kaiser-Meyer-Olkin measure of sampling adequacy is 0.756 and the value of Bartlett's test of sphericity is 72.309 at significance level of .000, indicating the dataset in this research is sufficient enough for factor analysis (Hair et al., 1987). Shown in Table 4-11, one factor is extracted in this construct, indicating the interruption management is a one-dimensional construct. The one factor explains 46% of the total variances in the dataset, and the eigenvalues is 2.312.

Illustrated in exploratory factor analysis result of virtual collaboration effectiveness (see Table 4-12), Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is 0.751 and the value of Bartlett's test of sphericity is 217.296 at significance level of .000, indicating the dataset in this research is sufficient enough for factor analysis (Hair et al., 1987). One factor is extracted in this construct, indicating virtual collaboration effectiveness is a one-dimensional construct. The one factor explains 64% of the total variances in the dataset, and the eigenvalues is 3.193.

The result of EFA attests that the proposed scales need no further modification. Such constructs are applied in the mass industry survey for testing the proposed hypotheses. The modified item set and the statements in questionnaire are listed in Table 4-13. The final questionnaires for mass survey are presented in appendix D & E.

Table 4-11: EFA Results of Interruption Management

Factors and items	Factor loading	Eigenvalues	% of variance
Interruption management		2.312	46.241
Handle interruption by priority	.628		
Handle interruption by urgency	.596		
Handle interruption by importance	.808		
Proper handling of prior interruptions	.723		
Regulation of less prior interruptions	.622		
KMO's MSA	0.756		
Bartlett's Test of Sphericity	72.309 at .000		

Table 4-12: EFA Results for Virtual Collaboration Effectiveness

Factors and items	Factor loading	Eigenvalues	% of variance
Virtual collaboration effectiveness		3.193	63.859
High quality communication	.706		
Assured collaborative efficiency	.802		
Ability to resolve conflicts	.790		
Member satisfaction	.831		
Overall good performance	.858		
KMO's MSA	0.751		
Bartlett‘s Test of Sphericity	217.296 at .000		

Table 4-13: Final Items and the Statements

Code	Item	Statement
Intra-team awareness		
Ita1	Awareness of other's availability	I am aware of my virtual teammates' availability for interruptions.
Ita2	Awareness of other's task priority	I am aware of my virtual teammates' priority for interruptions.
Ita3	Awareness of project progress	I am aware of the project progress of my collaboration work.
Ita4	Awareness of external environment	I am aware of the external environment of my virtual collaboration work.
Virtual technology		
Vtech1	Decrease negative interruptions	Remote technologies adopted in our team are able to help decrease negative interruptions.
Vtech2	Negotiate for interruption time	Remote technologies adopted in our team are able to negotiate for interruption time.
Vtech3	Show availability	Remote technologies adopted in our team are able to show user availability for interruption.
Vtech4	Help filter unnecessary interruptions	Remote technologies adopted in our team help to filter unnecessary interruptions.
Task interdependence		
Dep1	Close cooperation	Team members work closely with each other in doing their work.
Dep2	Frequent coordination	Team members frequently must coordinate their efforts with each other.
Dep3	Individual job dependency	The way individual members perform their jobs has a significant impact upon others in the team.

Motivating & governance system		
Mot1	Team-based motivation	My rewards depend primarily on how the entire team is doing.
Mot2	Contribution as team member	My rewards are strongly influenced by my contribution as a team member.
Mot3	Team consideration	The motivating and governance system in my team encourages me to consider more about the whole team in treating interruptions.
Interruption management		
InMgt1	Handle interruption by priority	Interruptions of high priority are usually handled first.
InMgt2	Handle interruption by urgency	Interruptions more urgent than ongoing tasks are usually fixed immediately.
InMgt3	Handle interruption by importance	Interruptions more important than ongoing tasks are usually fixed immediately.
InMgt4	Proper handling of prior interruptions	Interruptions with high priority are usually fixed timely and properly.
InMgt5	Regulation of less prior interruptions	Interruptions with low priority are seldom received during high mental load period.
Virtual collaboration effectiveness		
Effe1	High quality communication	I think the remote collaboration of our team is of high quality.
Effe2	Assured collaborative efficiency	I think my collaboration and interaction with teammates is efficient.
Effe3	Ability to resolve conflicts	I think our team is able to resolve conflicts.
Effe4	Member satisfaction	I'm satisfied about the being a member in the team.
Effe5	Overall good performance	Overall, I think collaboration of our team has good performance.

4.3 Mass Industry Survey

4.3.1 Data Collection

The main survey was conducted from December 2010 to September 2011 in Hong Kong, Shanghai and Beijing. The questionnaires were delivered to targeted respondents by face-to-face (Hong Kong & Shanghai) or electronic means (Beijing). The respondents were required to finish the questionnaires based on their personal experience concerning virtual collaboration. The author first collected responses from the acquainted virtual team members in textile related business, then asked them to introduce friends or colleagues who were also qualified for this survey, and sent questionnaires by electronic means if it was inconvenient for the respondents to fill in the questionnaire in-person. In the e-mails, the confidentiality of the research data was assured, and respondents were asked to be as objective as possible in answering the questions. The email address and telephone number of the correspondence researcher was provided in case respondents had enquiry about the questionnaire.

4.3.2 Sampling Strategy

Our sampling strategy was selected in line with research objective and some practical considerations. In this research, participants were solicited by the following two criteria: virtual teamwork experience (people currently working as virtual team members were preferable), and acquaintance with several kinds of virtual technologies, better with higher virtuality. The respondents must be experienced in virtual collaboration work and interruption-contingent environment; they should also have their own consideration on how to coordinate interruptions in the processes. The participants of the questionnaire survey should be project team members who were often engaged in interruption-contingent working environment and decision making, such as project manager, the management level and the operation level of a company, or the supportive technical experts in university. Snow ball sampling was used to get questionnaire respondents, in order to collect enough qualified respondents.

Reaching a sufficient number of respondents was more difficult in this research than in some other organizational behavior research. On one hand, although most organizations had embraced the form of virtual collaboration, a considerable number of companies did not have virtual teams that have relatively fixed members in pursuing emerging tasks. This largely increased sampling difficulty in the research. On the other hand, in order to develop a sample representative of the target population, the author insisted on a rigorous sample selection process. If the data were collected at high-exposure sites or through emails to a bunch of companies in a time, the number of respondents might be larger, but the author might lose control over the qualification of the subjects because the self-screening questions were often neglected by respondents.

4.3.3 Data Cleaning and Screening

Before applying statistical tests to the data set, the process of appropriate screening of data must not be neglected. First, the author checked that there were no coding errors and the variables had been re-coded properly. The missing values were also dealt with properly. Missing values in the database were identified by basic descriptive statistics. There were several ways to treat missing data. For those respondents that missed any variable in the sections except for the demographic information section, data of this case were excluded from all computation. This kind of listwise deletion was the most popular way of treating missing value although it would cause a substantial decrease of sample size. Except for that, there were a considerable respondents who chose '3 neutral' to all the questions in the 'motivating and governance system' section. This is probably because they felt uncomfortable expressing their actual perception about the reward structure of the organization they worked for. This kind of problem was frequently encountered in the research of reward and incentive research. The author chose to disqualify these questionnaires.

Second, the author ascertained that there were no distorting influences resulted from significant outliers. Data screening also required checking for logical consistency of responses. The cases which had the same answer for most questions were deleted from the database, because these respondents probably failed to treat the survey seriously. Third, the author assessed the distribution of the data since most of the estimation methods required the data to be normally distributed. Last but not least, the association of the variables was tested as the input of model estimation during the SEM process.

4.3.4 Data Analysis

An adequate sample size is important to the reliability of parameter estimates, model fit and statistical power (Shah & Goldstein, 2006). MacCallum et al. (1996) defines minimum sample size as a function of degrees of freedom that is needed for adequate power to detect the close model fit. In the investigation by Shah & Goldstein (2006) of 75 SEM models in operation management related papers, the median sample size is 202. In order to get relatively accurate and objective result, the author set 250 as the target sample size for the mass industry survey and distributed 320 questionnaires in total.

Among the 320 questionnaires distributed, 285 returned and 24 were excluded after careful cleaning and screening. A total of 261 eligible responses were obtained and analyzed, yielding an 81.6% effective response rate. The sample size is considered adequate for subsequent analysis. To ascertain valid parameter estimates, Bentler & Chou (1987) suggests that sample size of an SEM test should meet the criteria that the ratio of sample size to number of free parameters exceeds 5:1 as rule of thumb under normal distribution theory. However, as investigated by Baumgartner & Homburg (1996), a total of 41 percent of all the models in their investigation has ratios smaller than 5:1. The value of this ratio was 4.21 (reported in Table 4-14) in the SEM model, a little lower than the suggested value. But the author still considered it acceptable and could lead to credible results because the highly qualified data source was ensured throughout the data collection stage and the data screen process. As pointed out by Martin (1987), there may be a trade-off between collecting high-quality sample and gaining a large sample size to fulfill the need of statistical techniques.

Table 4-14: SEM Variable Counts

Sample size	261
Number of parameters estimated	62
Sample size/parameters estimated	4.21
Number of latent constructs	6
Number of observed variables	24
Number of unobserved variables	32
Observed variables/latent variables	4
Degree of freedom	238

The distributions of all the variables were close to normal distribution, and the independent variables showed significant linearity with the dependent variables. In the research, 164 of 261 questionnaires (62.8%) were responded face-to-face, whereas 97 questionnaires (37.2%) were filled online. Since there were two methods of responding questionnaires, the t-test and chi-square test were performed to ascertain there is no significant variation between the results of the two sets of responses. The t-test results of the two groups show no significant difference, with p-values ranging from 0.124 to 0.896. Besides, the chi-square test also reveals that there is no significant difference between the two groups, with p-value ranging from 0.136 to 0.737. The chi-square test was conducted with the categorical variables, which were mainly demographic variables such as “organization type”, “team type”, “respondent’s team role”, and “gender”, etc.

In addition, non-response bias of online survey was examined. Non-response bias exists in the survey when respondents answer differently from the potential population of interest who do not answer. Non-response bias can be problematic because the sample is no longer random, then it lacks the potential to be representative of the larger population from which the sample was drawn. In order to take effective measures against non-response bias, the author emphasized the confidentiality of the survey data and provided clear instructions on how to fill out the questionnaire on the first page of the questionnaire. To test the non-response bias in this research, the author adopted the method suggested by Armstrong & Overton (1977), the first 25% and the last 25% questionnaires were compared for consistency. The chi-square test showed no significant variance of the two data sets, with p-value of all categorical variables greater than 0.1. Since there was no difference detected, the two groups of responses could be combined for further analysis.

The author also needed to test the common method bias in the research. Common method bias may arise from self-reporting questionnaire surveys because all data derive from the same source (Podsakoff et al., 2003). Lindell & Whitney (2001) points out that common method variance tends to inflate correlations and overestimate the influence of hypothesized predictors. To evaluate whether this research suffers from common method bias, the author adopted the technique suggested by Podsakoff & Organ (1986): if common method variance poses a serious threat to the analysis of survey data, a single latent factor would account for a majority of variance in the data. In the principal axial factoring analysis, when the number of factor extracted was set to 1, the main factor extracted could only explain for 37% of the variance. The result revealed that no single factor was identified in explaining the majority of the variance, and no general factor emerged in the unrotated factor structure. In addition, a more rigorous approach, i.e. Harmon's one-factor test was performed to test the common method bias (Podsakoff et al., 2003). With the common method factor included, the results of the measurement model remained similar to the results without the factor, which suggested that this research does not suffer from common method bias.

4.3.4.1 Demographic Characteristics of Sample

Demographic information of the respondents were collected, including the respondents' characteristics such as their virtual collaboration experience and team role, as well as the characteristics of their virtual teams, such as the business nature and team type. Table 4-15 describes the demographic characteristics of the virtual teams and virtual organizations that investigated.

Among the virtual teams in which the respondents work, 21% are manufacturing oriented, 20% are marketing oriented, 10% are branding oriented, 14% are innovation oriented, 11% are R&D oriented, and the other 23% are integrated firms. Among the virtual teams, 34% are action teams, 17% are management teams, 16% are service teams, with R&D, consulting and project teams accounting for 11% respectively. Regarding team size, most of the virtual teams are small-sized: 60% of the investigated teams comprise less than 10 members (27% with less than 5 members, and 33% with 5-10 members), 22% have 11-20 members, while 10% are medium sized with 21-50 members, and only 8% are large teams with more than 50 members.

Table 4-15: Profile of the Organizations of Respondents

Demographics	Number	Percentage
Business type of organization		
Manufacturing oriented	55	21.1
Branding oriented	27	10.3
Marketing oriented	53	20.3
Research & development	28	10.7
Integrated	61	23.4
Innovation oriented	37	14.2
Type of virtual team		
management	44	16.9
R&D	28	10.7
action	88	33.7
service	42	16.1
consulting	29	11.1
project	30	11.5
Virtual team size (number of members)		
1-5	71	27.2
6-10	86	33.0
11-20	58	22.2
21-50	25	9.6
above 50	21	8.0

Table 4-16 introduces the demographic characteristics of the respondents. Among the 261 participants, 110 are male (42%) and 151 are female (56%). Virtual team leaders account for 25% of the sample while the majority is team members (69%), and the rest (about 5%) are the external advisors. Most of the respondents worked for hybrid virtual teams, in other words, they spend some of time in virtually collaborative projects while pursuing other jobs as employees in traditional organizations. This research uses virtuality to describe the time that respondents spend in virtual collaborative projects, which indicates the degree of virtualness. Fifty-seven percent of the respondents spend less than a half of their working time in virtual collaborative job, and 43% spend more than a half time working virtually which means virtual work is their main working style. This is evidence in the research that virtual collaborative work is becoming increasing important working style in today's organizations. Concerning virtual collaboration experience, 14% have less one-year experience, 28% have 1~3 years experience while 25% have 3~5 years experience, 32% have more than 5 years experience of virtual work. This set of data indicates that virtual means of communication has been employed for a period.

Table 4-16: Demographic Characteristics of the Main Survey Respondents

Demographics	Number	Percentage
Team role		
Team leader	66	25.3
Team member	181	69.3
Advisor/Supporter	14	5.4
Virtual collaboration experience		
0-6months	23	8.8
7-12 months	15	5.7
1-2years	46	17.6
2-3years	28	10.7
3-5years	65	24.9
above 5 years	84	32.2
Functional area		
Managerial	68	26.1
professional/ Technical	52	19.9
Sales / Marketing	77	29.5
Manufacturing / Production	19	7.3
Clerical / Office	29	11.1
others	16	6.1
Virtuality		
<1/3	76	29.1
1/3~1/2	72	27.6
1/2~2/3	54	20.7
>2/3	59	22.6
Gender		
Male	110	42.1
Female	151	57.9

4.3.4.2 Descriptive Analysis of Main Variables

In the conceptual model, there are four independent latent variables – intra-team awareness, virtual technology, task interdependence, motivating & governance system, and two dependent latent variables – interruption management, virtual collaboration effectiveness. The six constructs were developed into six sections in the questionnaire to measure the respondents' team status and their perceptions. Each latent construct in this research included three to five statements of item. Table 4-17 to Table 4-22 describe the mean scores and standard deviations for the variables examined in this research.

As Table 4-17 shows, the mean scores for items of intra-team awareness construct are within the range of 3.5 to 3.9. The two items "Awareness of other's availability" and "Awareness of external environment" are relatively higher at about 3.8. The two items "Awareness of other's task priority" and "Awareness of project progress" are relatively lower, at about 3.5. Checking availability of the recipient of an interruption is directly related to the disruptiveness of the interruption, so lots of people have paid attention to the availability awareness. However, the awareness of teammates' task priority and the whole project progress are also aspects of awareness, which provide essential context for virtual team members.

Table 4-17: Descriptions to the Intra-team Awareness Items

Code	Item	Mean	Std. Deviation
Ita1	I am aware of my virtual teammates' availability for interruptions.	3.81	.898
Ita2	I am aware of my virtual teammates' priority for interruptions.	3.51	.963
Ita3	I am aware of the project progress of my collaboration work.	3.50	1.014
Ita4	I am aware of the external environment of my virtual collaboration work.	3.84	.884

The virtual technology construct is measured by four items: "Decrease negative interruptions", "Negotiate for interruption time", "Show availability", and "Help filter unnecessary interruptions". The scores of the first three items all exceed 4, while the score for "Help filter unnecessary interruptions" is 3.70 (see Table 4-18). The result suggests that although some of the virtual teams employ the filtering technologies to manage interruption flow, such technology has not been accepted widely. There could be many reasons under this phenomenon. One of them is that such intelligent systems are not always user-friendly or easy to use, as the author concluded from the interview results. To improve the application of more intelligent technologies such as filtering systems to coordinate interruptions, more social and organizational issues should be concerned rather than technical issues.

Table 4-18: Descriptions to the Virtual Technology Items

Code	Item	Mean	Std. Deviation
Vtech1	Our virtual technologies are able to regulate unnecessary interruptions.	4.30	.848
Vtech2	Our virtual technologies are able to negotiate for interruption time.	4.12	.928
Vtech3	Our virtual technologies are able to show user availability for interruption.	4.16	.893
Vtech4	Our virtual technologies help to filter interruptions.	3.70	.997

Task interdependence is measured with three items: "Close cooperation", "Frequent coordination", and "Individual job dependency". Table 4-19 shows the mean scores for the three items, which are very close (3.67-3.69). The result indicates that respondents consider their tasks interdependent with their teammates, yet the dependence is not extremely strong.

Table 4-19: Descriptions to the Task Interdependence Items

Code	Item	Mean	Std. Deviation
Dep1	Team members work closely with each other in doing their work.	3.69	.983
Dep2	Team members frequently must coordinate their efforts with each other.	3.67	.959
Dep3	The way individual members perform their jobs has a significant impact upon others in the team.	3.97	.944

The motivating & governance system construct comprises three items: “Team-based motivation”, “Contribution as team member” and “Team consideration”. The scores of the three items (see Table 4-20) are at relatively lower levels (from 3.05 to 3.32). Especially, the item “My rewards are strongly influenced by my contribution as a team member” gets a mean score of 3.05, which is nearly a neutral answer. Such result suggests that there are virtual teams motivate their members on team level, and in the mean time there exist those teams which motivate and stimulate team members by allocating rewards according to individual performance. This finding is consistent with the respondents’ statements in the in-depth interview: some respondents think that although the team-based motivating & governance system encourages inter-member interaction and might change the members’ attitude toward interruptions, some virtual teams are adopting the individual-based system currently. The reason is mainly because it is not easy to alter the reward structure or team setting in a short period; and the management level has to consider about the probable downside of the collectivist system when it comes into realism.

Table 4-20: Descriptions to the Motivating & Governance System Items

Code	Item	Mean	Std. Deviation
Mot1	My rewards depend primarily on how the entire team is doing.	3.32	1.064
Mot2	My rewards are strongly influenced by my contribution as a team member.	3.05	1.220
Mot3	The motivating and governance system in my team encourages me to consider more about the whole team in treating interruptions.	3.29	1.170

The construct of interruption management is measured by five items: "Handle interruption by priority", "Handle interruption by urgency", "Handle interruption by importance", "Proper handling of prior interruptions", and "Regulation of less prior interruptions". Shown in Table 4-21, the scores in this construct are all above 4 (ranging from 4.00 to 4.20). The result suggests that respondents perceive their own teams excellently manage interruptions during collaboration.

Table 4-21: Descriptions to the Interruption Management Items

Code	Item	Mean	Std. Deviation
InMgt1	Interruptions of high priority are usually handled first.	4.20	.862
InMgt2	Interruptions more urgent than ongoing tasks are usually fixed immediately.	4.07	.827
InMgt3	Interruptions more important than ongoing tasks are usually fixed immediately.	4.07	.924
InMgt4	Interruptions with high priority are usually fixed timely and properly.	4.04	.881
InMgt5	Interruptions with low priority are seldom received during high mental load period.	4.00	.723

There are five items in the measuring virtual collaboration effectiveness: “High quality communication”, “Assured collaborative efficiency”, “Ability to resolve conflicts.”, “Member satisfaction”, and “Overall good performance”. Table 4-22 describes the mean scores and standard deviation for the five items. The mean scores are all above the neutral level (mean scores are from 3.82 to 3.99). The result reveals that the respondents consider the overall collaboration effectiveness in their virtual teams is relatively high, yet still there is space for improvement (no item in this construct has a mean score above 4).

Table 4-22: Descriptions to Virtual Collaboration Effectiveness Items

Code	Item	Mean	Std. Deviation
Effe1	I think the collaboration of our team is of high quality.	3.90	.795
Effe2	I think my coloration and interaction with teammates is efficient.	3.82	.815
Effe3	I think our team is able to resolve conflicts.	3.90	.819
Effe4	I'm satisfied about the collaboration in the team.	3.90	.847
Effe5	Overall, I think collaboration of our team has good performance.	3.99	.760

4.4 Measurement Model

4.4.1 Initial Model Test

Before the examination of the relationships of the constructs of the structural model, confirmatory factor analysis was performed to secure construct validity, i.e. to identify whether the measurement scales were related to the underlying items developed in this research. AMOS 17.0 was used to conduct the confirmatory factor analysis. Figure 4-2 depicts the hypothesized measurement model. Table 4-23 describes the main goodness of fit indices of the initial measurement model, and the results indicate that the model to some extent fit the data (χ^2=372.514, df =237, χ^2 /df =1.572, $p<0.001$, GFI=0.895, RMSEA=0.047). GFI and NFI are both beneath the satisfactory level, and all the other indices are above the acceptable level. In this case, the model can be further improved.

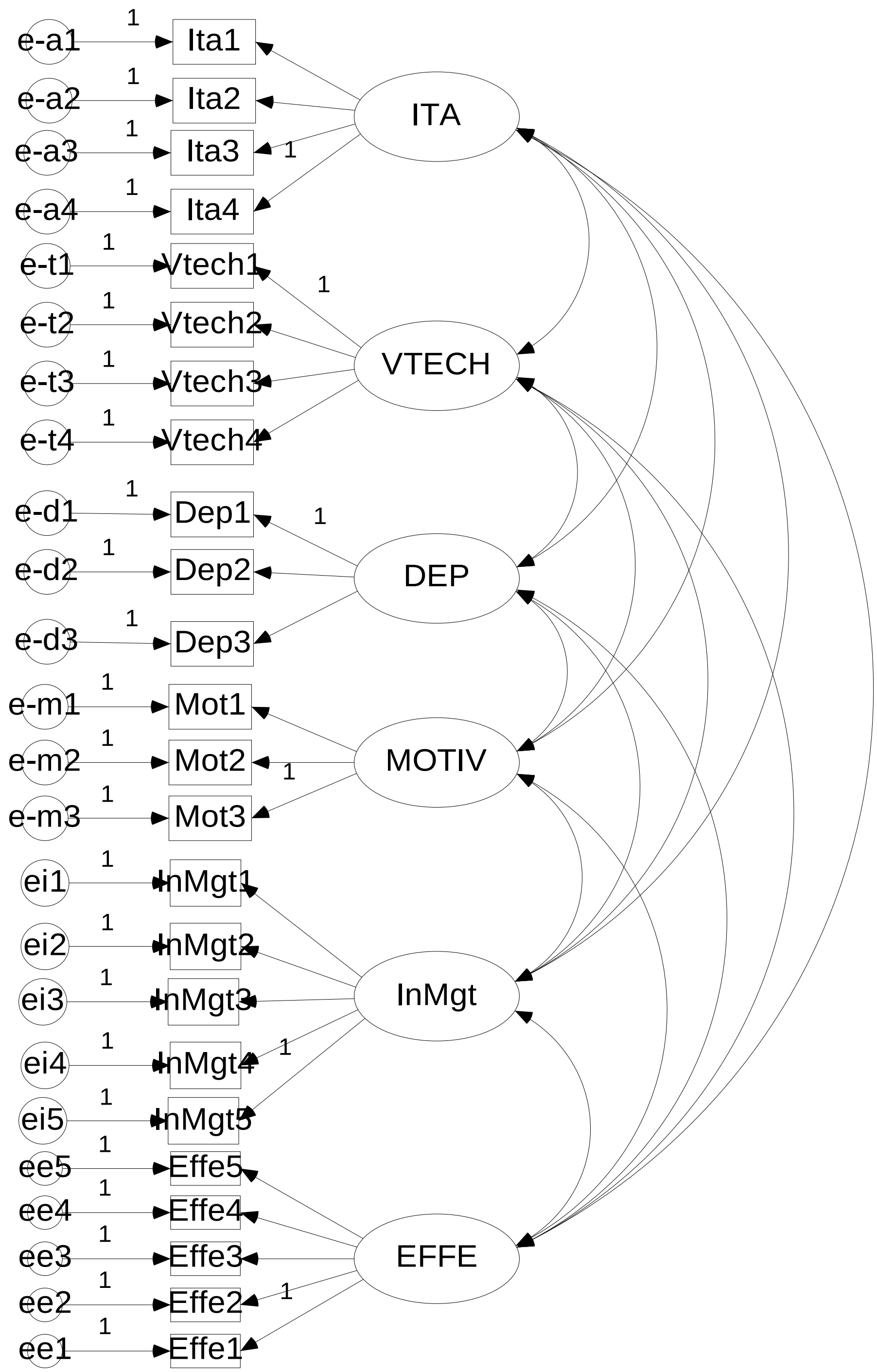


Figure 4-2: the Hypothesized Measurement Model

Table 4-23: Goodness of Fit Indices of the Initial Measurement Model

Goodness of Fit Indices	**Value**	**Criteria**
χ^2	372.514	NA
Degree of freedom (df)	237	NA
χ^2 /df	1.572	<3
GFI	**0.895**	>0.9
AGFI	0.867	>0.8
NFI	**0.895**	>0.9
CFI	0.959	>0.9
TLI	0.952	>0.9
RMSEA	0.047	<0.05
RMR	0.043	<0.05

4.4.2 Model Modification

Since the initial measurement model was not very satisfactory, the author attempted to make some modifications to the model. The modification indices of the initial test result revealed that the covariance between the error terms of Ita3 and Ita4 was particularly large. This indicated that a covariance line could be drawn to link these two error terms. After the modification, the measurement model (shown in Figure 4-3) shows good fit to the data. Table 4-24 shows the standard loading of each item and Cronbach's alphas of each construct, which are all exceed the satisfactory level 0.7 (Nunnally & Bernstein, 1994).

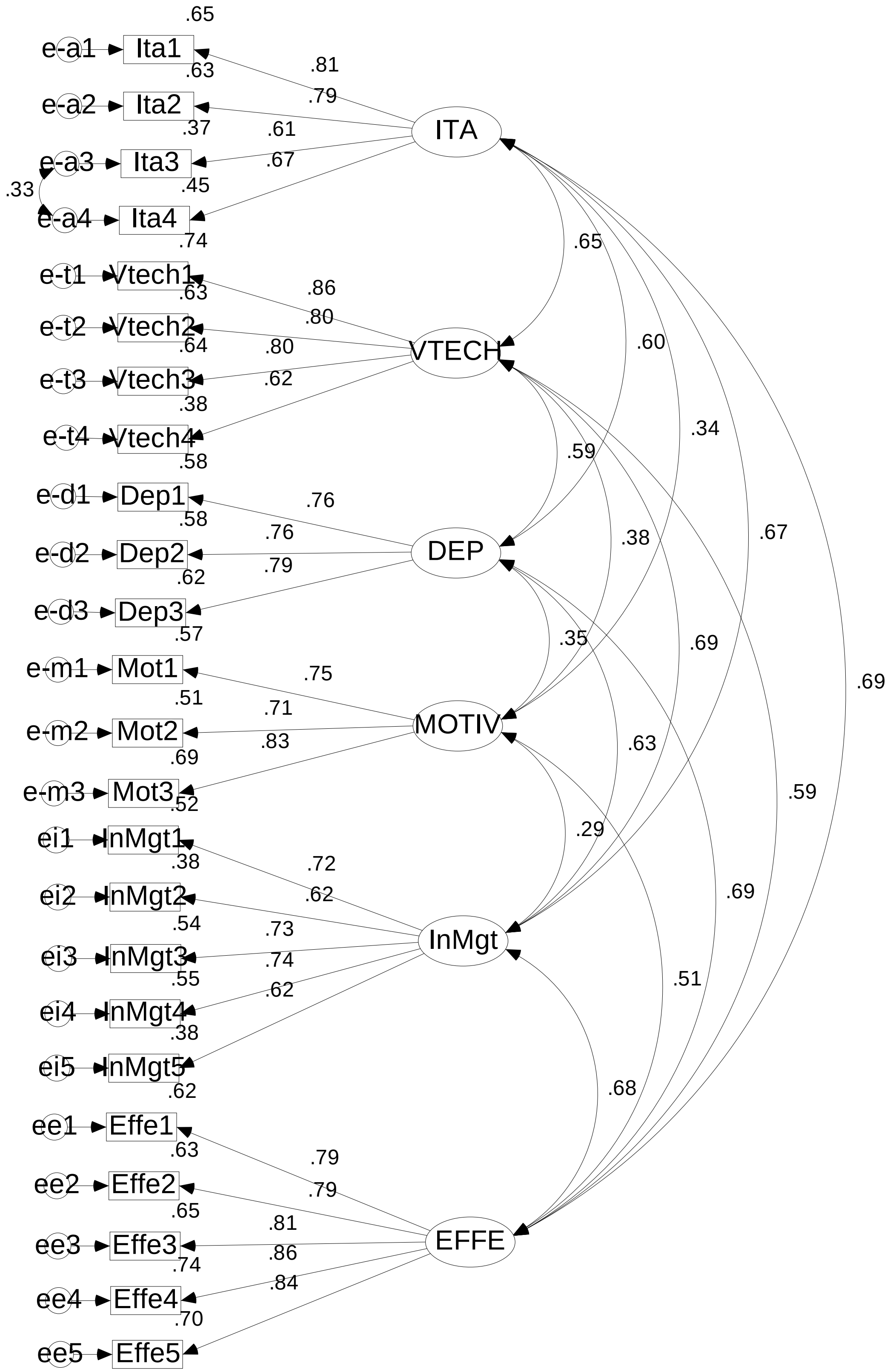


Figure 4-3: the Estimated Measurement Model

Table 4-24: Standardized Loadings and Reliabilities in Modified Measurement Model

Latent Variable	Indicator	Standard Loading	Cronbach's α
Intra-team Awareness	Ita1	0.808***	0.827
	Ita2	0.791***	
	Ita3	0.609***	
	Ita4	0.668***	
Virtual Technology	Vtech1	0.860***	0.847
	Vtech2	0.796***	
	Vtech3	0.802***	
	Vtech4	0.616***	
Task Interdependence	Dep1	0.761***	0.816
	Dep2	0.763***	
	Dep3	0.790***	
Motivating & Governance System	Mot1	0.754***	0.808
	Mot2	0.712***	
	Mot3	0.831***	
Interruption Management	InMgt1	0.721***	0.816
	InMgt2	0.618***	
	InMgt3	0.735***	
	InMgt4	0.745***	
	InMgt5	0.615***	
Virtual Collaboration Effectiveness	Effe1	0.790***	0.910
	Effe2	0.793***	
	Effe3	0.809***	
	Effe4	0.862***	
	Effe5	0.838***	
*** p<0.001			

The measurement model includes four constructs with 14 items. According to Hair et al. (1987), the statistical tests of SEM are very sensitive to sample size. All goodness-of-fit measures are some function of the chi-square and degree of freedom. If the sample size is very large, the statistical test will be almost certainly significant and the model will be rejected even if it actually describes the data well, and vice versa. As a result, some indices such as AGFI are produced less depend on the sample size. In fact, there is a trade-off between the fit of model and the simplicity of the model. A good model should describe the data well and be as simple as possible in the meantime. The modified model would fulfill such criteria.

The ratio of chi-square to degree of freedom is 1.485, which is within the range of 1 to 3, indicating good fit. The Goodness of Fit (GFI) index is 0.901, Adjusted Goodness of Fit (AGFI) index is 0.926. GFI indicates goodness-of-fit and AGFI attempts to adjust GFI for the complexity of the model (Hox & Bechger, 1998). Normally, GFI exceeds 0.9 and AGFI exceeds 0.8 are deemed as good model fit (Hair et al., 1987; Segars & Grover, 1993). The Normed Fit Index (NFI) is 0.947, Root Mean Square Residual (RMR) index is 0.025, Root Mean Square Error of Approximation (RMSEA) index is 0.037, Tucker-Lewis Index (TLI) is 0.981, and Comparative Fit Index (CFI) is 0.985 (see Table 4-25). TLI is also known as non-normed fit index (NNFI).

Table 4-25: Goodness of Fit Indices of the Modified Measurement Model

Goodness of Fit Indices	Value	Criteria
χ^2	350.443	NA
Degree of freedom (df)	236	NA
χ^2 /df	1.485	<3
GFI	0.901	>0.9
AGFI	0.847	>0.8
NFI	0.901	>0.9
CFI	0.965	>0.9
TLI	0.959	>0.9
RMSEA	0.043	<0.08
RMR	0.042	<0.05

4.4.3 Reliability and Validity

After the goodness of fit indices were assessed, the convergent validity, discriminant validity, unidimensionality and construct reliability were also tested.

- Construct Reliability

Construct reliability refers to the extent to which a variable is consistent with what it intended to measure. In other words, construct reliability measures the internal consistency of a construct. Except for the Cronbach's alpha, composite reliability is another criterion for assessing construct reliability. Composite reliability is calculated using the following formula:

$\rho = (\Sigma\lambda_i)^2 / [(\Sigma\lambda_i)^2 + (\Sigma\theta_i)]$

In the formula, ρ is composite reliability, λ_i is the *i*th factor loading, and θ_i is the *i*th error variance. The criteria of acceptable composite reliability is greater than 0.7 (Nunnally & Bernstein, 1994). As shown in table 4-26, the composite reliabilities of the constructs are all above the acceptable level, indicating good internal consistency of the constructs.

Table 4-26: Assessment of Construct Reliability

Construct	Composite reliability	Cronbach's α
Intra-team Awareness	0.829	0.827
Virtual Technology	0.871	0.847
Task Interdependence	0.827	0.816
Motivating & Governance System	0.763	0.808
Interruption Management	0.865	0.816
Virtual Collaboration Effectiveness	0.940	0.910

- Unidimensionality

Unidimensionality is a concept similar to construct reliability, which means that a set of items have only one underlying trait in common (Hair et al., 1987). A scale is unidimensional if all the items of the scale measure one common latent variable. Follow recommendation of Hox & Bechger (1998), the average variance extracted (AVE) is calculated for the constructs. AVE can be calculated using the following formula:

$AVE = \Sigma(\lambda_i^2) / [\Sigma(\lambda_i^2) + (\Sigma\theta_i)]$

In the formula, λ_i is the *i*th factor loading and θ_i is the *i*th error variance. AVE higher than 0.5 indicates that the scale explains more than the error term. As shown in Table 4-27, the composite reliabilities all exceed 0.7 and the AVEs are all greater than 0.5, which indicates that unidimensionality of the constructs are supported.

Table 4-27: Assessment of Unidimensionality

Construct	Composite reliability	Average Variance Extracted (AVE)
Intra-team Awareness	0.829	0.552
Virtual Technology	0.871	0.631
Task Interdependence	0.827	0.614
Motivating & Governance System	0.763	0.519
Interruption Management	0.865	.564
Virtual Collaboration Effectiveness	0.940	.758

- Convergent validity

Construct validity refers to the extent to which the scales of a construct measure the intended concept (DeVellis, 1991). Convergent validity and discriminant validity are two good ways to measure construct validity of the scales. Convergent validity is the degree to which theoretically similar indicators are measuring the same conceptual construct (Hair et al., 1987). In other words, convergent validity tests that constructs that are expected to be related are, in fact, related. Some researchers (e.g., Hair et al., 1987; Segars, 1997) suggest item loadings larger than 0.707 as the satisfactory level of good convergent validity, that is, over half of the variance is captured by the latent variable. Whereas Falk & Miller (1992) recommends the cutoff value 0.55 which means at least 30 percent of the variance are explained by the latent construct. This research adopts 0.55 as the cutoff line of factor loadings. All the factor loading of the six constructs are shown in Table 4-24, and the loadings are all significant without exception ($p < .001$), which suggesting good convergent validity.

As recommended by (Bollen, 1998), several fit indicators of CFA can also be used to assess convergent validity. In this research, Root Mean Square Error of Approximation (RMSEA) is 0.043, which is within the acceptable range (beneath 0.05) (Browne & Cudeck, 1993). Root Mean Square Residual (RMR) 0.042 is also considered satisfactory.

GFI, AGFI and CFI are 0.901, 0.847 and 0.965 respectively. In summary, the collective data show strong support of the convergent validity of the measurement model.

- Discriminant Validity

Discriminant validity is the degree to which a scale differs from other scales designed to measure a different conceptual variable. In other words, discriminant validity tests whether theoretically unrelated constructs are, in fact, unrelated. Table 4-28 shows the results of the average variance extracted and squared correlation of the constructs. In the table, diagonal elements (bold) are the average variance extracted between the constructs and their measures. Off-diagonal elements are the squared correlations. The AVE for each construct is greater than 0.5, and is greater than its inter-construct squared correlation. In the measurement model, higher average variance extracted from the individual constructs than the shared variances between the constructs suggest good discriminant validity (Hox & Bechger, 1998). The result indicates that the six constructs are conceptually distinct and are of discriminant validity.

Table 4-28: AVE and Squared Correlation of the Constructs

	EFFE	InMgt	MOTIV	DEP	VTECH	ITA
EFFE	**0.758**					
InMgt	0.466	**0.564**				
MOTIV	0.255	0.084	**0.519**			
DEP	0.473	0.392	0.123	**0.614**		
VTECH	0.353	0.476	0.144	0.350	**0.631**	
ITA	0.471	0.454	0.116	0.364	0.429	**0.552**

Notes:

EFFE=Virtual collaboration effectiveness; InMgt=Interruption Management; MOTIV=Motivating & Governance System; DEP=Task Interdependence; VTECH=Virtual Technology; ITA=Intra-team Awareness.

Diagonal elements (bold) represent the average variance extracted (AVE).

Off-diagonal elements are the squared correlations among constructs.

For discriminant validity, diagonal elements should be greater than off-diagonal elements.

4.5 Structural Model Analysis

4.5.1 Structural Equation Modeling Approach

Structural equation modeling (SEM) was employed in the research to test the causal relationship between sets of team and individual factors and the interruption management in virtual collaboration. SEM can help us to analyze the relationship among the research constructs that are not directly measurable, and estimate how well the model fits the data by examining the obtained measurement data.

The reason of adopting SEM to test the analytical framework on virtual team effectiveness is fourfold. Firstly, SEM is considered especially suitable for measuring psychological variables such as attitudes beliefs. Measurement is always recognized as difficult and error-prone. By explicitly modeling measurement error, SEM seeks to derive unbiased estimates between the latent constructs. Secondly, Cheng (2001) indicates that other multivariate techniques can not take into account the complex interaction effects among the posited variables, and therefore advocates SEM due to its ability in examining a series of dependence relationships simultaneously to address complicated managerial and behavioral issues. Hair et al. (1987) also sees SEM as a single comprehensive method that expands the explanatory ability and statistical efficiency for model testing. Thirdly, SEM is capable of measuring the relationships among observed and unobserved variables comprehensively by analyzing the covariance among observable variables. The latent variables are measured through linear combinations of the observed variables. Last but not least, the structural model allows the specification of error-term covariance. This can reduce inaccuracy caused by ignorance of error which actually exists in the explanatory variables.

The steps of performing SEM are described in figure 4-4. There are two components in the model distinguished by SEM: the structural model and the measurement model. The structural model shows potential causal dependencies between endogenous and exogenous variables, while the measurement model shows the relations between latent variables and their indicators.

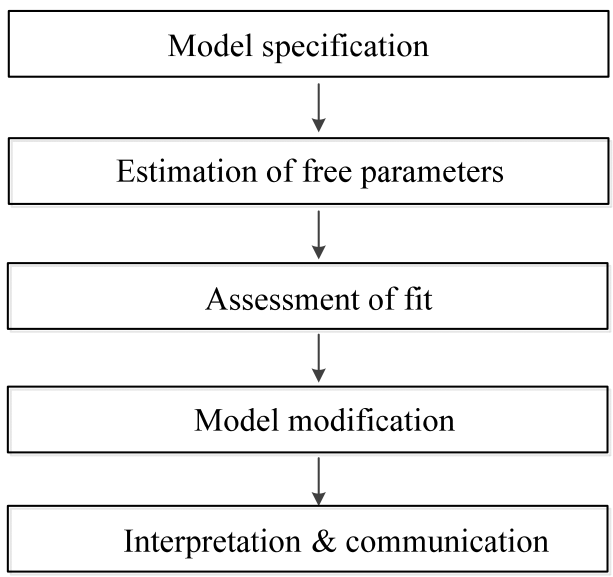


Figure 4-4: the Approach of Performing SEM

In specifying the path diagram in SEM, two types of relationships between variables can be posited: one is the "fixed" relationships that have already been estimated in previous research, and another is the free pathways in which hypothesized causal relationships are tested. As Cheng (2001) states, models with more constructs and indicators are more difficult to get high p-value in chi-square tests, resulting in poor model fit. Simple model with clear relationship between variables should be pursued in the premise of sound theoretical foundation in the processes of model construction and modification. After the construction of the initial conceptual model, the measurement model should be evaluated. Taking the interaction among the indicator variables into account, a test with all measures together is preferred over the measure of each construct separately. Maximum likelihood ratio (ML) was adopted as estimation method in the SEM model. ML assumes data are univariate and multivariate normal and requires that the input data matrix be positive definite, but it is relatively unbiased under moderate violations of normality (Bollen, 1998).

When assessing the overall model fit, it is generally recommended that a range of fit indices should be considered. absolute fit indices should be reported, including chi-square (χ^2), chi-square/df, goodness of fit index (GFI), adjusted goodness of fit (AGFI), root mean square residual (RMR), root mean square error of approximation (RMSEA) (Segars & Grover, 1993). To achieve the best fitting of measurement model, incremental modifications are essential procedures (Cheng, 2001). Through computing the goodness-of-fit indices, the indicators that did not meet the criteria were deleted. The model was continuously tested and revised because the drop of any variable would change the whole model simultaneously. The iterative process reached an end when it attained acceptable level of the goodness-of-fit indices. Incremental fit indices comprise comparative fit index (CFI), normed fit index (NFI), and nonnormed fit index (NNFI).

When the measurement model attained the recommended values of goodness-of-fit indices, the author moved forward to the test of the structural model. The structural model focuses on the relationship of latent variables. In general, large chi-square (χ^2) value indicates poor model fit to the data; however, using χ^2 by itself is beset with problems because it's very sensitive to sample size. Instead, χ^2/df is informative because it corrects for model size. GFI represents the relative amount of variance and covariance jointly accounted for by the model. It indicates how close the tested model is to the perfect model; and value greater than 0.09 is considered as good fit (Bentler & Chou, 1987). AGFI is the GFI adjusted for the degrees of freedom of the model, with value greater than 0.08 indicates good fit (Bentler & Chou, 1987). GFI and AGFI increase as goodness of fit increases. CFI is an incremental measure that directly based on the non-centrality measure. CFI values close to 0.90 or above indicate satisfactory model fit (Baumgartner & Homburg, 1996). Normed fit index (NFI) is a practical criterion for evaluation of model fit, but it has shown a tendency to underestimate fit in small samples. The problem of NFI index is solved by the NNFI, i.e. Tucker-Lewis Index (TLI), which is not affected by sample size.

RMR reflects the average amount of variance and covariance not accounted for by the model, and RMSEA estimates how well the model approximates the population covariance matrix per degree of freedom. RMSEA and RMR decrease as goodness of fit increases and are bounded below by zero (Browne & Cudeck, 1993). A marginal acceptance level for RMR is 0.08. However, RMR is related to the size of observed variances and covariances. So the standardized root mean square residual (SRMR) could be used to represent the average value across all standardized residuals. RMSEA value below 0.05 indicates a good model fit, while that between 0.05 and 0.08 is a reasonable fit. The result of SEM analysis is introduced in the next section.

4.5.2 The Structural Model

Following the procedures of structural equation modeling (Hair et al., 1987), the next step was to build the structural model. The hypothesized structural model is shown in Figure 4-5. The overall fit indices of the model and the explanatory power were examined. The significances of the paths specified by the conceptual model were tested. The overall goodness of fit indices (χ^2=361.010, df=239, χ^2/df=1.511, GFI=0.898, AGFI=0.871, CFI=0.963, RMSEA=0.044) indicate the model is acceptable (see Table 4-29). However, when the author examined the modification indices, it was found the model could be further improved. According to the error covariance, a covariance line was drawn between the error terms of InMgt3 and InMgt4. After the small modification, the model was improved and achieved excellent fit to the data. Figure 4-6 presents the final estimated structural model. As shown in table 4-30, the overall goodness of fit indices (χ^2=346.844, df=238, χ^2/df=1.457, GFI=0.901, AGFI=0.875, CFI=0.967, TLI=0.961, RMSEA=0.042, RMR=0.043) all exceed suggested levels.

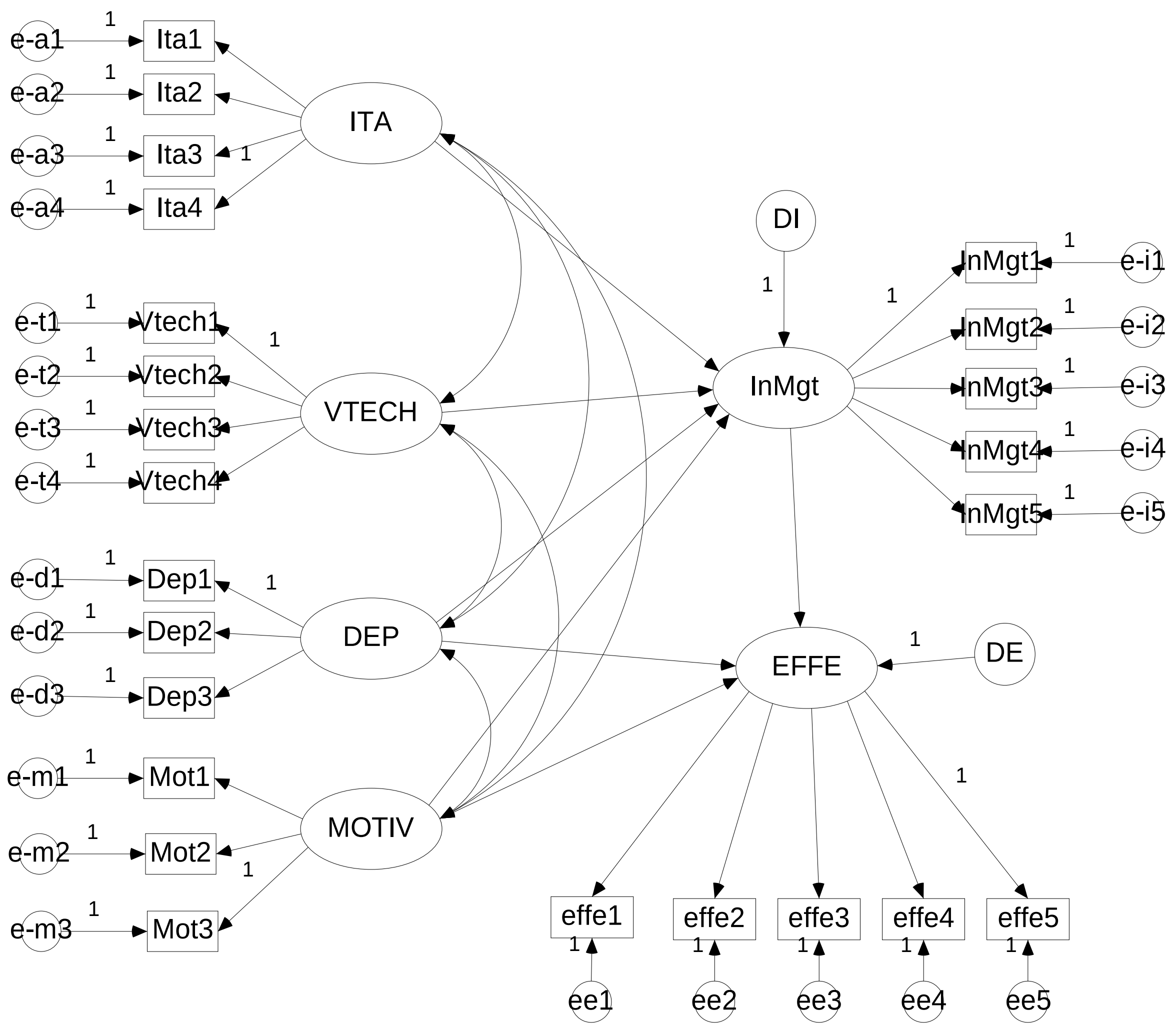


Figure 4-5: the Hypothesized Structural Model

Table 4-29: Goodness of Fit Indices of the Initial Structural Model

Goodness of Fit Indices	Value	Criteria
χ^2	361.010	NA
Degree of freedom (df)	239	NA
χ^2 /df	1.511	<3
GFI	**0.898**	>0.9
AGFI	0.871	>0.8
NFI	**0.898**	>0.9
CFI	0.963	>0.9
TLI	0.957	>0.9
RMSEA	0.044	<0.08
RMR	0.044	<0.05

Table 4-30: Goodness of Fit Indices of the Modified Structural Model

Goodness of Fit Indices	Value	Criteria
χ^2	346.544	NA
Degree of freedom (df)	237	NA
χ^2 /df	1.462	<3
GFI	0.901	>0.9
AGFI	0.875	>0.8
NFI	0.902	>0.9
CFI	0.967	>0.9
TLI	0.961	>0.9
RMSEA	0.042	<0.08
RMR	0.043	<0.05

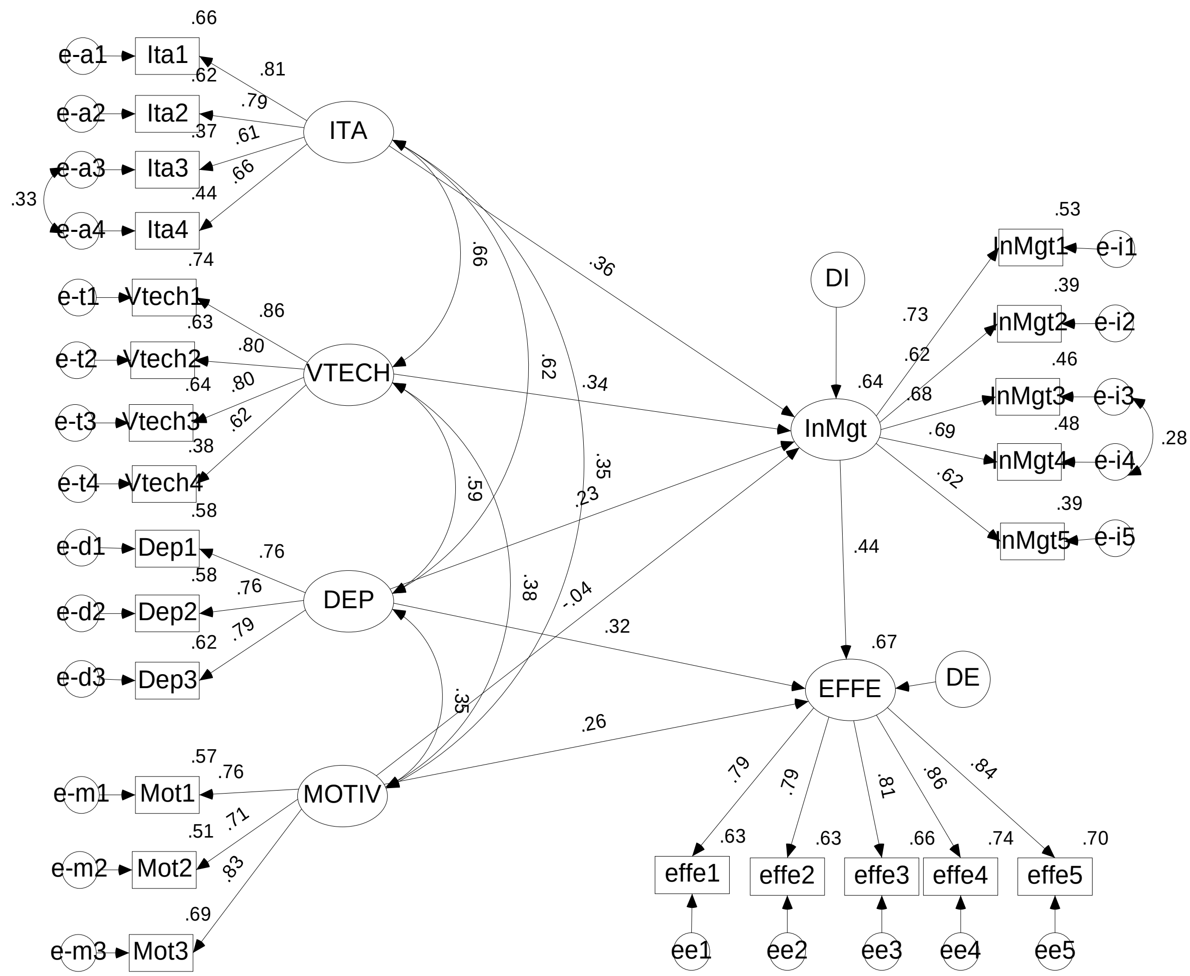


Figure 4-6: the Estimated Structural Model

The path diagram of the final structural model is depicted in Figure 4-7. The explanatory power of the model, which is evaluated by examining the portion of variance explained, is also reported in the model. The results suggest that the model is able to explain 64% of the variance in interruption management, and 67% of the variance in the virtual collaboration effectiveness.

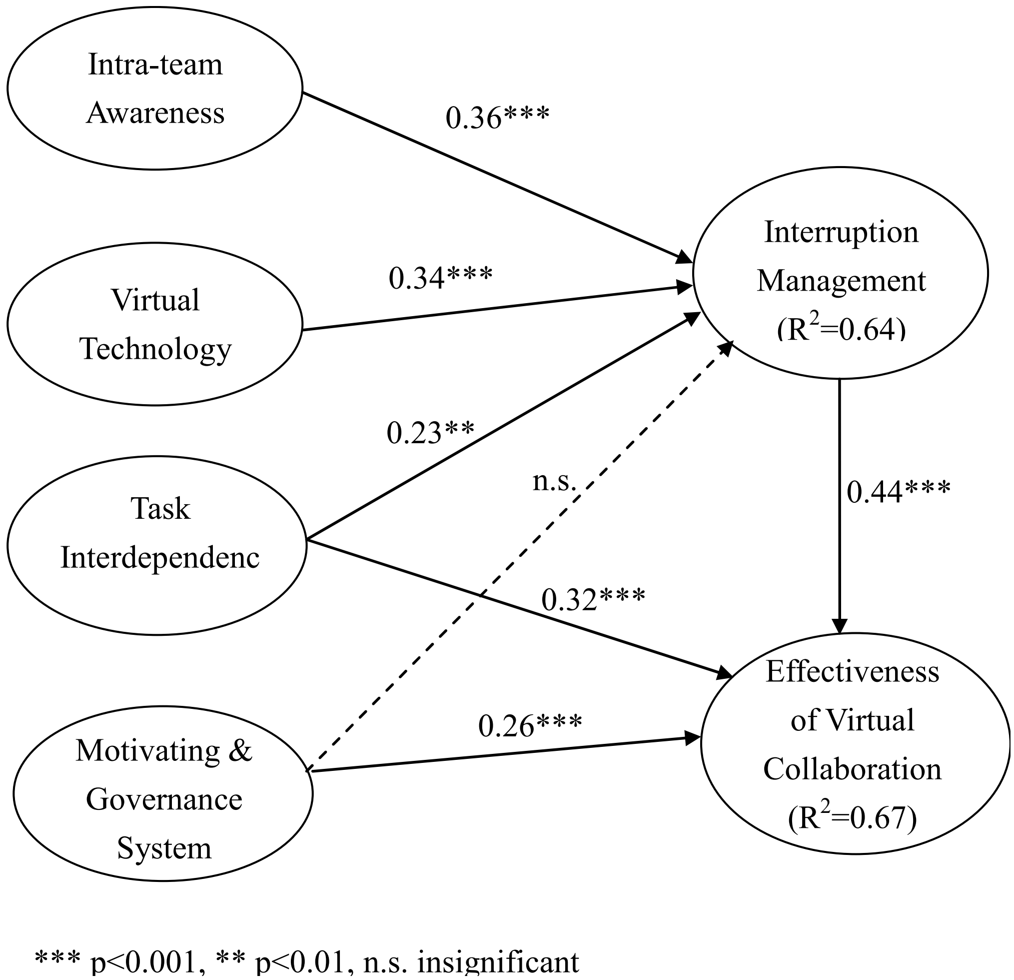


Figure 4-7: the Path Diagram of the Final Structural Model

4.5.3 Hypotheses Testing

According to the path diagram, interruption management can be explained by intra-team awareness (β=0.36), virtual technology (β=0.34), and task interdependence (β=0.23). These three factors jointly account for 64% of the variance in interruption management.

The relationship between motivating& governance system and interruption management is revealed to be insignificant. Meanwhile, virtual collaboration effectiveness is influenced by task interdependence (β=0.32), motivating & governance system (β=0.26) and interruption management (β=0.44). Beside the direct effects, intra-team awareness (β=0.16), virtual technology (β=0.15) and task interdependence (β=0.10) also indirectly influence virtual collaboration effectiveness. The regression weight of an antecedent factor on virtual collaboration effectiveness through the mediator is calculated as the cross-product of its impact on the mediating factor and the impact of the mediator on virtual collaboration effectiveness. These factors collectively explain 67% of the variance in virtual collaboration effectiveness.

Six hypotheses out of seven are supported in total (see Table 4-31). Hypothesis 1, 2, 3b, 4b, and 5 are strongly supported ($p<0.001$), and the hypothesis 3a is also supported, but not as strong as the previous hypotheses ($p<0.01$). Only one of the hypotheses is rejected (H4a), indicating that motivating & governance system may not be a significant determinant of interruption management.

Table 4-31: Summary of Hypothesis Test Results

Hypotheses	**Supported?**	**Significance level**
H1: ITA → InMgt The development of intra-team awareness has a positive effect on interruption management.	Yes	P<0.001
H2: VTech → InMgt The appropriate utilization of virtual technology has a positive effect on interruption management.	Yes	P<0.001
H3a: DEP → InMgt Task interdependence within the virtual team determines the significance of interruption management.	Yes	P<0.01
H3b: DEP→EFFE Well-strategized task interdependence within the virtual team is positively related to the virtual collaboration effectiveness.	Yes	P<0.001
H4a: MOTIV → InMgt Team-based motivating & governance system positively affects interruption management.	No	Insignificant
H4b: MOTIV → EFFE Team-based motivating & governance system positively affects the virtual collaboration effectiveness.	Yes	P<0.001
H5: InMgt → EFFE Interruption management positively affects the virtual collaboration effectiveness.	Yes	P<0.001

In addition to the structural model testing, control variables should be considered to test whether they have impact on the results. The demographic variables (respondent's gender, respondent's team role, virtual team size, virtual team type, business scope) were included in the model as control variable because their potential impact to the constructs. The result shows that no impact was detected in the test. The model with control variables was similar to that without control variables, and the author can infer that these variables have no significant impact on the result of hypotheses testing.

4.5.4 Reliability and Validity

A plausible outcome of SEM analysis should show a hypothesized model with more approximation of the real world phenomena. The final estimated model is proved to be a good fit to the data, supporting that our hypothetical model is a plausible one. Table 4-32 concludes the validity and reliability of the model.

Table 4-32: Summary of Validity of the SEM Analysis

Validity	Criteria	Value
Construct Validity		
Convergent validity	GFI>0.90	0.901
	Item loadings should be above 0.55, to show that over 30 percent of the variance is captured by the latent construct (Falk & Miller, 1992).	See Table 4-24
Discriminant validity	AVE > 0.5 (Segars, 1997)	See Table 4-27
Convergent & Discriminant Validities	Each construct AVE should be larger than its correlation with other constructs, and each item should load more highly on its assigned construct than on the other constructs (Gefen & Straub, 2005).	See Table 4-28
Reliability		
Internal consistency	Cronbach's alpha should be above .60 for exploratory research and above .70 for confirmatory research (Hair et al., 1987; Nunnally & Bernstein, 1994).	See Table 4-24
Unidimensional Reliability	The composite reliabilities all exceed 0.7 and the AVEs are all greater than 0.5 (Hox & Bechger, 1998).	See Table 4-27
Model Validity		
AGFI	>0.08 (Segars & Grover, 1993)	0.875
Squared Multiple Correlations	No official guidelines exist, but, the larger these values, the better.	

χ^2/df	<3 (Hair et al., 1987)	1.462
Residuals	RMR <.05 (Hair et al., 1987)	0.042
Path Validity Coefficients	The β and γ coefficients must be significant; standardized values should be reported for comparison purposes (Bollen, 1998; Hair et al., 1987)	6 out of 7 coefficients are significant

4.6 Summary

This chapter delineates the measurement development of the variables, modification processes of the questionnaires, survey administration, quantitative analysis methods, and the findings in this research. 89 valid responses were collected in the stage-one survey and 261 qualified responses were collected in the mass industry survey. The measurement scales of the constructs were undergone several validation processes to assure reliability and validity. The goodness of fit indices suggests a good fit between the final structural model and the data, and the model has satisfactory explanatory power.

The results indicate that six out of seven hypotheses are strongly supported. As hypothesized, intra-team awareness, virtual technology, task interdependence, motivating & governance system are positively associated with interruption management, and these factors have indirect relationships with virtual collaboration effectiveness that was mediated by interruption management; task interdependence directly affects virtual collaboration effectiveness. However, the hypothesized relationship between the motivating & governance system and virtual collaboration effectiveness is found to be insignificant.

5. Conclusion

This chapter presents a summary of findings, some discussions of the findings and identifies the major implications of this research for both academic research and industry practices. The first part summarizes the major findings with respect to the objectives of the research, and how the hypothesized relationships among the constructs are supported by the sample analysis. The second part discusses the empirical findings and related issues, such as virtual technology adoption, organizational norms, training and shared mental models in textile virtual collaboration. The third part addresses the theoretical and managerial implications of the research, followed by the discussion of limitation and future work in the last part.

5.1 Summary of Empirical Findings

In view of the significant role that smooth interaction plays in modern global business and corporation management, the author argues that effective interruption management will greatly enhance the effectiveness of virtual collaboration. This thesis examines technological and organizational aspects of the interruption in virtual collaboration process, which are important dimensions in controlling virtual collaborative quality.

5.1.1 Effect of Intra-team Awareness on Interruption Management

Intra-team awareness of virtual team is the members' understanding of other members' activities, which help them to be aware of the external contexts and provide guidance to their own tasks. The causal relationship between the construct of intra-team awareness and interruption management is found to be significant according to the structural equation modeling analysis.

Awareness display is an effective way to regulate unnecessary interruptions because it enables interrupters to check the recipient's availability before initiating interruptions. The necessary interruptions tend to happen when the recipient is not occupied in demanding tasks or the task boundaries. Such interruptions would be less likely to cause disruptions to the virtual collaborative work performance and task efficiency.

Existing technologies for awareness display allow work status sharing, personal task progress sharing, or schedule sharing, etc. For example, some software applications that integrate instant messaging with scheduling system allow availability display and timely update, showing whether the targeted person is performing mental-demanding tasks or the extent of his availability for interruptions. When sufficient and appropriate information (e.g., task type, complexity, expected completion time, etc.) about the ongoing task are shown, the team members could suffer less from undesirable interruptions.

The contents of display can vary, depending on specific needs of each project or team. Concluding from the interviews with experienced virtual team members, the author also suggests that showing something more specific than working status (available/busy/offline etc.), such as effort level and priority or other necessary details about the ongoing job would be helpful in coordinating interruptions. For instance, showing the effort level (which represents the degree to which one is occupied to the primary job) would help others to know how urgent and important your ongoing job is, compared to the interruption. It is also a good way to present the priority for different interruptions. For example, when the interruptee is performing an important task and he can set only related tasks as preferred interruptions, to prevent from feeling intruded upon by discrete interruptions. When performing time-sensitive tasks, high priority may goes to the interrupting tasks which are not time-consuming.

The awareness of the external context is also an indispensible element of intra-team awareness. Concerning the project progress and other team members' status provides the contextual cues that help to make wise decisions for the dispersed team members. One of the most vexing problems of virtual collaboration is that team members are dispersed across the world. The feeling of isolation created by the geographical distance makes members disconnected both in psychological feeling and in task collaboration. Sense of belonging to the team is lacking amongst the experts who collaborate in the ad hoc projects, in which they loosely collaborate with each other and communicate when needed. Paying more attention to others makes the team more connected and create atmosphere more like in a traditional team. More importantly, the development of such awareness improves members' responsibility in treating interruptions.

5.1.2 Effects of Virtual Technology on Interruption Management

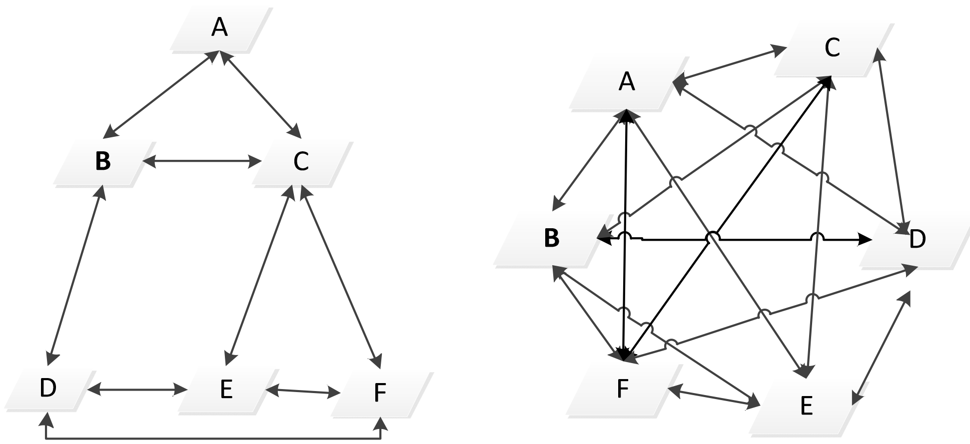
The causal relationship between virtual technology and interruption management is found to be significant according to the structural equation modeling results. These technologies, if utilized properly, can support positive interruption, regulate negative interruptions, and limit the disruptiveness an interruption may cause to virtual collaborators if adopted appropriately. The construct of virtual technology is developed especially for this research. The essential elements of virtual technology that support remote interaction should include: the ability to decrease negative interruptions, to negotiate for interruption time, to show availability and to filter unnecessary interruptions.

Synchronous technologies allow real-time communication and immediate feedbacks, but they cannot have control over interruptions. In contrast, asynchronous communicative technologies cannot effectively support tasks requiring real time interaction but reduce the chances for frequent immediate interruptions. In order to improve the management of interruptions, the technologies are expected to have more advanced and considerate functions like screening desired interruptions and regulating the unfavorable interruptions automatically. The unfavorable interruptions can be those that happen in inappropriate timing, the time-consuming and mentally demanding ones, or the requests unrelated to the primary tasks. The filtering systems with character recognition systems can screen out the undesired interruptions based on the answers of the pre-set questions, and let the desired interruptions interrupt the user. In addition, some technologies are able to mediate or negotiate with the interrupter about the time and method to interrupt if the recipient is occupied in the ongoing work. These technological advancements would obviously be helpful in coordinating and managing interruptions if utilized properly.

5.1.3 Effects of Task Interdependence on Interruption Management

The positive effect of task dependence on interruption management is supported by the empirical evidences. Task interdependence refers to the extent that team members depend on each other (in terms of information, materials, and support) to accomplish jobs. The construct of task interdependence is composed of three measurement items: “team members work closely with each other in doing their work”, “team members frequently must coordinate their efforts with each other”, and “the way individual members perform their jobs has a significant impact upon others in the team”.

The task interdependence might be relatively higher because of flat structure and simple hierarchy in virtual teams. As Figure 5-1 delineates, the traditional team structure is more hierarchical. The strict reporting structure in traditional teams allows only the communication between direct superiors and subordinates, which in fact limits the communication volume and restrains interruptions. However, in virtual team structure, the decrease of vertical levels results in more demands for communication. In addition, there is less sense of leadership and supervision in virtual teams. Hence, the informal interaction becomes highly functional in virtual collaboration, and in turn increases the interruptions among team members.



Structure in traditional teams

Structure in virtual teams

Figure 5-1: Comparison of the Structures in Traditional Teams and Virtual Teams

The relationship between task interdependence and interruption management to a large extent owes to the collective planning. With higher task interdependence, the team members would more likely to feel responsible to fix others' problems. With jobs inter-related and interdependent, people tend to pay more attention to other's demands. In this case, the team can function as an entity and members are likely to behave altruistically. The participants in the in-depth interviews confirm the underlying rationale of the relationship. They describe that they feel obligated and responsible of choosing proper timing and methods to handle interruptions. As an interruptee, effectively responding to the interruptions on the premise of not disturbing own work is essential in ensuring the smooth progress of collaborative projects.

5.1.4 Effects of Task Interdependence on Virtual Collaboration Effectiveness

There is both direct and indirect effect of task interdependence on virtual collaboration effectiveness. Task interdependence directly influences the virtual collaboration effectiveness, and also exerts an indirect effect via interruption management. Higher task interdependence is beneficial to virtual collaboration effectiveness, owing to the fact that interdependence creates incentives for facilitative behaviors toward their teammates. High levels of interdependence promote behaviors like planning, strategizing and prioritizing, and help a team become ready to perform their tasks. Hence, interdependence could facilitate cooperation among team members, and as such are important to the virtual collaboration effectiveness.

5.1.5 Effects of Motivating & Governance System on Virtual Collaboration Effectiveness

The motivating and governance system of the virtual team refers to how the team members are motivated and governed to ensure the holistic performance as well as individual contribution. It is associated with the standards and criteria of allocation of benefits and compensation (both monetary and non-monetary) to the members. The hypothesized effect of motivating & governance system on interruption management is found to be insignificant, while the effect on virtual collaboration effectiveness is supported. The construct of motivating and governance system is measured by: “my rewards depend primarily on how the entire team is doing”, “my rewards are strongly influenced by my contribution as a team member”, and “the motivating and governance system in my team encourages me to consider more about the whole team in treating interruptions”.

A team-based motivating & governance system is positively related to the virtual collaboration effectiveness. The common goals and awards can promote and assert the values of their interaction, as well as fully open discussion and shared efforts. Evenly distributed rewards (monetary such as salary, bonus, or nonmonetary such as promotion, award, vacation, recognition by management) from collaborative task completion motivate and encourage inter-cooperation amongst members, while a rigid governance system ensures that members fulfill their own tasks with high quality and encourages individual contribution. Such system is expected to enhance virtual collaboration, as well as team member’s satisfaction toward working in the team.

5.1.6 Effects of Interruption Management on Virtual Collaboration Effectiveness

Interruption management plays a role of mediator in the final structural model. It mediates the relationships between the antecedent factors (intra-team awareness, virtual technology, task interdependence, motivating & governance system) and the consequential factor (virtual collaboration effectiveness). In other words, interruption management has a direct effect on virtual collaboration effectiveness, and each antecedent factor has indirect effect on virtual collaboration effectiveness via interruption management. The construct of interruption management is measured by the items of "handle interruption by priority", "handle interruption by urgency", "handle interruption by importance", "proper handling of prior interruptions", and "regulation of less prior interruptions". With negative interruptions regulated and positive interruptions facilitated, appropriate interruption management could largely promote effective collaboration among the team members and the virtual team performance.

5.2 Discussions

5.2.1 Interruption Handling Strategy for Individuals

The workers are facing several dilemmas in interruption strategy: if people respond immediately to the interruption, their work will break off, and they may not be able to quickly resume the work after the break; if the interruptees don't want to be distracted from the ongoing work, they may choose to ignore the interruption when it happens, they can deeply engage in the primary work, but there exist risks that the information exchange may be valuable (for example: getting the information that can accelerate their work in hand) as well, also the time delayed for this non-response may cause some trouble to other workers in the team; and if workers choose to postpone the interruption to a more convenient time that they could focus on the work at hand, they also have the concern to take care of one more thing in the future.

People treat interruptions in different ways depending on the context of the situation. Some people would like to ignore interruptions until they reach some milestones in current tasks. Some prefer to deal with the interruptions promptly. Most people will choose to let others know that they don't want to be disturbed at the time when they are concentrating on some important work. For the ones in a closely cooperative and collaborative working environment or the managers whose responsibility is to coordinate various affairs, things are more paradoxical; they tend to be occupied whole-heartedly in the primary work while they have to be accessible to interruptions due to the apprehension of missing important messages. Facing these dilemmas, we are not provided with any universal solution. In each particular case individuals need to find optimal tradeoffs between seclusion and availability, openness and privacy, and direct or delayed handling of an interruption.

The author concludes the pattern of the interruption handling strategy for individuals as virtual team members according to the output in interviewing (see Figure 5-2). Participants state that in practices people sometimes interrupt the inappropriate person, especially for the inter-organizational or inter-departmental virtual teams. If the interruptions are not within their responsibilities, the recipients would let the interrupters approach other people who are in charge of the issue. If it is their responsibility to handle the tasks, then they will examine whether they are currently involved in other important tasks. For the available members, responding the interruptions would be an obligation as they are a team. For the occupied persons, they would probably compare the urgency of the incoming tasks with the ongoing ones, and choose to perform the more urgent ones. For the less urgent tasks, negotiating for another time to cope is always a good choice to make sure the efficiency of the whole team. For the urgent tasks, people would then check whether they are most important or the tasks with high priority. Only the urgent and important interruptions are allowed to get their attention immediately.

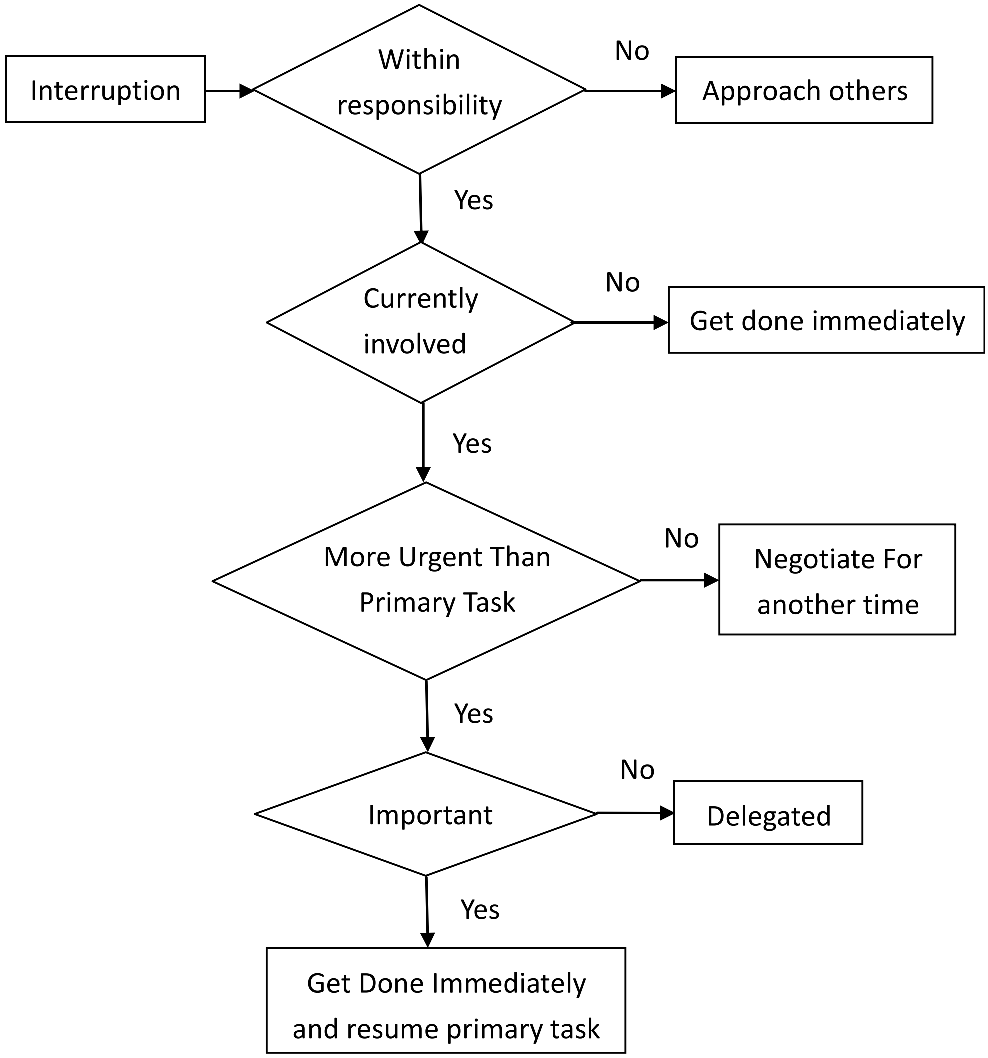


Figure 5-2: General Behavioral Pattern of Respondents in Interruption Handling

As elaborated earlier, interruptions can be varied considerably, depending on an array of factors such as the timing, requested level of attention, delivery channel. Each contextual interruption (prescriptive, structural, descriptive, and judgmental) would cause different levels of positive or negative effect to the team and its members. Based on the four types of interruptions reported by Jett & George (2003), this research concludes three types of consequences for those contextual interruptions, and suggest distinct strategies should be applied to handle with different interruptions in line with the context (shown in Figure 5-3). Each interruption can be perceived as an intrusion, a break, or distraction. An intrusion, such as unscheduled personal visit or phone calls in the middle of demanding tasks, is usually considered to be disruptive, making the interruptees miss the deadline for urgent tasks or affect the person's involvement for demanding tasks. A break, which can be a prescheduled break at certain time or planned video conference that breaks the continuity of primary job, is usually perceived as harmless. In most cases a break creates idle time within stressful jobs, facilitating job performance with alleviation of fatigue or stress, and a relaxation may inspire people with new ideas. Distractions, such as noise made by other persons at workplace or background music, seldom cause serious damage to task performing. They are sometimes found to be annoying because the related information would automatically store in long-term memory, yet sometimes regarded as refreshment to raise people's spirits by the change of work tempo.

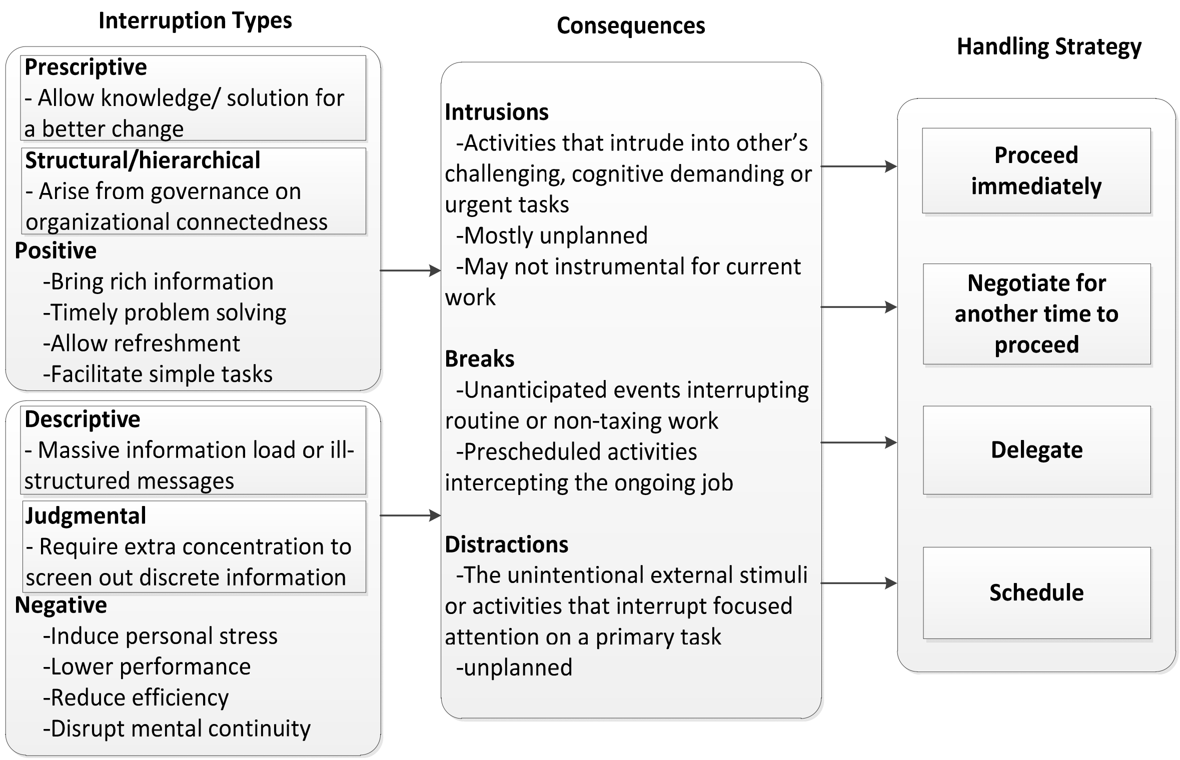


Figure 5-3: Handling Strategies for Diverse Contextual Interruptions

Interruptions can be handled separately and effectively according to different contextual conditions, such as the relative urgency and importance of interruption, interruption type, the expected consequence. For instance, when the incoming interrupting task is more urgent and important than the currently operating one, team members should handle the interruption immediately before resuming their current ones. If the interruption is very much important but less urgent than the current one, people can negotiate with the interrupter for another time to fix it. If the interruption is a trivial urgency, then it can be delegated to less occupied teammates. For the interruptions that would probably cause intrusion to the interruptee, individuals can choose to postpone handling. When the interruptions are just distractions, massive discrete information, or issues neither important nor urgent, the strategy of scheduling will work so as to maintain the concentration on primary task. The coordinating method of handling interruptions emphasizes the whole-team efficiency while maintaining team member's control of their independent tasks.

Interruptions sometimes are found to be intrusive; but helpful in modern managerial and professional work. There is a continuing conflict for the managerial workers between the need to concentrate upon one thing at work so that full processing capability can be gained to assure work quality and the need for being alert for the unexpected, especially relevant and important external events.

5.2.2 Task-technology-fit in Adopting Technologies

For virtual team members, properly treating interruptions in daily collaboration should rely on the optimal adoption and utilization of virtual technologies. One of the most important rationales of adopting information and communication technology (ICT) is the task-technology-fit. Adopting technologies according to the task structure of the virtual team is essential and helpful in collaboration. Virtual technologies vary in a spectrum of features, such as communication synchronicity, types of work that mainly facilitate, media richness, manipulation complexity, openness to interruptions, etc. Each virtual technology has its own characteristics: some are intrinsic and some are subjective to environmental factors. For instance, media richness is an inherent property of technology. Some communication technologies are plain media conveying merely texts, such medium include e-mail, messaging. Some richer medium help to convey non-verbal cues and even social cues, which are indispensible in linking up virtual members in a manner similar to face-to-face communication.

Another example is synchronicity, which refers to the ability that an ICT can allow simultaneous conversation and immediate feedback. Synchronous communication not only enables faster information delivery but also allows immediate response. Synchronicity of communication is an inherent property of a technology. Tasks of lower interdependence would be usually collaborated through tools with lower synchronicity; those tools should be good at the support of information exchange and update of team progress on the premise non-disturbance (e.g., emails, bulletin boards, file sharing centers, etc.). In addition, for tasks that need organized or well-archived material, less synchronous communication would be more flexible for preparation.

Likewise, some technologies are designed for simultaneous conversation, such as instant messaging, e-chat, and synchronous file sharing, such as electronic team room, project management, and collaborative calendar. The selection of communication technologies for different synchronicity level should take task nature into consideration. For urgent tasks, synchronous should be used to increase task efficiency. Tasks of higher interdependence would be usually collaborated through tools with higher synchronicity and technologies allow quick information sharing, instant discussion, immediate feedback, coordination of activities within a team (e.g., video conferencing, instant messaging, project management systems, electronic brainstorming systems, etc) so as to facilitate cooperation is required in this situation to complete these tasks. Despite the quick information exchange allowed by synchronous communication, it often causes more interruptions during virtual collaboration. It is even important to have sense of interruption management and regulation in the synchronous interaction to prevent disruptions caused to team members. As a matter of fact, immediate interruption does not always bring disruptive effect. The perceived disruptiveness caused by intra-team interruption is the combination of complex effects yielded by environmental factors, including tasks, team setting, personal resistance to external extractions, and individual capability to recovery from breaks.

In contrast to the aforementioned intrinsic characteristics, some properties of an ICT can be dependent on the task, person and the organization it is applied. For instance, the degree to which the ICT helps to develop team spirit among members is crucial for virtual teams. Members with strong team spirit are more likely to cooperate effectively. Team spirit is naturally nurtured during daily collaboration at work in face-to-face teams. Nevertheless, for virtual team members, the sense of belonging can only be cultivated through technologies. Some technologies could help the development of team spirit among distanced members under particular environments, such as instant messaging, online group chat, co-authoring system, and shared project calendar. Projects teams, for example, in which members are highly interdependent on each other, should raise better sense of connectedness among members by adopting the technologies that help foster team spirit.

User experience of an ICT is subjective to the individual perception. Each ICT has its user interface, manipulation method, and functions. Since team members have formed individual preferences and operational conventions, users would have different user experience toward one single ICT. To choose appropriate technologies to fulfill the destination task, industrial practitioners should try to achieve the balance between useful, practical functions and simple, clear interface.

5.2.3 Balance for Individual Connectedness-isolation

Each member in a virtual innovation team should find a way to balance the degree of connectedness and isolation to others. On the one hand, the team should decide its interruptibility level according to its core value and overall objective. Each type of team differs in the interruptibility, which is the level that team members can accept without feeling disturbed. For instance, the project teams gather various domains of experts to collaborate on one huge task, the high interdependence of their sub-tasks make interruptions among team members frequent and urgent; so the core value of those teams should be high level of team spirit, accordingly, the interruptions should be treated timely based on the rationale of whole-team success. On the contrary, the R&D teams focus on research and planning, which demand more time of individual thinking; such teams should regulate interruptions more strictly, so as not to influence the efficiency of product development.

On the other hand, the role of each member in a team should be clarified. The coordination related job performers are more responsible to treat interruptions promptly, while the research, service or administrative persons are less sensitive to interruptions. One of the interviewees shared his strategy for balancing interruption handling and task concentration. He concludes that 9 pm to11 pm is the period that fewer interruptions would come up, and it could be used for some more demanding job like planning. He would turn off all access for remote communication and focus on the primary job to assure task quality. However, some other positions require high levels of connectedness and sensitivity to the external environment, such as sales and marketing persons, who should always have the latest news at the first time.

5.2.4 Improving Organizational Norms in Virtual Teams

Although the organizational norms are not considered as the most primary factors in determining virtual collaboration performance and it is not incorporated in the conceptual model, the author reckons they do have certain effects on interruption management and team collaboration in practices. In this section, the development of team norms to improve interruption handling in virtual collaboration is briefly introduced for future research.

Norms are defined as a set of standards or rules shared by members of the team as applying to themselves and other group members, prescribing appropriate thought and behavior within the group (Postmes et al., 2001). Norms are regular behavior patterns that are relatively stable within a particular team, and can be the least visible and most powerful forms of social and organizational control over human action (Bettenhausen & Murnighan, 1985). Norms amongst team members can influence the attitude toward interruptions through regulating member behavior. For instance, Cohen (1994) considers norms to be positively related to the attitudinal measures of organizational commitment, trust in management, and satisfaction.

Our interview outcomes also suggest that norms should be accumulated among virtual team members to develop consensual behavior pattern, especially at the very beginning (i.e., orientation period) of a project. An array of pre-launch activities could help to develop norms, such as team mission statements and core values enable members to quickly adapt to the teamwork, help to set objectives, clarify respective roles, build personal relations, etc.

Norms' effect on interruption management is especially salient for virtual innovation teams. When facing a large extent of uncertainty which is commonplace in virtual contexts, norms lead team members to use their past experiences and consensus in similar social settings to guide behavior in current settings. From the psychological perspective, with higher level of organizational commitment, trust among co-workers, satisfaction to the job, people are more likely to perform altruistic behavior. In teams without developing norms purposely, when someone needs to seek help from a colleague, he (the interrupter) could expect the interruptee to respond quickly, but the interruptee may prefer to deal with it later when he is involved in other activities; such teams are less likely to perform excellent tasks due to lack of regulation. In contrast, in the teams with norms that are developed regularly and substantially, the interrupter would probably check the interruptee's states of availability before interrupting, and the interruptee would more likely to consider other member's situation when treating interruptions.

Without appropriate virtual communication technologies that help identifying the interruptees' working or mental status, interrupters have no awareness of what time is appropriate for initiating interruptions. Dissatisfaction arises at this point of interruption. The formation of norms helps team to regulate member behavior. Although norms are not always written or formal, they usually have a great and consistent power in influencing team decisions and behavior. Norms come into being during the processes that team members discuss and agree on what "ought to" happen under particular circumstances. Some companies have guidelines for team members in a new project, specifying the most important issues, the flowcharts, the procedures or checklists. Some interviewees consider such guidelines to be helpful in their work, make the task easy and more organized.

In summary, well-developed norms within a virtual innovation team are helpful to the interruption management of the team. Norms could encourage reciprocal interaction and develop situational awareness within the team in order to maintain control over interruptions in virtual environment. In a team with higher level of norms, team members are more probable to know how they and their teammates "ought to" deal with each situation in a volatile environment.

5.2.5 Training to Improve Interruption Management

Similar to team norms, training is also not a central issue in interruption management. Yet it is still necessary to briefly discuss its effect on interruption management in virtual collaboration. Previous research findings suggest that training is related to overall performance for the whole virtual team. For example, Gladstein (1984) demonstrates that training and technical consultation are positively associated with self-reported effectiveness in a telecommunication sales team. Campion et al. (1993) finds that training of clerical teams is positively related to manager-rated performance and member satisfaction.

Our interview outcomes suggest that for virtual innovation teams, training on both individual level and team level improves the quality of decision making. It is an effective means to leverage attitude and regulate behavior of team members toward interruptions during virtual teamworking. From the mental activity perspective, pertinent training can coordinate team member behavior by helping them to develop shared knowledge and behavior pattern.

According to the interview participants, online training is implemented via various kinds of information technologies such as teaching document sharing, videotape lectures, video conference for Q&A interactions and demonstration. Though virtual training is criticized for lack of control over the training effects, it is reported to be convenient and helpful. The training progress and effectiveness can be monitored or detected through electronic means. For instance, in some of virtual teams, trainee progress can be detected via computer input to match the training material and format to the trainee's actual learning status. Some teams even developed an intelligent tutoring system which can infer the trainee's cognitive states from their responses.

Training for virtual teams should incorporate elements of team task (e.g., task analysis, task simulation, goal setting, planning), team coordination (e.g., team building, team leader training, interpersonal communication skills) and issues regarding building virtual innovation team awareness and interruption handling strategy. The following four aspects are the most essential:

1) Technical training on how to manipulate the information and communication

technologies that used to facilitate remote collaboration. What differs in virtual teamwork with that in traditional teamwork is the communicational barrier caused by the loss of non-verbal cues in virtual environment. Extensive training on adaptation of communication infrastructure can facilitate the collective problem solving and decision making process.

2) Relevant educational resources provided (resources to which team members can refer when problems are detected, such as books, software, or consultants, etc.).

3) Training on intra-team awareness. Training in this aspect could help members to form collective cognition about team tasks and situations, and facilitate the team in anticipating problems.

4) Training on interruption handling strategy. This kind of training enables virtual innovation team members to be prepared of treating various interruptions in daily work, such as clarifying the rationale of both initiating and treating interruptions in each phase, introducing the interruption handling supportive technologies and their manipulation rules, and guidelines on treating interruptions contextually.

Succinctly, appropriate training for virtual team members could support better efficiency of interruption management in the team. Effective training should cover the following aspects: remote communication skills, ICT manipulation skills, developing intra-team awareness, as well as interruption handling strategies.

5.2.6 Shared Mental Model

In face-to-face interaction, team members are allowed to interact with substantial social cues and to communicate under normal circumstance; while in virtual interaction, team members face more restricted interaction environment barriers. Thus, team members can establish their own terminology and communications protocols during the team building period, and this helps the team in developing a variety of methods to achieve interaction accuracy and efficiency. Such rapport in the collaboration process can be concluded as shared mental model of a team. Researchers reckon that shared mental model helps teams to cope and adapt during stressful conditions (e.g., Mohammed et al., 2000). Shared mental model is defined as the content and organization of team-interaction knowledge held by team members about how team members should work together within a given task domain (Andres, 2011). Shared mental model develops in the process of experience sharing, task coordination and discussion, collaborative decision making, and reaching consensus during intra-team interaction.

Shared mental model facilitates the team communication in ways that team members will behave or even think in similar ways. Thus, high degree of mental model similarity among team members is beneficial for team member collaboration virtually. Team members have a mental picture of how they are anticipated to perform each kind of tasks under different situations without synchronic discussion, how their teammates will react in each circumstance, how interruptions can be handled, etc. Shared mental model also helps team members to predict the needs and information requirements of their teammates, and to anticipate the actions of other members for the purpose of adjusting their own behavior in the highly stressful conditions. The development of mental models can be enhanced by team-interaction training. Cannon-Bowers et al. (1993) puts forth that a team's shared mental model to improve team member collaboration should put efforts on several levels: (a) an understanding of team members' interacting tools; (b) an understanding to the team tasks and how to accomplish it; (c) an understanding of the role the team members play in the tasks.

In light of the discussion above, the author reckons that higher levels of shared mental model among virtual team members could enhance communication efficiency and accuracy, and to regulate interruption management in the long run. Shared mental model develops in the processes of intra-team cooperation, experience sharing, as well as task collaboration. Shared mental model could guide intra-team collaboration as it allows team members to share behavior patterns under various contexts.

5.3 Implications

5.3.1 Theoretical Implication

The theoretical contributions and implication of this research to the textile virtual collaboration can be concluded as the following four aspects.

- The construct of interruption management

Interruption management has received increasing attention in the academic area of virtual organization research as well as the practices of textile virtual teams. Disruptions that cause some unfavorable interruption is a vexing problem in virtual collaboration, so managing these interruptions becomes an important topic. A number of studies try to provide insights on how to improve interruption management, and demonstrate that interruption management have positive impact on the virtual collaboration. Nevertheless, very limited research has explained the concept of interruption management, what the criteria of effective interruption management are, and the role interruption management plays in virtual collaboration. Also, very limited literature has explored its antecedents.

This research attempts to fill in the gap of this critical issue. The author reckons that understanding the construct is an important step before illustrating its effects.

This research reviews related literature about interruption management, collects virtual team members' perception about what interruption management is and analyzes how interruption management can be realized. This research conceptualizes the construct of interruption management, so as it can be employed as a process variable in the input-process-output model. This research serves as a start in enriching this construct theoretically, and hopefully it can be undergone further verification and development. Taking a step further, the author identifies the antecedents of interruption management in the interruption-contingent globalizing textile business environment. Virtual technology and intra-team awareness are two factors in the technological aspect, while task interdependence and motivating & governance system are two factors in the organizational setting aspect.

- Instrument Development

In this research, the instrument scales of intra-team awareness, virtual technology and interruption management are developed particularly for this research because of a lack of well-developed scales for quantitative investigation. Based on related literature and the exploratory studies, the author developed initial measurement items and revised these scales through a stage-one survey, related reliability tests, and exploratory factor analysis. With satisfactory reliability and validity, these newly developed instruments contribute as foundations for future research in this field.

- Empirical framework of virtual collaboration effectiveness

Virtual collaboration effectiveness has been examined in relation to a series of factors. Surprisingly, little empirical research has explored the factors that impact interruption management and virtual collaboration in modern globalized organizational activities. The author builds the framework to examine how several aspects of dominant factors exert influence on textile virtual collaboration effectiveness particularly from the perspective of interruption management in today's globalizing collaborative environment. To address the issue of coordination of interruptions as team process, the construct of interruption management is introduced. This research proposes that four antecedent constructs – intra-team awareness, virtual technology, task interdependence, and motivating & governance system – exert significant effects on the interruption management and effectiveness of virtual collaboration. The effective management of interruption plays a critical role in mediating the effects between the antecedent factors and the consequential factor (virtual collaboration effectiveness).

Existing literature mostly focus on exploring the interruption effects on team performance and individual mental state, and how to deal with interruptions from the perspective of the interruptees. However, little attention is paid on how the virtual teams should coordinate interruptions on the team level. This research studies the topic of interruption management in the burgeoning virtual team collaboration. In constructing the empirical model to address interruption management in virtual collaboration, the research hopes to stress the importance of interruption management to the effectiveness of virtual collaboration and interaction, so as to maintain prosperity under the nomadic global business environment. The author conducts qualitative in-depth interviews, as well as quantitative questionnaire survey including a stage-one survey of 89 participants and a mass industry survey of 261 valid respondents; the author also adopts structural equation modeling to examine the hypothesized relationships in the hypothetical model. After undergone such multi-stage examinations, the final model is ensured of its validity, reliability and generalizability.

5.3.2 Practical Implication

- Implication of the integrated model

The model built in the research has wide implication in textile virtual teams. It provides management levels with systematic guidelines for improving interruption coordination from technological aspect and organizational settings.

The author suggests that the virtual teams should develop intra-team awareness, including the awareness of teammates' availability, task priority, progress, and external contexts, to grasp understanding toward the contextual cues in order to facilitate task performance. The author also recommends a team-based motivating and governance system for virtual organizations, which could effectively encourage individual contribution as well as allow higher levels of team spirits. Besides an even distribution of the rewards among team members to ensure team spirit and good cooperation, such system also pay emphasis on the rigorous governance over team members. For virtual technologies used to facilitate interruption management, the author recommends to develop more functions such as filtering unnecessary interruptions, negotiating interruption time, and show availability. Such approach is approved to be positively related to the virtual collaborative success, and could be taken as references for the textile virtual teams. Because the participants of the interviews and surveys are all from textile companies, the author considers the empirical results are significantly constructive to industrial practitioners.

- Interruption handling strategies for individuals

The vastly expanding global commerce is increasing the complexity of multi-national or cross-regional organization management. As a result, virtual collaboration as a new form of interaction is gaining increasing prevalence worldwide. Both intra-organization (may consist of different branches within one single company) or inter-organization (may consist of different firms bonded by alliances or supplying contracts) teams can accommodate the best structure of expertise from people virtually without any restriction of geographical boundaries. The distinct characteristics of virtual teams have resulted in the inevitable emergence of the interruption issue in virtual team collaboration processes.

The research contributes to the industrial practitioners with suggestions on strategies of handling interruptions. The author conducts in-depth interviews to discuss the optimal interruption handling skills for individuals in the processes of daily virtual collaborative work, in order to confirm the knowledge the author concludes from the literature and explore the knowledge that are absent from literature. The exploratory interviews has presented rich and illuminating data, which, together with the thorough literature review, enabled us to see a bigger picture of how interruptions can be coordinated, how to better regulate intra-team interaction and to alleviate the damage that caused by interruptions under virtual collaborative environment. In addition, a series of suggestions are formulated in enhancing interruption management skills for individuals in textile virtual collaboration.

- Recommendations on virtual technology adoption

Virtual team members are well-partitioned with their expertise, and they are dispersed in different locations. Hence, it is even crucial to share their knowledge and expertise through information and communication technologies. Recommendations on the adoption of virtual technology on the team level are concluded from opinions of the practitioners with much experience in textile virtual collaboration and reported in the thesis. The recommendations include task-technology fit, how to select technologies based on different external contexts, and so on.

5.4 Limitations and Future Research

Several limitations of this research are discussed in this part, and the author believes findings and limitations of the present research would stimulate significant future research.

First, the research is innovative in constructing a model to examine the antecedents of virtual collaboration effectiveness from the perspective of interruption management; it focuses on four antecedent constructs which are considered as the most significant promoting factors of interruption management. However, other factors may also play roles in determining the consequential factors in the model, such as training, team norms that discussed in this chapter previously. Shared mental model is also an important construct in interruption management and the collective behavior during virtual collaboration. Owing to time and limited resources, these factors are not examined through a longitudinal approach. Besides, strategies of interruption management can be slightly varied for different teams. This research classifies the virtual teams into several types, with their own characteristics, but the team type are not included in the hypothetical framework. Future research can extend the framework to integrate the suggested variables.

Second, the respondents of both in-depth interviews and the questionnaire surveys were all employees from the textile and apparel industry. Thus, although the hypothetical relationships of the framework are empirically proved to be significant among the targeted population, the generalizability of the model is not assured. Textile industry is a traditional industry with its own characteristics, which can be considerably varied from other industries, especially the newly emerged high-tech industries.

Third, due to the availability of respondents in both interviews and questionnaire survey, snowball sampling method is used in collecting data. Snowball sampling uses the recommendations to find people with specific characteristics that represent the target population. The advantage of this method is that new connections could be built through old relationship and adequate information can be shared and collected. The disadvantage is that it is prone to make biased estimates using snowball sampling. The respondents of this research are targeted as the virtual team members who have sufficient experience in global remote collaboration and communication within the textile and apparel industry, the snowball sampling helps us to gather qualified information within limited time span, and ensures efficiency and cost control (Kurant et al., 2011).

Fourth, several constructs are developed in this research because they have no previously developed measurement items. These constructs need to be examined by further research to establish higher validity and generalizability. Besides, all the constructs in the research are all unidimensional. Actually, constructs like interruption management could be further enriched. With my effort as a start, future researchers can also try to develop multi-dimensions for the construct.

Fifth, data of all observed variables come from self-report questionnaire survey, including the section of the effectiveness of virtual team performance. The self-report method of questionnaire survey has its weakness: higher esteem, which is also shared with other methods (Spector, 1994). The author adopts this method mainly because it's widely accepted in organizational research, and can be particularly useful in providing a picture of how people view their job and how they perceive during their work. Future researchers with more resources could try to collect data of the performance variable from more objective evaluation.

Appendix A: In-depth Interview Protocol

Section I—Introduction (5-6 minutes)

1. Welcome greetings
2. Self-introduction by the interviewer
3. Briefly describe the purposes of the research project
4. Explain the interview objectives and confidentiality

Section II—Open Questions (10-15 minutes)

1. Please briefly introduce your organization and your job specification
2. Please describe the remote team you work in, and the remote project you are pursuing
3. Your team role
4. Types and frequency of interruptions in your remote collaboration
5. Sources of interruptions

Section III—Main Questions (70-85 minutes)

Part 1: Technological Aspects (25-30 minutes)

- To what extent you are aware of the external contexts including availability and progress of your teammates in virtual environment?

  Probe:

  - Do you aware of the external environment of your remote tasks? Does the environment have any influence on your decision on interruptions?
  - Do you always check availability before you initiate interruptions? Is it easy to know other members' availability for interruptions?
  - Do you pay attention to other members' progress, task priority, etc.? Does such information help your decision on interruptions?
  - How do you think is your relationship with your remote teammates, when compared to traditional teams? Do you feel connected to your teammates? Do you feel that you can easily get to know other members when you want to? Does high connectedness affect interruption handling?

- To help managing and coordinating interruptions so that less disruption would occur to your daily virtual work, how do you think the virtual technologies should be?

Probe the essential functions of virtual technologies that help interruption management. If respondents do not mention the following functions, please ask whether these functions are perceived as important:

- Regulate interruptions
- Convey social cues (verbal, non-verbal, visual, expressional, etc.)
- Filter incoming interruptions
- Negotiate interruption time

Part 2: Organizational Aspects (20-25 minutes)

- How are the team members motivated and governed? Does such motivating and governance system affect your treatment toward interruptions?

  Probe:

  - Does your team allocate rewards based on performance?
  - Does your team allocate rewards based on team performance or individual performance?
  - How effective do you think team members are governed?

    - Do you think such system affect your attitude toward interruptions? How?
    - How do you think the system works in motivating your performance?
    - Do you have any suggestions on the motivating and governance system?

- Do you feel independent on task performing during virtual collaboration? How does the task interdependence affect your attitude and behavior to interruptions?

  Probe:

    - To what extent do the tasks of your team members are related and inter dependent?
    - How do the tasks of your team members are related and inter dependent?
    - Do you think high interdependence would make you feel more obliged to cooperate with your teammates in term of being more open to their interruptions?
    - Do you think task interdependence influence your task performance?

Part 3: interruption management and collaboration performance (25-30 minutes)

- For virtual collaboration among the textile companies, what are the standards for effective interruption management?

Probe:

- Which interruptions do you think are disruptive and which are desirable?
- What is your overall criterion in treating interruptions? What are your strategies in treating different interruptions?
- Elaborate the efforts you or your teammates made in order to better coordinate interruptions, and its effect on final performance of the project.
- Does your team have any down-to-earth steps in advancing interruption management on the team level?
- Does good interruption management influence the final effectiveness of virtual team collaboration in your opinion?

Section IV—Conclusion (5 minutes)

1. Summarize the discussion
2. Thank the participants

Appendix B: Questionnaire for Stage-one Survey (English Version)

THE Hong Kong

POLYTECHNIC UNIVERSITY

INSTITUTE OF TEXTILES & CLOTHING
紡織及製衣學系

香港理工大學

Survey on Remote Team Communication

Thank you very much for participating in this survey and provide us with invaluable opinions.

1. Are you involved in any kind of remote communication during work (remote communication refers to the communication among people who locate in different place and need the aid of communication tools such as phones, E-mails)?

	Yes
	No (this survey stops here, thank you for your time)

2. **This survey targets at your experience in interaction through electronic means as a member in a remote team, please take the people with whom you often interact and collaborate remotely at work as a remote team.**

3. **"Interruption" in a remote team refers to the events that generated by a team member to initiate interaction with other member(s) and breaks the continuity of his/her (their) ongoing job.**

CONFIDENTIALITY ASSURED

I assure absolute confidentiality for those who complete this survey. All responses of the completed surveys will not be documented for any other purposes and the identity respondents will not be disclosed without the respondents' permissions.

SURVEY RESULTS SHARING

Results of this survey will be summarized in a final report upon completion of the research study. This report will then be shared with interested respondents who participate in the process upon request in order to promote an effective team communication. If you have any questions or suggestions about this survey, please contact Ms Siyan Fang at telephone number (00852)-5137- (Hong Kong) / E-mail: serena.fong@

Institute of Textiles & Clothing

The Hong Kong Polytechnic University

Direction: please give out your mark regarding each statement based on your experience (1—strongly disagree, 2—slightly disagree, 3—neutral, 4—slightly agree, 5—strongly agree).

I. Intra-team Awareness	disagree		neutral		agree
1. I am aware of my virtual teammates' availability for interruptions.	1	2	3	4	5
2. I am aware of my virtual teammates' priority for interruptions.	1	2	3	4	5
3. I am aware of the project progress of my collaboration work.	1	2	3	4	5
4. I feel connected to my remote teammates.	1	2	3	4	5
5. I am aware of the external environment of my virtual collaboration work.	1	2	3	4	5

II. Task Design	disagree		neutral		agree
1. Team members work closely with each other in doing their work.	1	2	3	4	5
2. Team members frequently must coordinate their efforts with each other.	1	2	3	4	5
3. The way individual members perform their jobs has a significant impact upon others in the team.	1	2	3	4	5

III. Motivating and Governance System	disagree		neutral		agree
1. My rewards depend primarily on how the entire team is doing.	1	2	3	4	5
2. My reward is strongly influenced by my contribution as a team member.	1	2	3	4	5
3. The motivating and governance system in my team encourages me to consider more about the whole team in treating interruptions.	1	2	3	4	5
4. The motivating and governance system in my team is able to stimulate and reinforce individual performance.	1	2	3	4	5
5. My rewards depend primarily on my position.	1	2	3	4	5

IV. Remote Communication Tool	disagree		neutral		agree
1. Remote technologies adopted in our team are able to help decrease negative interruptions.	1	2	3	4	5
2. Remote technologies adopted in our team are able to negotiate for interruption time.	1	2	3	4	5
3. Remote technologies adopted in our team are able to show user availability for interruption.	1	2	3	4	5
4. Remote technologies adopted in our team help us to be more "present" in interaction.	1	2	3	4	5
5. Remote technologies adopted in our team help to filter unnecessary interruptions.	1	2	3	4	5

V. Interruption Management	disagree		neutral		agree
1. Interruptions of high priority are usually handled first.	1	2	3	4	5
2. Interruptions more urgent than ongoing tasks are usually fixed immediately.	1	2	3	4	5
3. Interruptions more important than ongoing tasks are usually fixed immediately.	1	2	3	4	5
4. Positive interruptions are usually properly fixed.	1	2	3	4	5

5. Negative interruptions are regulated.	1	2	3	4	5
6. Interruptions with high priority are usually fixed timely and properly.	1	2	3	4	5
7. Interruptions with low priority are seldom received during high mental load period.	1	2	3	4	5
8. Overall, I think our team has good interruption management.	1	2	3	4	5

VI. Collaboration Effectiveness	disagree		neutral		agree
1. I think our remote work is completed on time.	1	2	3	4	5
2. I think our remote work is completed within budget.	1	2	3	4	5
3. I think the remote collaboration of our team is of high quality.	1	2	3	4	5
4. I think my collaboration and interaction with teammates is efficient.	1	2	3	4	5
5. I think our team is able to resolve conflicts.	1	2	3	4	5
6. I'm satisfied about the being a member in the team.	1	2	3	4	5
7. Overall, I think collaboration of our team has good performance.	1	2	3	4	5

VII. For each communication tool listed in the left column, please give your marks regarding your frequency of using this tool in remote communication (1-5 frequency from low to high: 1-seldom, 5-very frequent), and please indicate whether you agree that these tools are useful and easy to use (1-disagree, 2-slightly disagree, 3-nuetral, 4-slightly agree, 5-slightly disagree).

	Frequency of use					Perceived usefulness					Perceived Ease of use				
Phone/mobile	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
E-mail	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Web/video conference	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Instant messaging (msn, skype, etc.)	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

Information sharing center	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Intelligent systems (please specify)	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

VIII. General Information (please tick the appropriate one or indicate with a different color)

1. Business type of your organization

	1 Manufacturing oriented		2 Branding oriented
	3 Marketing / Merchandising		4 Research & development
	5 Integrated		6 Innovation oriented

2. Your role in the remote team

	1 Team leader		2 Team member
	3 Advisor/Supporter		

3. Your knowledge expertise

	1 Managerial		2 Professional / Technical
	3 Sales / Marketing		4 Manufacturing/Production
	5 Clerical / Office		6 Others (please specify______)

4. Your education level

	1 High diploma or others		2 Bachelor
	3 Master		4 Doctoral

5. Gender

	1. Male		2. Female

Thank you very much for your participation, wish you all the best!

Appendix C: Questionnaire for Stage-one Survey (Chinese Version)

THE Hong Kong

POLYTECHNIC UNIVERSITY

香港理工大學

INSTITUTE OF TEXTILES & CLOTHING
紡 織 及 製 衣 學 系

关于远程团队沟通协作的调研

首先衷心感谢您百忙之中抽空参与此次调研, 您的意见对我们来说弥足珍贵!

请问您在工作中是否需要与他人进行远程沟通(即双方在不同地方,无法面对面交流,需要远程沟通工具，如电话、Email 等的辅助才能进行沟通) (请在合适选项前的框内打√)?

	是
	否 (此次调研结束，谢谢您)

此份问卷的问题均是针对您在远程沟通工作过程中的经验提问，请将您工作中或者项目中经常进行远程沟通的人员视为一个团队。

问题中涉及的"外部打扰"(interruption)是指远程团队成员在没有预期的情况下，打断队友正在进行的工作，与队友进行远程沟通，如交流问题，请求帮助等。

保密性

所有资料只作科学研究用途，调查资料将会保密，**研究结果只展现综合数据，不涉及任何个人信息。**研究结果的可信赖度取决于阁下对问题的认真和客观回答，请您填写此问卷时，细心阅读各项问题，**真实地表达您的感受。**您所提供的资料对我们的研究会有很大帮助。

分享调研成果

阁下如希望进一步了解研究结果，或您对此项研究有任何疑问和建议，请通过下列联系方式与本人联系：香港理工大学 方思艳(中国香港电话 00852-5137- ，中国内地电话 0086-137- ，电子邮件 serena.fong@)。

香港理工大学 纺织及制衣学系

答题方法: 请根据您的实际经验,针对每一题的表述圈出最符合的分数: 1—不同意,2—比较不同意,3—中立, 4—比较同意, 5—同意。

一 团队成员间相互了解度	不同意		中立		同意
1. 我能了解远程队友是否方便受到外部打扰。	1	2	3	4	5
2. 我能了解远程队友较为希望收到怎样的外部打扰。	1	2	3	4	5
3. 对于团队整体进度状况，我有较清楚的认识。	1	2	3	4	5
4. 我感到我们整个团队是相通的。	1	2	3	4	5
5. 对于远程项目的外部环境，我有较清楚的认识。	1	2	3	4	5

二 团队作业的相互关联度	不同意		中立		同意
1. 团队成员需要紧密配合来完成工作。	1	2	3	4	5
2. 团队成员间需要经常相互协调。	1	2	3	4	5
3. 团队中个人处理任务的方式会对其他人有较大的影响。	1	2	3	4	5

三 薪酬管理体系	不同意		中立		同意
1. 我的薪酬分配主要基于团队业绩。	1	2	3	4	5
2. 我的薪酬分配很大程度取决于我对整个团队的贡献。	1	2	3	4	5
3. 我们团队的薪酬管理体系可以有效激励个人在处理外部打扰的时候多考虑整体利益。	1	2	3	4	5
4. 我们团队的薪酬管理体系可以激励个人业绩。	1	2	3	4	5
5. 我的薪酬分配主要取决于职位。	1	2	3	4	5

四 远程沟通工具	不同意		中立		同意
1. 我们使用的远程工具能帮助减少带来负面影响的外部打扰。	1	2	3	4	5
2. 我们使用的远程工具能帮助协调时间以便更好地处理外部打扰。	1	2	3	4	5
3. 我们使用的远程工具能帮助我了解队友是否方便接受外部打扰。	1	2	3	4	5
4. 我们使用的远程工具能使远程沟通更像面对面的沟通。	1	2	3	4	5
5. 我们使用的远程工具能帮助过滤掉不必要的外部打扰。	1	2	3	4	5

五 对外部打扰的管理	不同意		中立		同意
1. 我们处理外部管理是按照优先级排序的。	1	2	3	4	5
2. 对于比手头的任务更加紧急的外部打扰，我们会立即处理。	1	2	3	4	5
3. 对于比手头的任务更加重要的外部打扰，我们会立即处理。	1	2	3	4	5
4. 对于有利于目前工作的外部打扰，我们要保证及时适当地处理。	1	2	3	4	5
5. 对于不利于目前工作的外部打扰，我们可以暂时搁置或拦截。	1	2	3	4	5
6. 对于优先级很高的外部打扰，我们要保证及时适当地处理。	1	2	3	4	5
7. 当我们在处理极需集中精力的工作时，一般很少收到优先级较低的外部打扰。	1	2	3	4	5
8. 总体来说，我们团队的外部打扰管理的质量较高。	1	2	3	4	5

六 团队协作绩效	不同意		中立		同意
1. 我觉得我们团队的远程协作通常很守时。	1	2	3	4	5
2. 我觉得我们团队的远程协作的支出通常不超预算。	1	2	3	4	5

3. 我觉得我们团队的远程协作质量较高。	1	2	3	4	5
4. 我觉得我与队友的远程协作和互动有较高效率。	1	2	3	4	5
5. 我觉得我们团队可以妥善解决内部分歧。	1	2	3	4	5
6. 身为此团队的一员我感到很满意。	1	2	3	4	5
7. 总体而言,我觉得我们的团队协作有较好的表现。	1	2	3	4	5

七 请针对左侧所列出的每种沟通工具，对其使用频率和在远程团队沟通合作中的有效性和易用性进行打分（1-很低，2-较低，3-中立，4-较高，5-很高）。

	使用频率					有效性					易用性				
1. 电话/手机	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
2. 电子邮件	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
3. 网络/视频会议	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
4. 即时通讯（如 msn,qq)	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
5. 信息共享中心	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
6. 其他智能远程协作系统（请问您使用的是____）	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

八 个人信息(请圈出最适合的一项)

1. 您所在企业的业务类型

(1)制造主导 (2)品牌主导 (3)营销/贸易主导

(4)研发 (5) 综合型 (6)创新主导

2. 您在远程团队中的角色

(1)团队领导　(2)团队成员　(3)外部支持/指导

3. 您的专业领域

(1)管理/沟通　(2)研发/技术　(3)销售/营销

(4)生产制造　(5)行政　(6)其他 (请注明 __________)

4. 您的学历

(1) 专科，职业技术类及其他　(2)大学本科　(3)硕士　(4)博士

5. 性别

(1) 男　(2) 女

再次衷心感谢您的参与和支持, 祝您事业顺利!

Appendix D: Questionnaire for Mass Industry Survey (English Version)

THE Hong Kong

POLYTECHNIC UNIVERSITY

香港理工大學

INSTITUTE OF TEXTILES & CLOTHING

紡織及製衣學系

Survey on Remote Team Communication

Thank you very much for participating in this survey and provide us with invaluable opinions.

1. Are you involved in any kind of remote communication during work (remote communication refers to the communication among people who locate in different place and need the aid of communication tools such as phones, E-mails)?

	Yes
	No (this survey stops here, thank you for your time)

2. **This survey targets at your experience in interaction through electronic means as a member in a remote team, please take the people with whom you often interact and collaborate remotely at work as a remote team.**

3. **"Interruption" in a remote team refers to the events that generated by a team member to initiate interaction with other member(s) and breaks the continuity of his/her (their) ongoing job.**

CONFIDENTIALITY ASSURED

I assure absolute confidentiality for those who complete this survey. All responses of the completed surveys will not be documented for any other purposes and the identity respondents will not be disclosed without the respondents' permissions.

SURVEY RESULTS SHARING

Results of this survey will be summarized in a final report upon completion of the research study. This report will then be shared with interested respondents who participate in the process upon request in order to promote an effective team communication. If you have any questions or suggestions about this survey, please contact Ms Siyan Fang at telephone number (00852)-5137- (Hong Kong) / E-mail: serena.fong@ .

Institute of Textiles & Clothing

The Hong Kong Polytechnic University

Direction: please give out your mark regarding each statement based on your experience (1—strongly disagree, 2—slightly disagree, 3—neutral, 4—slightly agree, 5—strongly agree).

I. Intra-team Awareness	disagree		neutral		agree
1. I am aware of my virtual teammates' availability for interruptions.	1	2	3	4	5
2. I am aware of my virtual teammates' priority for interruptions.	1	2	3	4	5
3. I am aware of the project progress of my collaboration work.	1	2	3	4	5
4. I am aware of the external environment of my virtual collaboration work.	1	2	3	4	5

II. Task Design	disagree		neutral		agree
1. Team members work closely with each other in doing their work.	1	2	3	4	5
2. Team members frequently must coordinate their efforts with each other.	1	2	3	4	5
3. The way individual members perform their jobs has a significant impact upon others in the team.	1	2	3	4	5

III. Motivating and Governance System	disagree		neutral		agree
1. My rewards depend primarily on how the entire team is doing.	1	2	3	4	5
2. My reward is strongly influenced by my contribution as a team member.	1	2	3	4	5
3. The motivating and governance system in my team encourages me to consider more about the whole team in treating interruptions.	1	2	3	4	5

IV. Remote Communication Tool	disagree		neutral		agree
1. Remote technologies adopted in our team are able to help decrease negative interruptions.	1	2	3	4	5
2. Remote technologies adopted in our team are able to negotiate for interruption time.	1	2	3	4	5
3. Remote technologies adopted in our team are able to show user availability for interruption.	1	2	3	4	5
4. Remote technologies adopted in our team help to filter unnecessary interruptions.	1	2	3	4	5

V. Interruption Management	disagree		neutral		agree
1. Interruptions of high priority are usually handled first.	1	2	3	4	5
2. Interruptions more urgent than ongoing tasks are usually fixed immediately.	1	2	3	4	5
3. Interruptions more important than ongoing tasks are usually fixed immediately.	1	2	3	4	5
4. Interruptions with high priority are usually fixed timely and properly.	1	2	3	4	5
5. Interruptions with low priority are seldom received during high mental load period.	1	2	3	4	5

VI. Collaboration Effectiveness	disagree		neutral		agree
1. I think the remote collaboration of our team is of high quality.	1	2	3	4	5
2. I think my collaboration and interaction with teammates is efficient.	1	2	3	4	5
3. I think our team is able to resolve conflicts.	1	2	3	4	5
4. I’m satisfied about the being a member in the team.	1	2	3	4	5
5. Overall, I think collaboration of our team has good performance.	1	2	3	4	5

VII. For each communication tool listed in the left column, please give your marks regarding your frequency of using this tool in remote communication (1-5 frequency from low to high: 1-seldom, 5-very frequent), and please indicate whether you agree that these tools are useful and easy to use (1-disagree, 2-slightly disagree, 3-nuetral, 4-slightly agree, 5-slightly disagree).

	Frequency of use					Perceived usefulness					Perceived Ease of use				
Phone/mobile	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
E-mail/groupware	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Web/video conferencing	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Instant messaging (msn, skype, etc.)	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Information sharing center	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Intelligent systems (please specify_)	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

VIII. General Information (please tick the appropriate one or indicate with a different color)

1. Business type of your organization

	1 Manufacturing oriented		2 Branding oriented
	3 Marketing / Merchandising		4 Research & development
	5 Integrated		6 Innovation oriented

2. Type of your remote team

	1 Management		2 R&D
	3 Action (perform specific jobs such as marketing, survey, manufacturing, etc.)		4 Service

	5 Consulting		6 Project

3. Team size (approximate total number of members in your team)

	1~5		6~10		11~20
	20~50		Above 50		

4. Your role in the remote team

	1 Team leader		2 Team member		3 Advisor/Supporter

5. How long have you been working as a **remote team member**

	0~6 months		7~12 months		1 ~2 years
	2 ~3 years		3~5 years		More than 5 years

6. Your knowledge expertise

	1 Managerial		2 Professional / Technical
	3 Sales / Marketing		4 Manufacturing/Production
	5 Clerical / Office		6 Others (please specify______)

7. The proportion of remote work in your daily work?

	<1/3		1/3~1/2		/2~2/3		>2/3

8. Gender

	3. Male		4. Female

Thank you very much for your participation, wish you all the best!

Appendix E: Questionnaire for Mass Industry Survey (Chinese Version)

THE Hong Kong POLYTECHNIC UNIVERSITY
香港理工大學

INSTITUTE OF TEXTILES & CLOTHING
紡織及製衣學系

关于远程团队沟通协作的调研

首先衷心感谢您百忙之中抽空参与此次调研, 您的意见对我们来说弥足珍贵!

请问您在工作中是否需要与他人进行远程沟通(即双方在不同地方,无法面对面交流,需要远程沟通工具，如电话、Email 等的辅助才能进行沟通) (请在合适选项前的框内打√)?

	是
	否 (此次调研结束，谢谢您)

此份问卷的问题均是针对您在远程沟通工作过程中的经验提问，请将您工作中或者项目中经常进行远程沟通的人员视为一个团队。

问题中涉及的”外部打扰”(interruption)是指远程团队成员在没有预期的情况下，打断队友正在进行的工作，与队友进行远程沟通，如交流问题，请求帮助等。

保密性

所有资料只作科学研究用途，调查资料将会保密，**研究结果只展现综合数据，不涉及任何个人信息。**研究结果的可信赖度取决于阁下对问题的认真和客观回答，请您填写此问卷时，细心阅读各项问题，**真实地表达您的感受。**您所提供的资料对我们的研究会有很大帮助。

分享调研成果

阁下如希望进一步了解研究结果，或您对此项研究有任何疑问和建议，请通过下列联系方式与本人联系：香港理工大学 方思艳(中国香港电话 00852-5137-   ，中国内地电话 0086-137-   ，电子邮件 serena.fong@   )。

香港理工大学 纺织及制衣学系

答题方法: 请根据您的实际经验,针对每一题的表述圈出最符合的分数: 1—不同意,2—比较不同意,3—中立, 4—比较同意, 5—同意。

一 团队成员间相互了解度	不同意		中立		同意
1. 我能了解远程队友是否方便受到外部打扰。	1	2	3	4	5
2. 我能了解远程队友较为希望收到怎样的外部打扰。	1	2	3	4	5
3. 对于团队整体进度状况，我有较清楚的认识。	1	2	3	4	5
4. 对于远程项目的外部环境，我有较清楚的认识。	1	2	3	4	5

二 团队作业的相互关联度	不同意		中立		同意
1. 团队成员需要紧密配合来完成工作。	1	2	3	4	5
2. 团队成员间需要经常相互协调。	1	2	3	4	5
3. 团队中个人处理任务的方式会对其他人有较大的影响。	1	2	3	4	5

三 薪酬管理体系	不同意		中立		同意
1. 我的薪酬分配主要基于团队业绩。	1	2	3	4	5
2. 我的薪酬分配很大程度取决于我对整个团队的贡献。	1	2	3	4	5
3. 我们团队的薪酬管理体系可以有效激励个人在处理外部打扰的时候多考虑整体利益。	1	2	3	4	5

四 远程沟通工具	不同意		中立		同意
1. 我们使用的远程工具能帮助减少带来负面影响的外部打扰。	1	2	3	4	5
2. 我们使用的远程工具能帮助协调时间以便更好地处理外部打扰。	1	2	3	4	5
3. 我们使用的远程工具能帮助我了解队友是否方便接受外部打扰。	1	2	3	4	5
4. 我们使用的远程工具能帮助过滤掉不必要的外部打扰。	1	2	3	4	5

五 对外部打扰的管理	不同意		中立		同意
1. 我们处理外部管理是按照优先级排序的。	1	2	3	4	5
2. 对于比手头的任务更加紧急的外部打扰，我们会立即处理。	1	2	3	4	5
3. 对于比手头的任务更加重要的外部打扰，我们会立即处理。	1	2	3	4	5
4. 对于优先级很高的外部打扰，我们要保证及时适当地处理。	1	2	3	4	5
5. 当我们在处理极需集中精力的工作时，一般很少收到优先级较低的外部打扰。	1	2	3	4	5

六 团队协作绩效	不同意		中立		同意
1. 我觉得我们团队的远程协作质量较高。	1	2	3	4	5
2. 我觉得我与队友的远程协作和互动有较高效率。	1	2	3	4	5
3. 我觉得我们团队可以妥善解决内部分析。	1	2	3	4	5
4. 身为此团队的一员我感到很满意。	1	2	3	4	5
5. 总体而言,我觉得我们的团队协作有较好的表现。	1	2	3	4	5

七 请针对左侧所列出的每种沟通工具，对其使用频率和在远程团队沟通合作中的有效性和易用性进行打分（1-很低，2-较低，3-中立，4-较高，5-很高）。

	使用频率					**有效性**					**易用性**				
1. 电话/手机	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
2. 电子邮件	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
3. 网络/视频会议	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
4. 即时通讯 (如msn,qq)	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
5. 信息共享中心	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
6. 其他智能远程协作系统（请问您使用的是___）	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

八 个人信息(请圈出最适合的一项)

1. 您所在企业的业务类型

(1)制造主导 (2)品牌主导 (3)营销/贸易主导

(4)研发 (5) 综合型 (6)创新主导

2. 您所在远程团队的类型

管理（统筹规划，制定策略）

研发（包括产品开发，研究，创新等）

实施（实施某项具体工作，包括营销，销售，客户调查，生产制造等）

服务（包括售前售后服务，技术支持维护等）

咨询（提供咨询服务，帮助解决问题）

项目（为某项目专门成立的团队）

3. 您在远程团队中的角色

(1)团队领导 (2)团队成员 (3)外部支持/指导

4. 您有多久远程沟通的工作经验

(1) 0~6 个月 (2) 7~12 个月 (3) 1 年~2 年

(4) 2 年~3 年 (5) 3 年~5 年 (6) 5 年以上

5. 团队成员大致数量

(1) 1~5 (2) 6~10 (3)11~20 (4)20~50 (5)50 以上

6. 您的专业领域

(1)管理/沟通 (2)研发/技术 (3)销售/营销

(4)生产制造 (5)行政 (6)其他 (请注明 __________)

7. 您在平时的工作中大约花多少时间在远程工作上

(1) <1/3 (2) 1/3~1/2 (3) 1/2~2/3 (4) >2/3

8. 性别

(1) 男 (2) 女

再次衷心感谢您的参与和支持, 祝您事业顺利！

REFERENCES

Ackerman, M. S. (2000). The intellectual challenge of CSCW: The gap between social requirements and technical feasibility. *Human-Computer Interaction, 15*(2), 179-203.

Acosta, E. A., & Selker, T. (2007). *Mediating disruption in human-computer interaction from implicit metrics of attention.* Doctoral Dissertation, Massachusetts Institute of Technology Cambridge, MA, USA.

Adamczyk, P., & Bailey, B. (2004). If not now, when?: the effects of interruption at different moments within task execution. In: *Proceedings of the SIGCHI conference on Human factors in computing systems,* New York, 271-278.

Adamczyk, P. D., & Bailey, B. P. (2005). A method and system for intelligent interruption management. In: *Proceedings of Human Factors in Computing Systems: CHI'04*, New York, 271-278.

Agarwal, N., & Singh, P. (1998). Organisational rewards for a changing workplace: an examination of theory and practice. *International Journal of Technology Management, 16*(1), 225-238

Algesheimer, R., Dholakia, U. M., & Gurău, C. (2011). Virtual team performance in a highly competitive environment. *Group & Organization Management, 36*(2), 161-190.

Ancona, D. G., & Caldwell, D. F. (1992). Bridging the Boundary: External Activity and Performance in Organizational Teams, *Administrative Science Quarterly, 37*(4), 634-665.

Andres, H. P. (2011). Shared Mental Model Development During Technology-Mediated Collaboration. *International Journal of e-Collaboration (IJeC), 7*(3), 14-30.

Armstrong, J. S., & Overton, T. S. (1977). Estimating nonresponse bias in mail surveys. *Journal of Marketing Research*, *14*(3), 396-402.

Bailey, B., & Konstan, J. (2006). On the need for attention-aware systems: Measuring effects of interruption on task performance, error rate, and affective state. *Computers in Human Behavior, 22*(4), 685-708.

Bailey, B. P., & Iqbal, S. T. (2008). Understanding changes in mental workload during execution of goal-directed tasks and its application for interruption management. *ACM Transactions on Computer-Human Interaction (TOCHI), 14*(4), article No. 21, NY, USA.

Bailey, B. P., Konstan, J. A., & Carlis, J. V. (2000). Measuring the effects of interruptions on task performance in the user interface. In: *Proceeding of Systems, Man, and Cybernetics, IEEE International Conference, vol.2,* 757 – 762.

Bailey, B. P., Konstan, J. A., & Carlis, J. V. (2001). The effects of interruptions on task performance, annoyance, and anxiety in the user interface. In: *Proceedings of IFIP*

TC.13 International Conference on Human-Computer Interaction, IOS Press, Amsterdam, 593–601.

Baker, G. (2004). The effects of synchronous collaborative technologies on decision making: A study of virtual teams. *Advanced Topics in Information Resources Management (IRMJ), 15*(4), 79-93.

Bal, J., & Foster, P. (2000). Managing the virtual team and controlling effectiveness. *International Journal of Production Research, 38*(17), 4019-4032.

Bamberger, P. A., & Levi, R. (2009). Team-based reward allocation structures and the helping behaviors of outcome-interdependent team members. *Journal of Managerial Psychology, 24*(4), 300-327.

Basoglu, K. A., Fuller, M. A., & Valacich, J. S. (2012). Enhancement of recall within technology-mediated teams through the use of online visual artifacts. *ACM Transactions on Management Information Systems (TMIS), 3*(1), article No. 2, NY, USA.

Baumgartner, H., & Homburg, C. (1996). Applications of structural equation modeling in marketing and consumer research: a review. *International Journal of Research in Marketing, 13*(2), 139-161.

Bearden, W. O., Money, R. B., & Nevins, J. L. (2006). A measure of long-term orientation: Development and validation. *Journal of the Academy of Marketing Science, 34*(3), 456-467.

Bélanger, F., & Allport, C. D. (2008). Collaborative technologies in knowledge telework: an exploratory study. *Information Systems Journal, 18*(1), 101-121.

Bentler, P., & Chou, C. (1987). Practical issues in structural modeling. *Sociological methods and research, 16*(1), 78-117.

Berry, G. R. (2011). Enhancing Effectiveness on Virtual Teams. *Journal of Business Communication, 48*(2), 186-206.

Bettenhausen, K., & Murnighan, J. (1985). The emergence of norms in competitive decision-making groups. *Administrative Science Quarterly, 30*(3), 350-372.

Bjørn, P., & Ngwenyama, O. (2009). Virtual team collaboration: building shared meaning, resolving breakdowns and creating translucence. *Information Systems Journal, 19*(3), 227-253.

Bollen, K. A. (1998). *Structural Equation Models.* Wiley Online Library. DOI: 10.1002/0470011815.b2a13089.

Boudreau, M. C., Gefen, D., & Straub, D. W. (2001). Validation in information systems research: A state-of-the-art assessment. *MIS Quarterly*, *25*(1), 1-16.

Brislin, R. W. (1970). Back-translation for cross-cultural research. *Journal of cross-cultural psychology, 1*(3), 185-216.

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In: K. A. Bollen & J. S. Long (Eds.), *Testing structural equation models*. Newbury Park, CA: Sage, 136-162.

Burmistrov, I., & Leonova, A. (2003). Do interrupted users work faster or slower? The microanalysis of computerized text editing task. *Human-computer interaction: theory and practice (Part I). Mahwah, New Jersey: Lawrence Erlbaum Associates*, 621-625.

Campion, M., Medsker, G., & Higgs, A. (1993). Relations between work group characteristics and effectiveness: Implications for designing effective work groups. *Personnel Psychology, 46*(4), 823-823.

Campion, M. A., Palmer, D. K., & Campion, J. E. (1997). A review of structure in the selection interview. *Personnel Psychology, 50*(3), 655-702.

Cannon-Bowers, J. A., Salas, E. C., & Sharolyn, C. (1993). Shared mental models in expert team decision making. In: N. John, Jr. Castellan, (ed.), *Individual and group decision making: Current issues*. Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc., 221-246.

Card, S. K., Moran, T. P., & Newell, A. (1983). *The psychology of human-computer interaction*, Erlbaum, Hillsdale, NJ.

Cheng, E. W. L. (2001). SEM being more effective than multiple regression in parsimonious model testing for management development research. *Journal of Management Development, 20*(7), 650-667.

Churchill Jr, G. (1979). A paradigm for developing better measures of marketing constructs. *Journal of Marketing Research, 16*(1), 64-73.

Cohen, S. (1994). Designing effective self-managing work teams. *Advances in interdisciplinary studies of work teams, 1*, 67-102.

Cohen, S., & Bailey, D. (1997). What makes teams work: Group effectiveness research from the shop floor to the executive suite. *Journal of Management, 23*(3), 239-290.

Crabtree, A., Rodden, T., & Benford, S. (2005). Moving with the times: IT research and the boundaries of CSCW. *Computer Supported Cooperative Work (CSCW), 14*(3), 217-251.

Cutrell, E., Czerwinski, M., & Horvitz, E. (2001). Notification, disruption, and memory: Effects of messaging interruptions on memory and performance. In *Proceedings of INTERACT 2001*. IFIP. Conference on Human-Computer Interaction, Tokyo, Japan, 263-269.

Czerwinski, M., Cutrell, E., & Horvitz, E. (2000). Instant messaging and interruption: Influence of task type on performance. In: *Proceedings of OZCHI 2000*, 356-361.

Dabbish, L., & Kraut, R. (2004). Controlling interruptions: awareness displays and social motivation for coordination. In: *Proceeding of the 2004 ACM conference on Computer supported cooperative work,* 182-191.

Dabbish, L., & Kraut, R. (2008). Awareness displays and social motivation for coordinating communication. *Information Systems Research, 19*(2), 221-238.

Daft, R. L., & Lengel, R. H. (1984). Information richness: A new approach to managerial information processing and organization design. *Research in Organizational Behavior, 6*, 191-233.

Daft, R. L., & Lengel, R. H. (1986). Organizational information requirements, media richness and structural design. *Management Science*, *32*(5), 554-571.

Dekel, U., & Ross, S. (2004). A Plug-In Based Framework for Research on Interruption Management in Distributed Software Development. In: *Proceedings of the 2004 OOPSLA Workshop on Eclipse Tchnology Exchange.*

DeMatteo, J. S., Eby, L. T., & Sundstrom, E. (1998). Team-based rewards: current empirical evidence and directions for future research. *Research in Organizational Behavior, 20*, 141-183.

DeSanctis, G., & Poole, M. S. (1994). Capturing the complexity in advanced technology use: Adaptive structuration theory. *Organization Science*, *5*(2), 121-147.

DeVellis, R. (1991). *Scale development: theory and applications.* Newbury Park, CA: Sage.

Ding, D. X., Hu, P. J. H., & Sheng, O. R. L. (2011). e-SELFQUAL: A scale for measuring online self-service quality. *Journal of Business Research, 64*(5), 508-515.

Dourish, P., & Bellotti, V. (1992). Awareness and coordination in shared workspaces. In: *Proceedings of the 1992 ACM Conference on Computer-Supported Cooperative Work,* 107-114.

Dubrovsky, V. J., Kiesler, S., & Sethna, B. N. (1991). The equalization phenomenon: Status effects in computer-mediated and face-to-face decision-making groups. *Human-Computer Interaction, 6*(2), 119-146.

Erickson, T., & Kellogg, W. A. (2000). Social translucence: an approach to designing systems that support social processes. In: *ACM transactions on computer-human interaction (TOCHI), 7*(1), 59-83.

Escriba-Moreno, M. A., & Canet-Giner, M. T. (2006). The combined use of quality management programs and work teams: A comparative analysis of its impact in the organizational structure. *Team Performance Management, 12*(5/6), 162-181.

Falk, R. F., & Miller, N. B. (1992). *A Primer for Soft Modeling*. Akron, OH, US: University of Akron Press.

Feldman, D. C. (1984). The development and enforcement of group norms. *The Academy of Management Review, 9*(1), 47-53.

Feldman, S. P. (1989). The broken wheel: the inseparability of autonomy and control in innovation within organizations. *Journal of Management Studies, 26*(2), 83-102.

Field, A. (2005). Exploratory factor analysis. In: *Discovering Statistics Using SPSS* 2nd edition. London: Sage Publications, 619-680.

Flynn, B. B., Sakakibara, S., Schroeder, R. G., Bates, K. A., & Flynn, E. J. (1990). Empirical research methods in operations management. *Journal of Operations Management, 9*(2), 250-284.

Fogarty, J., Hudson, S. E., Atkeson, C. G., Avrahami, D., Forlizzi, J., Kiesler, S., Lee, J. C., & Yang, J. (2005). Predicting human interruptibility with sensors. *ACM Transactions on Computer-Human Interaction (TOCHI), 12*(1), 119-146.

Fry, L., & Slocum Jr, J. (1984). Technology, structure, and workgroup effectiveness: A test of a contingency model. *Academy of Management Journal, 27*(2), 221-246.

Fulk, J., Schmitz, J., & Steinfield, C. W. (1990). A social influence model of technology use. In: J. Fulk & C. W. Steinfield (Eds.), *Organizations and Communication Technology.* Newbury Park, CA: Sage, 117-140.

Gallupe, R. B., Dennis, A. R., Cooper, W. H., Valacich, J. S., Bastianutti, L. M., & Nunamaker, J. F. (1992). Electronic brainstorming and group size. *The Academy of Management Journal, 35*(2), 350-369.

Garrett, R. K., & Danziger, J. N. (2007). IM= Interruption management? Instant messaging and disruption in the workplace. *Journal of Computer-Mediated Communication, 13*(1), 23-42.

Gefen, D., & Straub, D. (2005). A practical guide to actorial validity using pls-graph: Tutorial and annotated example. *Communications of the Association for Information Systems, 16*, 91-109.

Gillie, T., & Broadbent, D. (1989). What makes interruptions disruptive? A study of length, similarity, and complexity. *Psychological Research, 50*(4), 243-250.

Gladstein, D. (1984). Groups in context: A model of task group effectiveness. *Administrative Science Quarterly, 29*(4), 499-517.

González, V. M., & Mark, G. (2004). Constant, constant, multi-tasking craziness: managing multiple working spheres. In: *Proceedings of the SIGCHI conference on Human factors in computing systems,* 113-120.

Graetz, K. A., Boyle, E. S., Kimble, C. E., Thompson, P., & Garloch, J. L. (1998). Information sharing in face-to-face, teleconferencing, and electronic chat groups. *Small Group Research, 29*(6), 714-743.

Grandhi, S., & Jones, Q. (2010). Technology-mediated interruption management. *International Journal of Human-Computer Studies, 68*(5), 288-306.

Gunawardena, C. N. (1995). Social presence theory and implications for interaction and collaborative learning in computer conferences. *International journal of educational telecommunications, 1*(2/3), 147-166.

Gundlach, M., Zivnuska, S., & Stoner, J. (2006). Understanding the relationship between individualism–collectivism and team performance through an integration of social identity theory and the social relations model. *Human Relations, 59*(12), 1603-1632.

Gutwin, C., & Greenberg, S. (2004). The importance of awareness for team cognition in distributed collaboration. In: E. Salas & S. M. Fiore (Ed.), *Team Cognition: Understanding the Factors that Drive Process and Performance*. Washington: APA Press, 177-201.

Hackman, J. (1987). The design of work teams. In: R.T. Golembiewski (Ed.), *Handbook of organizational behavior*. New York: Marcel Dekker, 315- 342.

Hackman, J. R. (1990). *Groups that work (and those that don't): Creating conditions for effective teamwork.* San Francisco: Jossey-Bass.

Hair, J. F., Anderson, R. E., & Tatham, R. L. (1987). Multivariate data analysis with readings. New York: Macmillan.

Harr, R., & Kaptelinin, V. (2007). Unpacking the social dimension of external interruptions. In: *Proceedings of The 2007 International ACM Conference on Supporting Group Work*, NY, USA, 399-408.

Hauptman, O. (1986). Influence of task type on the relation between communicationa nd performance: The case of software development. *R&D Management, 16*(2), 127-139.

Haynes, S. N., Richard, D., & Kubany, E. S. (1995). Content validity in psychological assessment: A functional approach to concepts and methods. *Psychological Assessment, 7*(3), 238.

Hertel, G., Geister, S., & Konradt, U. (2005). Managing virtual teams: A review of current empirical research. *Human Resource Management Review, 15*(1), 69-95.

Hertel, G., Konradt, U., & Orlikowski, B. (2004). Managing distance by interdependence: Goal setting, task interdependence, and team-based rewards in virtual teams. *European Journal of Work and Organizational Psychology, 13*(1), 1-28.

Hiltz, S. R., Johnson, K., & Turoff, M. (1986). Experiments in Group Decision Making Communication Process and Outcome in Face to Face Versus Computerized Conferences. *Human Communication Research, 13*(2), 225-252.

Hinkin, T. R. (1995). A review of scale development practices in the study of organizations. *Journal of Management, 21*(5), 967-988.

Honeywell, J. A., Dickinson, A. M., & Poling, A. (1997). Individual Performance as a Function of Individual and Group Play Contingencies. *Psychological Record, 47*, 261-274.

Horvitz, E., Apacible, J., & Subramani, M. (2005). Balancing awareness and interruption: Investigation of notification deferral policies. *User Modeling, 3538*, 433-437.

Hox, J. J., & Bechger, T. M. (1998). An introduction to structural equation modeling. *Family Science Review, 11*, 354-373.

Hudson, J. M., Christensen, J., Kellogg, W. A., & Erickson, T. (2002). I'd be overwhelmed, but it's just one more thing to do: Availability and interruption in research management. In: *Proceedings of the SIGCHI conference on Human factors in computing systems: Changing our world, changing ourselves*, 97-104.

Iqbal, S. T., & Bailey, B. P. (2005). Investigating the effectiveness of mental workload as a predictor of opportune moments for interruption. In: *Proceeding of CHI '05 extended abstracts on Human factors in computing system,* 1489-1492.

Iqbal, S. T., & Bailey, B. P. (2006). Leveraging characteristics of task structure to predict the cost of interruption. In: *Proceedings of the SIGCHI conference on Human Factors in computing system,* 741-750.

Jett, Q. R., & George, J. M. (2003). Work interrupted: A closer look at the role of interruptions in organizational life. *Academy of Management Review, 28*(3), 494-509.

Jick, T. D. (1979). Mixing qualitative and quantitative methods: Triangulation in action. *Administrative Science Quarterly, 24*(4), 602-611.

Johnson, D. W., & Johnson, R. T. (1989). *Cooperation and competition: Theory and research*. Edina, MN, US: Interaction Book Company.

Kaiser, H. F. (1960). The application of electronic computers to factor analysis. *Educational and psychological measurement*, *20*, 241-251.

Kerrin, M., & Oliver, N. (2002). Collective and individual improvement activities: the role of reward systems. *Personnel Review, 31*(3), 320-337.

Kiggundu, M. (1983). Task interdependence and job design: Test of a theory. *Organizational Behavior and Human Performance, 31*(2), 145-172.

Kim, J. O., & Mueller, C. W. (1978). *Factor analysis: Statistical methods and practical issue.* Beverly Hills, CA: Sage Publications.

Kirkman, B. L., Rosen, B., Tesluk, P. E., & Gibson, C. B. (2004). The impact of team empowerment on virtual team performance: The moderating role of face-to-face interaction. *The Academy of Management Journal*, *47*(2), 175-192.

Koehne, B., Shih, P. C., & Olson, J. S. (2012). Remote and alone: coping with being the remote member on the team. In: *Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work,* 1257-126.

Kohn, A. (1993). *Punished by Reward: The Trouble With Gold Stars, Incentive Plans, A's, Praise, and Other Bribes.* Boston, MA, USA: Houghton Mifflin.

Kozlowski, S., & Bell, B. (2003). Work groups and teams in organizations. *Handbook of psychology: Industrial and organizational psychology, 12*, 333-375.

Kurant, M., Markopoulou, A., & Thiran, P. (2011). Towards Unbiased BFS Sampling., *IEEE Journal on Selected Areas in Communications, 29*(9), 1799-1809.

Lawler III, E. E. (1995). *Organizational effectiveness: New realities and challenges.* San Francisco: Jossey-Bass.

Liden, R. C., Wayne, S. J., & Bradway, L. K. (1997). Task interdependence as a moderator of the relation between group control and performance. *Human Relations, 50*(2), 169-181.

Liebowitz, J. (2010). Interruption Management: A Review and Implications for IT Professionals. *IT Professional*, *13*(2), 44-48.

Lind, M. R. (1999). The gender impact of temporary virtual work groups. *IEEE Transactions on Professional Communication, 42*(4), 276-285.

Lindell, M. K., & Whitney, D. J. (2001). Accounting for common method variance in cross-sectional research designs. *Journal of applied psychology, 86*(1), 114.

Lipnack, J., & Stamps, J. (2000). *Virtual teams: People working across boundaries with technology*. New York: John Wiley & Sons.

Ljungberg, F. (1999). Exploring CSCW mechanisms to realize constant accessibility without inappropriate interaction. *Scandinavian Journal of Information Systems, 11*(1), 25-50.

MacCallum, R. C., Browne, M. W., & Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods, 1*(2), 130-149.

Mark, G., Gonzalez, V. M., & Harris, J. (2005). No task left behind?: examining the nature of fragmented work. In: *Proceedings of the SIGCHI conference on Human factors in computing systems,* 321-330.

Martin, J. A. (1987). Structural equation modeling: A guide for the perplexed. *Child Development*, *58*(1), 33-37.

Martins, L. L., Gilson, L. L., & Maynard, M. T. (2004). Virtual teams: What do we know and where do we go from here? *Journal of Management, 30*(6), 805-835.

Maynard, M. T., Mathieu, J. E., Rapp, T. L., & Gilson, L. L. (2012). Something (s) old and something (s) new: Modeling drivers of global virtual team effectiveness. *Journal of Organizational Behavior*, *33*(3), 342-365.

McFarlane, D. C. (2002). Comparison of four primary methods for coordinating the interruption of people in human-computer interaction. *Human-Computer Interaction, 17*(1), 63-139.

McFarlane, D. C., & Latorella, K. A. (2002). The scope and importance of human interruption in human-computer interaction design. *Human-Computer Interaction, 17*(1), 1-61.

McLeod, P. L., Baron, R. S., Marti, M. W., & Yoon, K. (1997). The Eyes Have It: Minority Influence in Face-To-Face and Computer-Mediated Group Discussion. *Journal of applied psychology, 82*(5), 706-718.

Miles, M., & Huberman, A. (1984). *Qualitative data analysis: A sourcebook of new methods*. CA, USA: Sage.

Milewski, A. E., & Smith, T. M. (2000). Providing presence cues to telephone users. In: *Proceedings of the 2000 ACM conference on Computer supported cooperative work,* 89-96.

Minassian, S. O., Muller, M. J., & Gruen, D. (2004). Diverse strategies for interruption management in complex office activities. Poster submitted to *CSCW 2004*.

Miyata, Y., & Norman, D. A. (1986). Psychological issues in support of multiple activities. In: D.A. Norman and S.W. Draper (Eds), *User Centered System Design*, Hillsdale, N.J., USA: Lawrence Erlbaum, 265-284.

Mohammed, S., Klimoski, R., & Rentsch, J. (2000). The measurement of team mental models: We have no shared schema. *Organizational Research Methods, 3*(2), 123-165.

Monge, P., & Fulk, J. (1999). Communication technology for global network organizations. In: G.DeSanctis and J.Fulk (Eds), *Shaping organizational form: Communication, connection, and community.* Newbury Park, CA, USA: Sage.

Monk, C. A., Boehm-Davis, D. A., & Trafton, J. G. (2002). The attentional costs of interrupting task performance at various stages. In: *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 46(22), 1824-1828.*

Naik, N., & Kim, D. J. (2010). Virtual Team Success: Towards a Theory of Performance in Virtual Teams. In: *Proceedings of AMCIS 2010*, paper 429.

Neuendorf, K. A. (2002). *The content analysis guidebook*. Thousand Oaks, CA, USA: Sage.

Nickel, J. E., & Oneal, S. (1990). Small-group incentives: Gain sharing in the microcosm. *Compensation & Benefits Review, 22*(2), 22-29.

Nunamaker Jr, J. F., Reinig, B. A., & Briggs, R. O. (2009). Principles for effective virtual teamwork. *Communications of the ACM, 52*(4), 113-117.

Nunnally, J., & Bernstein, I. (1994). Assessment of reliability. *Psychometric Theory,* 2nd Edition. New York, USA: McGraw-Hill.

O'Conaill, B., & Frohlich, D. (1995). Timespace in the workplace: Dealing with interruptions. In: *Proceedings of Conference companion on Human factors in computing systems,* 262-263.

Olson, G. M., & Olson, J. S. (2000). Distance matters. *Human-Computer Interaction, 15*(2), 139-178.

Pearce, J. L., & Gregersen, H. B. (1991). Task interdependence and extrarole behavior: A test of the mediating effects of felt responsibility. *Journal of Applied Psychology, 76*(6), 838.

Perlow, L. A. (1999). The time famine: Toward a sociology of work time. *Administrative Science Quarterly, 44*(1), 57-81.

Peterson, R. A. (1994). A meta-analysis of Cronbach's coefficient alpha. *Journal of Consumer Research*, *21*(2), 381-391.

Podsakoff, P., MacKenzie, S., Lee, J., & Podsakoff, N. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*(5), 879-903.

Podsakoff, P. M., & Organ, D. W. (1986). Self-reports in organizational research: Problems and prospects. *Journal of Management, 12*(4), 531-544.

Postmes, T., Spears, R., & Cihangir, S. (2001). Quality of decision making and group norms. *Journal of Personality and Social Psychology, 80*(6), 918-930.

Potts, L., & Jones, D. (2011). Contextualizing Experiences: Tracing the Relationships Between People and Technologies in the Social Web. *Journal of Business and Technical Communication, 25*(3), 338-358.

Preece, A. D., & Shinghal, R. (1994). Foundation and application of knowledge base verification. *International Journal of Intelligent Systems, 9*(8), 683-701.

Raghuram, S., Garud, R., Wiesenfeld, B., & Gupta, V. (2001). Factors contributing to virtual work adjustment. *Journal of Management, 27*(3), 383-405.

Ren, Y., Kiesler, S., & Fussell, S. R. (2008). Multiple group coordination in complex and dynamic task environments: Interruptions, coping mechanisms, and technology recommendations. *Journal of Management Information Systems, 25*(1), 105-130.

Rico, R., & Cohen, S. G. (2005) Effects of task interdependence and type of communication on performance in virtual teams, *Journal of Managerial Psychology, 20* (3), 261 – 274.

Riopelle, K., Gluesing, J. C., Alcordo, T. C., Baba, M. L., Britt, D., McKether, W., Monplaisir, L., Ratner, H. H., Wagner, K. H. (2003). Context, task and the evolution of technology use in global virtual teams. In: C. B. Gibson & S. G. Cohen (Eds.), *Virtual teams that work: Creating conditions for virtual team effectiveness.* San Francisco: Jossey-Bass, 239–264.

Saavedra, R., Earley, P. C., & Van Dyne, L. (1993). Complex interdependence in task-performing groups. *Journal of Applied Psychology, 78*(1), 61-72.

Segars, A. H. (1997). Assessing the unidimensionality of measurement: A paradigm and illustration within the context of information systems research. *Omega, 25*(1), 107-121.

Segars, A. H., & Grover, V. (1993). Re-examining perceived ease of use and usefulness: A confirmatory factor analysis. *MIS Quarterly*, *17*(4), 517-525.

Sen, S., Geyer, W., Muller, M., Moore, M., Brownholtz, B., Wilcox, E., et al. (2006). FeedMe: a collaborative alert filtering system. In: *Proceedings of the 20th anniversary conference on Computer supported cooperative work,* 89-98.

Shachaf, P. (2008). Cultural diversity and information and communication technology impacts on global virtual teams: An exploratory study. *Information & Management, 45*(2), 131-142.

Shah, R., & Goldstein, S. M. (2006). Use of structural equation modeling in operations management research: Looking back and forward. *Journal of Operations Management, 24*(2), 148-169.

Short, J., Williams, E., & Christie, B. (1976). *The social psychology of telecommunications*. New York: John Wiley.

Siegel, J., Dubrovsky, V., Kiesler, S., & McGuire, T. W. (1986). Group processes in computer-mediated communication. *Organizational behavior and human decision processes, 37*(2), 157-187.

Somech, A., Desivilya, H. S., & Lidogoster, H. (2009). Team conflict management and team effectiveness: The effects of task interdependence and team identification. *Journal of Organizational Behavior, 30*(3), 359-378.

Spector, P. E. (1994). Using self-report questionnaires in OB research: A comment on the use of a controversial method. *Journal of Organizational Behavior, 15*(5), 385-392.

Speier, C., Vessey, I., & Valacich, J. S. (2003). The Effects of Interruptions, Task Complexity, and Information Presentation on Computer-Supported Decision-Making Performance. *Decision Sciences, 34*(4), 771-797.

Spink, A., Cole, C., & Waller, M. (2008). Multitasking behavior. *Annual Review of Information Science and Technology, 42*(1), 93-118.

Spira, J. B. (2005). The high cost of interruptions. *KM World, 14*(8), 1-32.

Sproull, L., & Kiesler, S. (1986). Reducing social context cues: Electronic mail in organizational communications. *Management Science, 32*(11), 1492-1512.

Staples, D. S., Hulland, J. S., & Higgins, C. A. (1998). A Self Efficacy Theory Explanation for the Management of Remote Workers in Virtual Organizations. *Journal of Computer Mediated Communication, 3*(4), 0.

Stevens, J. (1992). *Applied multivariate statistics for social sciences*,. Hillsdale, NJ: Erlbaum.

Suchan, J., & Hayzak, G. (2001). The communication characteristics of virtual teams: A case study. *IEEE Transactions on Professional Communication, 44*(3), 174-186.

Sundstrom, E., & Altman, I. (1989). Physical environments and work-group effectiveness. *Research in organizational behavior, 11*(2), 175-209.

Sundstrom, E., McIntyre, M., Halfhill, T., & Richards, H. (2000). Work Groups: From the Hawthorne Studies to Work Teams of the 1990s and Beyond. *Group Dynamics, 4*(1), 44-67.

Tang, D., & Birnholtz, J. (2010). Sharing awareness information improves interruption timing and social attraction. In: *Proceedings of the 28th of the international conference extended abstracts on Human factors in computing systems,* 3685-3690.

Tang, J. C., & Begole, J. B. (2003). Beyond instant messaging. *Queue, 1*(8), 28-37.

Thompson, J. D. (1967). *Organizations in action: Social science bases of administration.* NY: McGraw-Hill.

Thompson, L. F., & Coovert, M. D. (2002). Stepping Up to the Challenge: A Critical Examination of Face-to-Face and Computer-Mediated Team Decision Making. *Group Dynamics, 6*(1), 52-64.

To, K., Harwood, R., & Zhang, Z. (2002). Managing Innovation Activity Processes: Part I: Strategic Management Views and Mechanisms for Global Fashion Marketplaces. *Journal of the Textile Institute, 93*(3), 36-53.

Townsend, A., DeMarie, S., & Hendrickson, A. (1998). Virtual teams: Technology and the workplace of the future. *The Academy of Management Executive, 12*(3), 17-29.

Valacich, J. S., & Schwenk, C. (1995). Devil's Advocacy and Dialectical Inquiry Effects on Face-to-Face and Computer-Mediated Group Decision Making. *Organizational Behavior and Human Decision Processes, 63*(2), 158-173.

Van de Ven, A. H., Delbecq, A. L., & Koenig, R. (1976). Determinants of coordination modes within organizations. *American Sociological Review, 41*(2), 322-338.

Wageman, R. (1995). Interdependence and group effectiveness. *Administrative Science Quarterly, 40*(1), 145-180.

Wageman, R. (2001). The meaning of interdependence. In: M. E. Turner (Ed.), *Groups at work: Theory and research.* Mahwah, NJ: Lawrence Erlbaum, 197-217.

Walther, J. B. (1992). Interpersonal Effects in Computer-Mediated Interaction A Relational Perspective. *Communication Research, 19*(1), 52-90.

Weisband, S. P., Schneider, S. K., & Connolly, T. (1995). Computer-mediated communication and social information: Status salience and status differences. *Academy of Management Journal*, *38*(4), 1124-1151.

Wiberg, M., & Whittaker, S. (2005). Managing availability: Supporting lightweight negotiations to handle interruptions. *ACM transactions on computer-human interaction (TOCHI), 12*(4), 356-387.

Woods, D. D., Cook, R. I., & Billings, C. E. (1995). The impact of technology on physician cognition and performance. *Journal of Clinical Monitoring and Computing, 11*(1), 5-8.

Zijlstra, F. R. H., Roe, R. A., Leonora, A. B., & Krediet, I. (1999). Temporal factors in mental work: Effects of interrupted activities. *Journal of Occupational and Organizational Psychology, 72*(2), 163-185.