PROBLEMATIZING COLLABORATION CONTEXTS IN INNOVATION MANAGEMENT: AN EMPIRICAL STUDY IN TEXTILE TECHNOLOGY DEVELOPMENT

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KO KA BO KRISTA

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

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CERTIFICATE OF ORIGINALITY

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_______________________________ (Signed)

_______Ko Ka Bo Krista_______ (Name of student)

DEDICATION

This thesis is dedicated to my family.

ABSTRACT

In this thesis, the author attends to the innovation project and collaboration issues among the textile and apparel industries. Innovation is one of the most vexing challenges, but it is vital to the survival and prosperity of modern corporations. Managing innovation involves cross-functional project teams that are geographically dispersed and have to align contingently with one another in highly autonomous structures. An effective collaboration is therefore critical to the support of their interdependent tasks and the accomplishment of definite goals. Yet, the relevant literature devotes scant attention to the relationship between team collaboration effectiveness within innovation contexts, while there are manifest indications of such concerns in today's business environment.

This research study in general aims to explore the contextual antecedents of collaboration in the context of innovation team, and to evaluate how collaboration effectiveness influences innovation project outcomes. In particular, the author endeavors to develop a conceptual model for analyzing and elucidating cross-functional collaboration within the context of innovation project. At the beginning, the author reviews extant literature and state-of-the art collaboration systems, and elucidate dynamic contextual factors among innovation team members. It is concluded that team consensus, organizational contexts and innovation complexities are the contextual antecedents of collaboration among innovation project teams.

Thus, the author correlates the interrelationship among these factors, and proposes a conceptual collaboration model for innovation project teams.

The author adopts both qualitative and quantitative methods to examine the proposed conceptual model in three distinct phrases. Firstly, the author conducts in-depth interviews with team members who work on textiles innovation projects. These industry practitioners' views on collaboration issues are collected and analyzed for conceptualizing the collaboration context. The three contextual antecedents are comprehended significantly in the course of collaboration, and the project performance and effectiveness are much subject to the influence of collaboration antecedents. Secondly, the author observes ethnographically the collaboration issues amongst a group of virtual project teams in a textiles innovation project. The results affirm the proposed conceptual model, and provide insights on the moderating effects of the relationship between innovation projects and the course of collaboration. The findings are followed by an industry survey and further analyzed using inference techniques.

The author collects 267 sets of useful data from the practitioners of textile innovation projects. Multivariate analytic techniques in confirmatory factor analysis (CFA) and structural equation modeling (SEM) are applied to the model and test the empirical results. The results affirm the contextual antecedents in innovation management and their structure associated with collaboration effectiveness amongst innovation project teams.

LIST OF PUBLICATIONS

Referred Journal Papers

- Ko, K. K. B., To, C. K. M., Zhang, Z. M., Ngai, E. W. T. & Chan, T. L. K. (2011). Analytic Collaboration in Virtual Innovation Projects. *Journal of Business Research*, *64*(12), 1327-1334.
- Ko, K. K. B., To, C. K. M., & Zhang, Z. M. (2014). Problematizing Collaboration in Innovation Project Management. (Under draft, to be submitted)

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- Ko, K. K. B., To, C. K. M., & Zhang, Z. M. (2011). Collaboration Concerns in Textile Innovation Projects. In: *The Fiber Society 2011 Spring Conference*, Hong Kong.
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CHAPTER 1

INTRODUCTION

1.1. Background

In today's highly competitive business environment, organizations consider the effectiveness of innovation process as their principal concern for survival. Fundamentally, there are three major prerequisites to cope with the competition in the global marketplaces, which are lower cost, higher quality and timeliness to launch. All prerequisites address the same direction of improving the innovation process. Meanwhile, it is vital to differentiate heterogeneous market segments and to target the most profitable sector. They have to respond quickly to the rapidly changing customers' expectations with better and faster products or services to market than their competitors.

Perhaps, innovation is considered as a process of organizational learning (Krishnan and Christoph, 2005). Conventionally, organizations have different functional departments to be responsible for individual task activities in the innovation process. For instance, customer preferences and market data are firstly collected by the Sales & Marketing department; then information is forwarded to the engineering team for definitions of innovation requirements, evaluation of the respective technical specification and performance, etc; at the mean time, the information needs to be transferred to the Research & Development department to explore the feasibility of future innovation potentials. During the process, each functional team is mainly concerned with its own particular tasks and fails to discern the entire picture of the innovation purposes, process requirements and likely impediments. The flow of such information is often restricted along directions with minimum interactions amongst the functional teams (Bochenek et al., 2001). Thus, the degree of cross-functional cooperation achieved in project teams is critical to the success of innovation, as the process of developing and introducing new technologies and products demands combined knowledge and expertise of multidiscipline functional teams. Therefore, it is foremost important to develop and maintain cooperative and inter-supportive interactions amongst the innovation teams.

In recent years, there has been a substantial increase in the recognized challenges in organizations implementing innovation activities to capture global business opportunities, in which teams' talents are dispersed in various countries in different time zones. These innovation teams in multi-site organizations are tasked for round-the-clock operations. The alliances of these ill-separated teams would pose a series of inter-affecting problems of resources commitment and risk bearing (David and Lloyd, 2001). The advent of worldwide connectivity through the internet and information technologies leads to the breakdown of geographical and time barriers both within and between organizations in their pursuit of business growth (Guillen, 2001).

As such innovation management becomes a system in which virtual teams collaborate with one another in a designated period of time towards particular innovation objectives and goals. Virtual teams are so coined as a group of geographically and organizationally dispersed knowledge workers brought together across time and space by information and communication technologies in response to specific customer needs or to accomplish unique projects (DeSanctis and Poole, 1997; Iacono and Weisband, 1997; Ko et al., 2011; Nguyen, 2013; Lipnack and Stamps, 1997; Jarvenpaa et al., 1998; Townsend et al., 1998; Jarvenpaa and Leidner, 1999).

Succinctly said, a virtual team is a group of co-workers, working interdependently on the same project, which is located over more than a single physical workplace; their substantial interaction and communication are mostly 'co-located' virtually by electronic communication technologies, other than face-to-face meetings at a physical location.

Recent trend demonstrates that virtual innovation management is superseding the traditional management paradigm owing to its substantial contributions towards overhead cost savings, minimized travel expenses, time and budget saved by using collaborative internet tools. It also provides the possibility in compressing the corresponding project schedules and creating a "virtual workplace" to bring dispersed talents together (Boughzala et al., 2012; Cynthia, 1997; Lipnack and Stamps, 1997; Nguyen, 2013). Yet, innovation management still faces a lot of challenges in virtual environment. Besides the existing problems that traditional innovation management encompasses in knowledge acquisitions and sharing, balance between autonomy and control, etc, certain studies find that there are three particular issues confronting virtual innovation management, which are inter-team interaction and communication (McGrath and Hollinshead, 1994; Warkentin et al., 1997; Hightower and Sayeed, 1995, 1996), task coordination (Jarvenpaa and Leidner, 1999; Ko et al., 2011) and cultural differences (Kimble et al., 2000).

To overcome the challenges, scholars have devoted substantial efforts to investigate communication issues and difficulties among virtual team members under time, place and culture constraints (McGrath and Hollinshead, 1994; Mesly et al., 2014; Warkentin et al., 1997; Hightower and Sayeed, 1995, 1996; Kimble et al., 2000). It is an on-going challenge at the management level because of the complexity in team composition and dispersed business tasks. It is essential for organizations to assure that the principles of project management, which had always been relied on, could be modified and applied to this new organizational form.

This research study aims to present systematic depiction and discussions on the fundamentals of virtual cross-functional innovation project team and identify how these compositions of elements add value and lead to successful project outcomes. The outcomes of this research provide insights to both researchers and industry practitioners in better understanding the development of necessary skills for effective project collaboration under which the differences in virtual cross-functional teams can be overcome.

1.2. Scope of the Research Problems

In short, virtual teams are widely implemented by organizations nowadays for the execution of innovation projects; however the collaborative relationships, performance management and accountability of these project teams are still great issue of concern.

There is still inadequate research documenting the innovation project management within virtual contexts and the essence of team collaboration towards project performance. As a matter of fact, how virtual team managers can improve the chance of success in managing innovation projects is not a type of step-by-step problem solving tasks. Teams committed to innovation should tackle loads of indiscernible difficulties and uncertainty during the course of team interaction and communications. Therefore, it is important for innovation managers to understand how issues of collaboration can be handled under a virtual environment, as the innovation operations and progress are very dynamic, unable to be treated as in conventional organization environment.

This research looked at the issues of collaboration in the innovation projects, both from perspectives of management of technological innovation and virtual team. Therefore the author placed the primary research focus on the human aspects and interaction processes involved in collaborative innovation. The technological and engineering aspects of innovation development such as building systems or defining innovation specification would not be much concerned and elaborated.

In order to acquire a better understanding on the collaboration issues of process innovation projects, in-depth interviews with industry practitioners were carried out. The author also documented a case study of an industry innovation project, which concerned an advanced technology systems integration in a leading textile corporation.

1.3. Objectives of this thesis

Based on the key problems identified in the previous section and the inspirations from the industrial practitioners, this research study aims to elucidate the composition and importance of collaboration in nowadays virtual innovation environment. It thus sheds the light on the antecedents and consequence of effective project collaboration innovation practices.

Objectives of this research study are summarized as below:

a. To study the fundamental issues of virtual teams collaboration in the context of textiles-related innovation projects

b. To provide understanding of the role of collaboration process in virtual project team success from the perspective of project members

c. To explore the impact of virtual team antecedents on the development of project collaboration

d. To investigate the impact of virtual teams' collaboration of innovation projects on the project success

e. To evaluate the team members' usage responses in collaboration tools and to determine the tools characteristics that influence their perceived task effectiveness

f. To propose possible solutions for improving project success and enhancing the team effectiveness

A theoretic model of project collaboration is proposed to explain the relationships among collaborative antecedents, collaboration processes and project output within the context of virtual innovation projects.

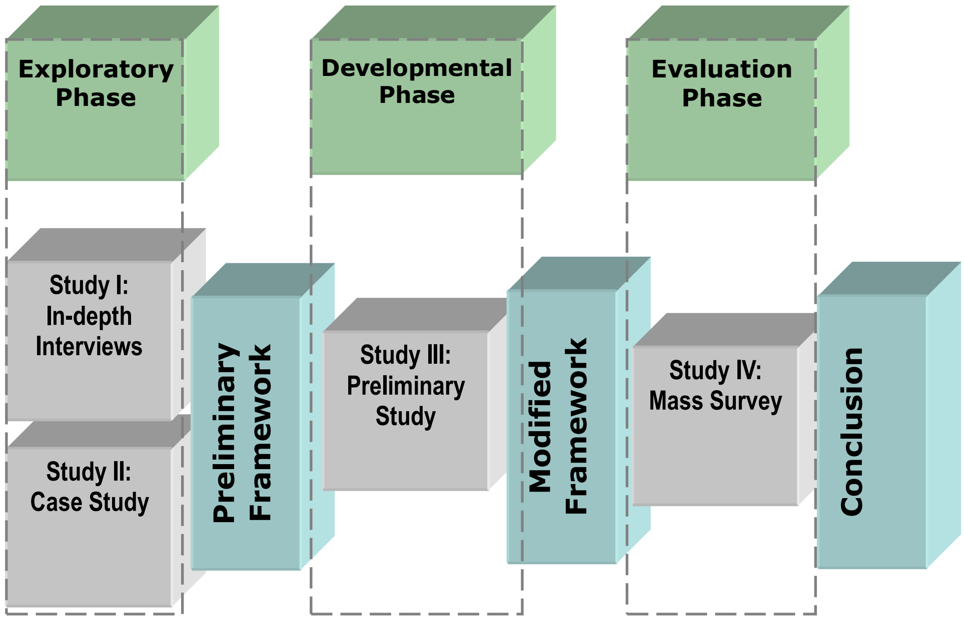
1.4. Research Approach

To answer the research questions, a model of collaborative constructs in the virtual innovation project environment is proposed and examined. This study was conducted in three phases: a) an exploratory phase, b) a developmental phase, and c) an evaluative phase (See figure 1.1).

In the exploratory phrase, in-depth interviews (Study I) were conducted with 15 virtual project team members who worked on textiles innovation projects, in an attempt to document team members' views and perceptual experiences on the collaboration issues occurred during the project periods. Data were analyzed to form a preliminary list of key elements for the establishment of collaboration constructs.

The secondary research phrase for data collection was an ethnographic observation on a virtual project team working on a textiles-related innovation project (Study II). In response to the requests from industrial practitioners, this helped to determine the key elements for constructing the effectiveness of project collaboration, in order to specify the major difficulties facing by the virtual project teams under an innovation project setting.

Figure 1.1: the Outline of the Research Approach



In the developmental phrase, based on the results from the observations and interviews, a set of comprehensive antecedents of virtual team collaboration on innovation projects were summarized. A preliminary model was then suggested, corresponding with the previous literatures, observations and interviews accordingly. Data for testing the preliminary model were collected through the means of survey in a preliminary study (Study III). The primary source of participants was the virtual project team members of textile processing innovation projects, who were recruited from the tertiary education sector and the textiles industry. The sampled project teams were chosen for two reasons. Firstly, they are expected to be well-established and managed due to the industry background. Secondly, they could provide valuable insights not only for academics but also to the industry practitioners.

In the last evaluative phrase, the preliminary model was modified based on the results of preliminary study. The modified framework containing collaboration constructs and project outputs was then tested for generalization in other sectors. A mass survey was employed and delivered to various project team members with virtual innovation project team experience (Study IV). Participants were recruited based on their working experiences as a virtual team member in innovation projects. The email delivering processes served as a selection procedure to discern their corresponding industry, company background, and innovation history. The responses were grouped and analyzed using statistical inference methods.

1.5. Significance of the study

This study on the collaboration issues of virtual innovation project teams not only serves as an exploration of knowledge in the project management dimension, but also contributes to a new scientific foundation for future application of effective project collaboration.

This study outlines and clarifies the various definitions and views held by different researchers on the collaboration definitions and attempts to present a clear view of multi-dimensional characteristics of project collaboration. By focusing on the interaction among innovation project teams, the research works provide an insight into the dynamics of collaboration under the virtual project setting.

The study also introduces and tests a model for the description of relationship among innovation project teams' contextual elements, project collaboration effectiveness, and project output in a virtual project management setting. Previous models have been used in team performance research but not many have been used to examine the dynamics of project collaboration that exists in the virtual innovation project settings.

From the industrial perspective, organizations, which implement virtual project teams in handling their innovation projects, can benefit from the study; as they can avoid the potential pitfalls in managing innovation teams in virtual organization structures. In this research, the author attempts to offer a more comprehensive understanding on the collaboration issues that are associated with the management of virtual innovation project teams. It thus provides recommendations for managers to improve the overall project performance when managing innovation projects within virtual contexts.

1.6. Organization of Thesis

This thesis is divided into six chapters. Chapter 1 provides a background of the research, presents the aims and objectives of the study. It also delineates the research approach and identifies the significance of the study.

Chapter 2 reviews the current literature on three main concepts employed in the study: traditional and virtual project teams, innovation project management and project success. Included in this review are discussions of the transitions of team structure from traditional form to virtual basis, concepts of innovation project management, collaboration issues related to the virtual innovation project team, and their interrelationships with project success.

Chapter 3 describes an in-depth interview study that aims to obtain textiles-innovation team members' views and working experiences on the collaboration issues occurred during the project periods. This chapter also provides a situation analysis of the research data and develops a framework from an evaluation of the interview data.

Chapter 4 describes the case study that examined the measures of collaborative innovation project management and their relationships with project success. This chapter also suggests the effects of contextual antecedents on the collaboration effectiveness of innovation projects.

Chapter 5 presents a quantitative study and the research methodology used in this study. This chapter also describes the data collection method, the choice of participants, and the data analysis techniques of research data. It goes on to report the results of the measurement model and a structural model is developed. The chapter concludes by discussing the results of the testing of the hypotheses.

Chapter 6 presents and discusses the implications of the current study for future research work and for practice. This chapter also delineates the achieved contributions of the study.

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction

This chapter aims to acquire better understandings on the concept of collaboration among innovation projects, how contextual factors influence the management of collaborative processes and effectiveness.

In this chapter, the author reviews extant literature and state-of-the art collaboration systems, summarizing the corresponding contextual factors, collaborative work processes and effectiveness indicators. The author also elucidates dynamic antecedents among nowadays innovation projects collaboration. In the first section, the author discusses the role of collaboration, which has taken place along the modern management era, how the ever-changing collaboration processes are managed and assisted. The review of extant literature provides us with solid foundation on the collaboration topic. It also deepens our current research in how collaboration can be managed and facilitated among the ever-changing business environment. In the second section, the author first discusses the significant role of virtual innovation project collaboration in today's business environment. Then, the author identifies the list of antecedents that determines collaborative processes and the outcome, and discusses the analytic relationships of these identified factors.

The review begins with Section 2.2, provides an abstract introduction on the collaboration concept. Section 2.2.1 discusses collaboration from the organization science perspective, and reviews its hierarchical based attributes. Section 2.2.2 addresses the characteristics of conventional project teams. It also explores the role and significance of collaboration among conventional project teams given by the altering organizational structure. Section 2.2.3 addresses the characteristics of virtual project teams, and discusses the impact of advanced information technology on virtual team collaboration. This is followed by a discussion on innovation projects in Section 2.3, which discusses various collaboration challenges faced by virtual innovation project teams. An integrated management model for adopting collaboration mechanisms among virtual innovation projects is introduced in section 2.4, which identifies and discusses on key antecedents that influence the management of collaborative context among virtual innovation project teams.

2.2. The Context of Collaboration

Before the investigation on how collaboration has taken place in innovation projects and how it can be managed, it is important to acquire a clear picture on what collaboration is. The exploration of multidisciplinary literatures provides insight into the complex nature of collaboration. Therefore, in this section, the author first discusses the definition of collaboration and looks into different levels of collaboration and its roles among different team structures in abstract.

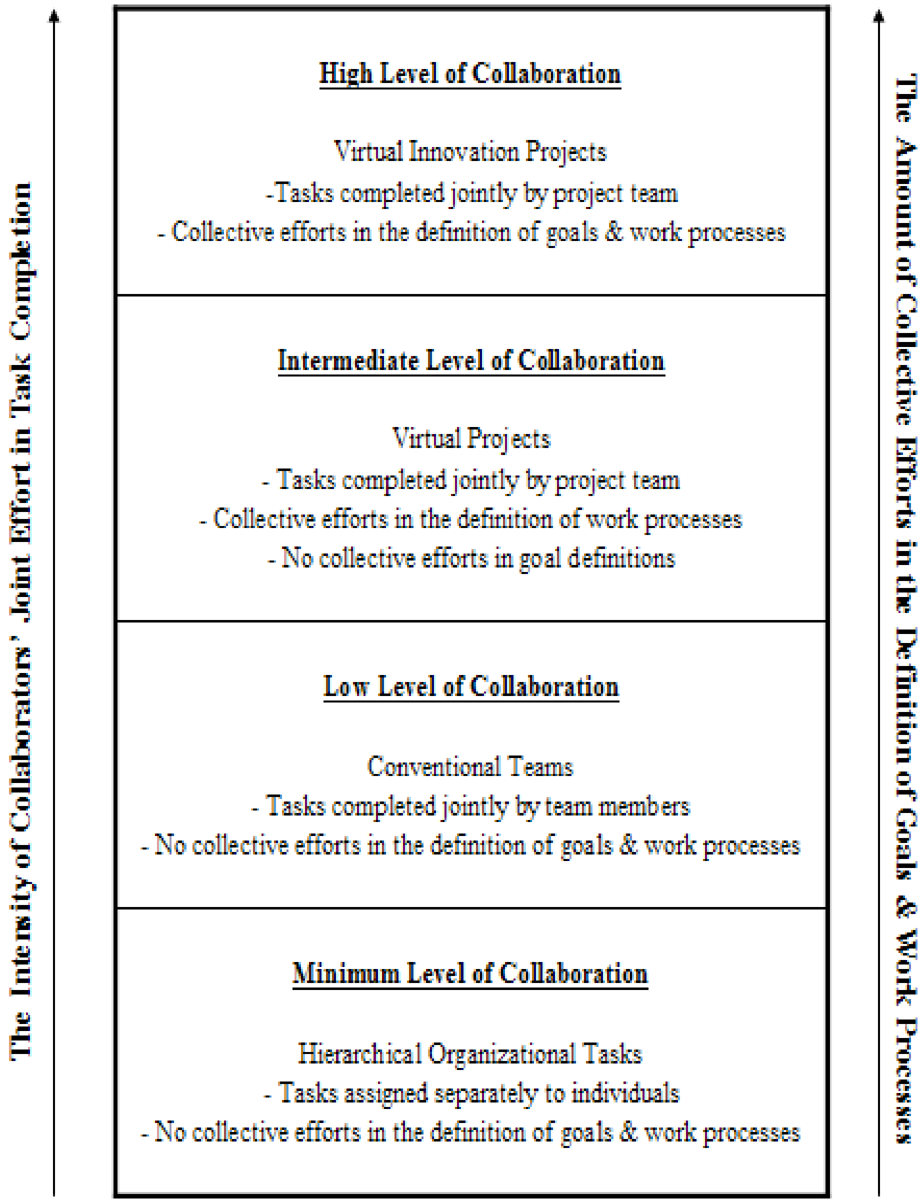
Scholars have provided various definitions for collaboration from the standpoints of different research domains. From the viewpoint of applied behavioral science, Wood and Gray (1991) suggests that collaboration occurs when a group of autonomous stakeholders of a problem domain engage in an interactive process, using shared rules, norms, and structures, to act or decide on issues related to that domain. It is a process-oriented definition which focuses on the interactive course in which a group of independent stakeholders collaborate jointly towards their common interest. From the perspective of management science, Phillips et al. (2000) defines collaboration as a co-operative relationship among organizations that relies on neither market nor hierarchical mechanisms of control. Their description emphasizes the internal procedures and emerging guidelines among institutional-based collaboration. In the social studies field, Himmelman (1996) views the collaboration process as a continuum of strategies that range from bettering the community to transforming it through “empowerment collaboration”. The main focus of such definition is put on the strategies employment processes, which aim at bettering the society as an ultimate outcome.

In the pioneer book *Collaborating: Finding Common Ground for Multiparty Problems*, Gray (1989, p. 5) states an integrative view of collaboration. She defines collaboration as a process “through which parties who see different aspects of a problem can constructively explore their differences and search for solutions that go beyond their own limited vision of what is possible”. Her definition points out the significance of gathering experts from a variety of professions. Experts could provide their skilled knowledge from different point of views; the open discussions thus lead to a solution beyond one’s limit.

In this research study, the author defines collaboration as working processes in which two or more individuals work interdependently by employing a combination of supportive tools to achieve a common goal. Along the series of working activities, messages are gathered and incorporated into new insights as the output. Actors involved may or may not have any previous relationship before conducting the collaborative tasks. Unlike any routine tasks within organizations, collaborative tasks are not hierarchical bounded but mostly creative and innovative in nature. Participants have no clear guidelines on how tasks should be done or how goals can be accomplished. Therefore, during collaboration, participants may go through a series of creative processes for intelligence generation through learning, sharing their knowledge and building up consensus.

Regarding to our definition, collaboration exists when two or more individuals work jointly by using supportive tools to achieve a common goal. Collaboration therefore not only takes place in nowadays virtual-basis project tasks, but also occurs in different ways among other forms of team works. Apart from the number of individuals involved, this study suggests collaboration to be classified according to the intensity of collaborators' joint effort, and the level of collaborators' empowerment in defining the type of work practices and the common goal. First, the intensity of collaborators' joint effort greatly affects the level of task interdependency among them. The higher the level of task interdependency among collaborators, the more complex the collaboration process will be. Second, whether there are collective efforts from collaborators in defining their working processes determines the viability of tasks adjustments. The higher the viability of task adjustments, the more complex the collaboration process will be. At last, whether collaborators are empowered in defining the common goal determines the level of autonomy, which is delegated to them. Based on these three dimensions, the author can thus distinguish collaboration among different types of working arrangement into four levels (See Figure 2.1).

Figure 2.1: the Classification of Collaboration



In hierarchical organizations, subordinates merely follow the instructions given by the manager, and finish tasks assigned to them. Subordinates at the lower hierarchy are neither involved in decision making nor goal setting processes. There is no input from team members in defining the goal and their working practices, as they just do what they are told by the manager. The intensity of joint effort is almost none as subordinates' works are separated from that of others. Managers are responsible for combining all the works done into a final output. Thus, a minimum level of collaboration exists in hierarchical organizations.

In conventional team collaboration, team leaders call for group meetings regularly. Groups of subordinates are then gathered at the same venue to share their views on certain issues or problems. These group discussions provide team members with the chance to acquire better understandings on the problem sources. Team members could solve those problems jointly through brainstorming and decide on the best possible solution. Such collaboration processes are especially important as conventional teams are expected to resolve non-routine problems, which have never been tackled before. Although there is no collective input from conventional team members in defining their common goal and work practices, tasks are completed jointly by them. This kind of work arrangement is therefore differentiated as low level of collaboration.

In the 20th century, the advancement of information technology has introduced a new form of project management known as virtual project management. It is a working arrangement by which group of individuals work across time, space and organizational boundaries using information and communication technologies for a finite period of time towards achieving specific goals. Virtual project management is a common practice in nowadays business landscape, as it allows organizations to save great amounts of expenses and be more compatible with the globalized economy.

Many organizations have identified the significance of team collaboration, especially its value in attaining better working processes among virtual teams. Among virtual teams, decision making becomes a process, which is mainly based on collective basis rather than individual basis. Effective collaboration not only ensures a dynamic flow of knowledge and information sharing, it also equips project managers with better capability to obtain enhanced problem solving strategies. The implementation of proper collaboration supportive tools could further enhance project outcomes and help to save significant costs (DuFrene, 2011; Maruping and Magni, 2014).

Even though there is no collective input from virtual project teams in defining their goals, virtual team members share their responsibilities in shaping their working practices, such as: selecting the combination of collaboration supportive tools and communication patterns (Maruping and Magni, 2014). Tasks are also accomplished by virtual team members on collective basis. This kind of work arrangement is therefore defined as intermediate level of collaboration.

In comparison with other project forms, innovation projects tend to start with loosely defined and vague objectives, the objectives will only become clearer when the project proceeds. Every innovation project team member is therefore responsible for defining the emerging goals throughout the whole project. Moreover, there are neither strict rules nor comprehensible plans for guiding innovation project teams; it is thus a joint responsibility for its team members to design and process with exploratory and experimental work practices among innovation projects.

The internalization of innovation activities is often costly, based on the exchange of information resources under market imperfections (Pisano, 1990). Innovation costs within organizations vary considerably due to the influence of hierarchical structures. It is therefore crucial to take into account the combined options of technological collaborations between organizational hierarchy and market. These combined options are viewed as highly efficient instruments for managing innovations (Ulset, 1996). As a result, enterprises collaborate with each other in order to acquire resources or expertise that they do not possess, or too costly to produce by themselves, while the risks of performing collaboration are not too great. Virtual innovation project team members must contribute their respective knowledge jointly to help in achieving the goal. This kind of creative work arrangement is therefore defined as high level of collaboration.

To conclude, collaboration is an indivisible and significant element among teamwork throughout these decades. Collaboration is defined as a special working arrangement where people work together in a particular way towards a common goal by employing supportive tools. It is a common practice to utilize team collaboration in various business environments. The deployment of an effective collaboration allows its members to exploit the unique strengths of each other, and to generate the most proficient solutions in the fastest time possible. Today, effective team collaboration is still in an imperative role in accomplishing successful innovation projects.

In the following sections, the author explores and discusses how collaboration plays its role in the development of modern management era. By studying different collaboration patterns in detail, the author thus reviews the evolution process of collaboration among organizations, teams and individuals. A thorough understanding of collaboration can help us to deepen our current knowledge in nowadays virtual innovation projects collaboration; it can also provide valuable insights on the potential challenges, which are faced by collaborators all these times.

2.2.1. Perspective of Traditional Hierarchical Collaboration

Traditional organizations often put emphasis on job allocation, division of labor, uniform emergent policies, and management control (Taylor, 1911). These characteristics were applicable during the transformation period of industrial society, which improved work effectiveness and brought desirable outputs. However, the traditional business processes are not as compatible as they were for the enhancement of work effectiveness and outcome in nowadays complex and innovation-based business environment. During the period of industrial economy, the processes of working together in traditional and hierarchical organizations are identified as cooperation. In terms of the extent of interaction, commitment and complexity, cooperation falls at the bottom level of collaboration (Himmelman, 1996).

Cooperation is defined as the process of working or acting together among different actors. In its simplest form, it involves actors working in harmony.

While cooperation also occurs in a more complex context, for example, the inner systems of human beings or the administrative system of a country.

In its simplest form, cooperation involves factors working in harmony, while in its more complicated forms, cooperation can involve systems as complex as the inner workings of a human being or even the social patterns of a nation. It is in the opposite form of working separately in competition. Cooperation can also be accomplished by working with computers, which allows us to handle shared resources simultaneously at the same processing time.

Based on organizational theories, Weber (1978) points out the existence of office hierarchy system in bureaucratic organizations, the importance of stable rules and laws during business operations and the requirement of skills training or job specialization. He states the idea of how implementing bureaucracy provides organizations with accountability, responsibility, control, and consistency. On the other hand, Taylor (1911) analyzes the management patterns of traditional organizations in a scientific point of view. Taylor states that the management attributes of work division, incentive system, scientifically trained workers and efficiency aim to maximize the organizations’ output with limited input. Although the set of behaviors, which traditional hierarchical organizations obtained, helps the management level to facilitate the efficiency along its streamlined workflow, these attributes seems to restrict the level of collaboration among its subordinates.

First, traditional organizations are characterized as centralized, and bureaucratic in structure. There is often an internal composition with several layers of management. These management layers help to control the company by maintaining a high level of authority. The top management level obtains the power to make all the decisions concerning the whole company. And, they would dedicate tasks to the middle level who are responsible for the planning and execution of coordination tasks concerning on the business processes (Danneels, 2008).

Within the centralized organizational structure, lower level employees have very limited job empowerment and authority. They could not make any decisions without prior approval. This organizational structure is known as top-down management, whereby executives at the top communicate with middle managers, who then communicate with first-level managers, who at last tell the technical staff what to do and how to do it. Thus, employees at lower level in the hierarchy do not have the chance to get involved in both decision making and goal setting processes.

Second, traditional organizations are structured levels of hierarchy, and the department boundaries are determined by the similarity of functionality, e.g. engineering, manufacturing, and sales, etc. in a manufacturing company or customer service, accounting, billing, etc. in a service company. The problem created is that work is fragmented in a way that people may not realize the responsibility for being a part of the "whole process". They may overestimate the importance of their own positions and fail to understand the overall benefits of the company or customers they serve.

Poor team work between departments may lead to poor internal and external cooperation, redundancies of effort, delays caused in decision-making and general inefficiency. It is most noticeable when a piece of work is completed and “thrown over the wall” to another department. An urgent decision may directly impact a customer to be delayed for a couple of days because it requires signatures from more than one department head. If a decision could take so long to be made, a company would certainly suffer from its internal inefficiency, unhappy clients, as well as losing market shares and profits.

Third, division of labor is also widely employed in traditional hierarchical organizations, especially in the mass production of goods. Each employee has a specialized and narrowly defined job allocation. And, the job training provided for them focuses on strengthening their technical skills. The evaluation of their performance is standardized, as there is only one best way to complete the task. Therefore, they just have to carry out and repeat the work activities, which they have been assigned. For example, in the textiles manufacturing division, subordinates on the assembly line just have to follow instructions given by their group leader and to complete tasks, which are assigned to their workstations. In such arrangement, subordinates’ works are separated from others’ and managers are responsible for combining all the work done into a final output.

Last but not least, human governance of traditional hierarchical organizations is based on uniform and strictly enforced rules. All business procedures are managed strictly according to the book. The overall task outcomes, especially those at the production floor, are motivation driven. The incentive system designed for employees is either in monetary form or in terms of promotion opportunities, in which monetary terms are more welcomed by the lower level subordinates. Thus, the system is based on individual performance, which leads to its employees concentrating on their own efficiency but not the quality of the final output.

The above discussion on organization theories therefore suggests the various attributes of traditional hierarchical organizations, such as: division of labor, limited job empowerment and strictly enforced rules, to be the main reason of its minimum level of collaboration. The role of management level is especially important among the cooperation of traditional hierarchical organizations, as it acts as a link between decision makers and frontline employees.

2.2.2. Perspective of Conventional Project Teams Collaboration

The prevalence of mass produced goods has increased since the industrial revolution in favor of mass production procedures and for economies of scales. The advancement of industrial technology induced the mass production of virtually identical goods, and the production cost for each unit also decreased. As a result, organizations could reallocate their resources more effectively. In the view of resources allocation, most of the organizations would first consider ways which allow them to streamline the internal working arrangements for improving the overall task efficiency.

In order to gain an edge on their competitors in the chaotic global economy, it is necessary for top management level to look for ways to improve the overall profits and work effectiveness. Thus, many organizations would consider transforming the traditional hierarchical structure into a modern and effective working arrangement, which employs project management. Particularly, project management often plays a critical role in the growth of an organization. However, cooperation does not encourage the exchange of information and ideas within traditional organizations, which impede the transformation. Therefore, in order to facilitate the exchange of ideas among involved participants, communication becomes a key element throughout the entire process of conventional project management.

Communication is defined as a two way process among participants, who exchange information and ideas in order to reach mutual understanding. In its simplest form, it is a means of connecting people or actors, which happens in our daily lives. While communication has an important role in business context, an organization cannot operate properly without communication among subordinates, departments and management levels.

In conventional team collaboration, there are often meetings held among team members for the enhancement of information exchange. These meetings can facilitate both formal and informal forms of communications. In the view of formal communication, team members can contribute by expressing their views and professional knowledge on the discussed issues. These group discussions not only provide its members with the chance to acquire better understandings on the problem sources, but they could also solve those problems jointly by coming up with the best possible solution. From the viewpoint of informal communication, team members can also build up personal relationships and team rapport through chatting casually when they are off meetings or in other informal occasions.

Apart from the communication processes, coordination of project tasks is another critical activity among conventional project teams. As project works are entirely different from routine works in traditional organizations, it is crucial for project managers to manage diverse tasks in a flexible manner but yet with clearly defined work schedules. With the support of both effective communication and coordination processes, project teams have greater possibilities to reach for effective and desirable project outcomes.

The project goal of conventional project team is dedicated from the top management level; the team is therefore responsible for project implementation in order to deliver the desirable output to the top. The work procedures are also determined by project managers but not team members. Although there is no collective input from conventional project team members in defining their common goal and work practices, tasks are jointly completed by them. The above discussion on conventional project management thus suggests that the attributes of such work arrangement contributes to a low level of collaboration.

2.2.3. Perspective of Virtual Teams Collaboration

In this section, the author reviews characteristics of team formation and its differences between traditional and virtual team work situations.

According to Sundstrom et al. (1990, p. 120), a team is defined as "an interdependent collection of individuals who work together towards a common goal and who share responsibility for specific outcomes of their organizations".

Moreover, Katzenbach and Smith (1993, p.44) also introduce one of the most commonly cited definitions of a team, as follows:

> "A team is a small group of individuals with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable."

Both definitions are in line with the structure of project teams investigated in this research study. Project teams are in general composed of a small number of individuals from different functional departments, or organizations who have bonded together to solve a common problem or achieve the same goal through collaboration.

The main attribute that differentiates project team from other kind of groups should be “the common goal” or “the common purpose” mentioned in the above definitions. Individuals are carefully selected and grouped as a team based on their specific skills. They thus combine their efforts to tackle a “common” problem, or to achieve the “common” project goal. In order to reach the “common” purpose, these individuals often work towards a “common” direction assigned by the project manager.

Another aspect that separates project teams from other work groups should be the term “collaboration”, which is mentioned above. Some organizations might have work groups, which regard themselves as teams; however, their work is mainly done by a combination of individual contributions. Project teams should have accomplished their common goals through carrying out a series of collaborative activities in a collective effort (Ko et al., 2011).

In addition to the above definitions of a team, the author is going to discuss the attributes of traditional project teams as in the following. In the past, it is costly to manage project teams with cross-national members around the globe. As there were limited choices of tools for communication and coordination, team members had to travel across countries for group discussions and task executions. These travelling times and expenses thus became a considerable cost factor for project teams and organizations respectively. In order to manage and lessen the overall project costs, project managers are more likely to recruit team members who are located nearby or at the same office building. Therefore, traditional project team members are generally collocated at the same working environment. Ever since the project initiation meeting has been held, its team members could introduce themselves to each other, and start building up their social relationships. The project team therefore constructs a preliminary pattern for its future interaction and communication activities.

As mentioned above, traditional project teams usually recruit its members from the same geographical location. Such recruitment criteria help to reduce the possible negative effects resulting from the time zones variance. In order to regulate and confine team members' working attitudes and habits, organizations might impose certain guidelines or rules correspondingly. As in the same time zone area, it will be more effective for project team members to cooperate under one particular set of working schedules. Based on the above physical and time considerations, it is not surprising that traditional project team members often locate closely to each other, and share a similar set of working behaviors. Therefore, it is less complicated to call for a meeting among these team members, even though they are actually dispersed in various functional departments of a company.

In fact, traditional project team individuals have a number of opportunities to conduct direct observations on other team members. To be specific, there are two main occasions that consent to such purpose, which are formal meetings and informal social gatherings. Firstly, there are two types of formal meetings; one is scheduled with agenda and another one is unforeseen with imperative issues to settle. Many organizations regard scheduled meetings as a regular internal activity. Therefore, project team members acquire sufficient time to perform better preparations on their viewpoints and emotional stands. On the other hand, there are volatile meetings, which are unexpected but crucial to the handling of emergency issues. Project team members thus have to come up with immediate solutions for solving the emergency problems.

The dissimilar natures of various formal meetings allow traditional project team members to attain diverse assortment of team interacting observations (Chidambaram, 1996). Refer to scheduled meetings as an example, team members are grouped in the same conference room at the same time to discuss on topics, which were listed on the agenda. During the meeting progress, project team members could observe each individual's facial gestures, body gestures and verbal expressions (such as: voices, tones and speeds of speech) directly. Through the above observations, individuals might then analyze other project team members' emotions and perspectives.

Secondly, there are a number of informal occasions in which team members can interact casually, such as: (1) meeting on the transportation vehicles to or from the office, (2) meeting in the office corridors, (3) meeting over lunch or dinner in the restaurant, (4) meeting in sport centers or other facilities during leisure time. These informal activities can greatly improve the trust associations and interrelationships between project team members (Purvanova, 2013). Trust relationships thus benefit the project team from effective team cooperation (Jarvenpaa et al., 1998; Purvanova, 2013). In addition, project team members might form social units with those who share common interests with them. Although it might lead to better mutual understandings and trust affiliations within these smaller social circles, they might also create an opposing boundary against members coming from different social units.

Nowadays, the advancement of telecommunications and information technologies provides project teams with more opportunities and convenience to communication with each other at lower cost (Arnison and Miller, 2002). The set of virtual communication tools is a key facilitator for developing and managing virtual project teams. Virtual project teams are formed by individuals who gathered temporarily to accomplish a particular task or purpose. These virtual team members might not be located at the same site but physically mobile or organizational mobile (DuFrene, 2011). Project managers are thus required to devote extra efforts in choosing the proper combination of communication patterns and coordination mechanism for the facilitation of virtual team management.

The team characteristics of virtual project teams induce a number of obstacles in the collaboration processes. Firstly, goal setting in virtual projects is as important as it is among traditional projects. However, it is more challenging for virtual team members to achieve their goals as they are mobile in nature. They may either travel frequently between different time zone areas or travel between different organizations to accomplish multiple tasks (O'Leary et al., 2011). Secondly, comparing with the comprehensive described work schedule of traditional project teams, the actions undertaken by virtual team members are tentative in nature. The work processes are subjected to change regarding the occurrence of any unexpected situation or difficulties. Thirdly, virtual project team members are not necessarily collocated but dispersed in nature, which leads to more difficulties in team management. Thus, more efforts are needed to ensure a proper coordination among virtual project teams. Lastly, it is common to recruit virtual project team members with various working expertise or cultural backgrounds. Therefore, it is important to develop a friendly and harmonious working environment for virtual project team members to maintain the effectiveness of their work processes.

In spite of the traditional measurement of project outputs, Santoro et al. (2006) suggest a new standard for evaluating virtual project success. The suggested evaluation approach is based on the extent of collaboration taken place among virtual project team members. Regarding virtual projects, its concept of collaboration is rooted at the implementation of information technologies enabling tools. Through applying these collaboration supportive tools, team members could be more actively engaged in both communication and coordination processes. However, it is difficult to sustain an effective collaboration among virtual project teams due to the geographical and institutional boundaries. It is therefore indispensable for project managers to design and employ an appropriate set of supportive instruments and mechanisms according to each team’s unique collaboration pattern.

In order to provide a virtual platform to assist team collaboration, a large amount of collaboration supportive tools are provided in online basis (Berry, 2011). These online supportive tools are then deployed to set up as a virtual workplace for its diverse members (colleagues, clients and partners) to collaborate in (Boughzala et al., 2012). The utilization of online supportive tools enables project team members to communicate effectively in virtual manner (Ko et al., 2011). Virtual team members could have discussions with instant feedbacks in chat rooms or through messengers without any geographic concerns. The application of synchronous collaboration tools greatly reduces the corporate travel expenses. Meanwhile, virtual team members could also interpret problems on hand and share their viewpoints asynchronously. The application of asynchronous collaboration tools greatly alters the communication pattern among their operation processes (Klitmøller et al., 2013). For example, it is not necessary for team members to be alert with the time zones or working hours of other team members just for a phone conversation.

Moreover, it is important to sustain an effective team collaboration environment for enhancing the performance of virtual project team (Nguyen, 2013). Comfortable working environments are obliging in encouraging team members to voice out their opinions and listen to each other during the collaboration processes. Team members not only benefit from acquiring better understanding of the problems on hand, but also learn from other individuals' insights. As a result, they will not hesitate to exchange any of their ideas, and be more willing to offer and accept suggestions from teammates to make adjustments and improvements. Therefore, an effective collaboration environment facilitates the exchange of knowledge, as well as encourages the creation of proficient solutions for problem solving.

Unlike conventional project teams, decision making in virtual project teams becomes a critical process, which is carried out in collective basis rather than individual basis (Townsend et al., 1998). Virtual team members do not just follow guidelines delegated from the top, but they can express their viewpoints and make decisions collectively. Therefore, the effectiveness of collaboration processes among virtual project teams is greatly influential to the effectiveness of their decision making processes. An effective collaboration process ensures an active flow of information and opinions between virtual project team members. The sufficient amount of information thus allows virtual project team members to generate more creative ideas and possible solutions for solving various problems on hand. Nevertheless, the implementation of proper collaboration supportive tools could further enhance virtual project outcomes and help organizations to save significant resources and costs.

Virtual project teams are particularly formed in order to accomplish specific tasks and objectives. Therefore, project goals are usually determined by the top management at an earlier stage. Even though there is no collective input from virtual project teams in defining their goals, virtual team members share their responsibilities in determining their definite set of working practices, such as: to select a combination of collaboration supportive tools, to design an appropriate communication patterns and to come up with mutually agreed work schedules. Based on the jointly designed working processes, virtual team members thus carry out tasks in sequence on a collective basis. The above discussion on virtual project teams thus suggests that the attributes of its work arrangement contributes to an intermediate level of collaboration.

2.3. Virtual Innovation Projects Collaboration

In responding to the enormous changes in the global business environment, collaboration becomes a prevailing practice in nowadays project-based business landscape (Klitmøller et al., 2013; Vasconcelos and Ramirez, 2011). The internalization of innovation activities are often costly, based on the exchange of information resources under market imperfections (Pisano, 1990). Innovation costs within organizations also vary due to the influence of hierarchical structures. It is therefore crucial to take into account the combined options of technological collaborations between organizational hierarchy and market. These combined options are viewed as highly efficient instruments for managing innovations (Ulset, 1996). As a result, enterprises collaborate with each other in order to acquire resources or skills that they do not possess, or are too costly to produce by themselves, while the risks of performing collaboration are not too great.

Many companies adopt types of partnership to form alliance in their business operations, and it is as well one of the important strategic tools for new business development (Hoang and Rothaermel, 2005). Regarding to innovation inputs, organizations often seek partners for the provision of resources and capabilities that they lack of or weak at (Gulati, 1995). The effective combination of partners' resources could therefore maximize firm competency and innovation capabilities. Joint innovation projects collaborated between organizations with well-organized networking could enhance the effectiveness of novelty works involved, thus increasing the new product development rate (Vonortas, 1997). Therefore, team collaboration may have an impact on the degree of innovation performance and success.

Despite confrontations aroused in projects conducted within a single institute, managing innovation projects which involved multiple institutions are additionally challenging. The complexity of innovation projects is increased by the characteristics of innovation project teams, such as: quantity of dispersed project members, diversity of expertise and professions, various combinations of virtual collaboration supportive tools and collaboration gaps among different groups of participants (Ko et al., 2011). Such complexity thus leads to additional challenges to be reconciled.

Collaboration is a key aspect in innovation management as it enables intensive technical and social interactions, which are essential to tackle complex innovation problems under a distributed project environment. Collaboration issues may result from the engineering of technical interdependencies, such as product module dependencies and engineering capabilities, or from the challenges of social and organization interdependencies for wide array of functional expertise, task scheduling and communication channels (Wageman et al., 2012). A better understanding of collaboration in the innovation setting will allow for areas of enhancement such as improving working processes, modification of supportive tools and minimized negative outcomes of innovation activities.

Past research on collaboration have either dealt primarily with teams within structures of innovation team units or cross-functional teams working on phases of non-routine collective work tasks. The structural contexts of innovation mainly center on product development projects, which operated across institution borders. Researchers (Forrester, 2000; Gressgard, 2011; Hall and Andriani, 2003; To and Harwood, 2000) often put their focus on the discussions of project contexts and knowledge management among innovation teams. In conventional organizational studies, researchers (Ancona and Caldwell, 1992; Curtis, Krasner, and Iscoe, 1988; Pinto and Pinto, 1990; Wynn and Novick, 1995) paid much attention to team activities and the effectiveness of communication and coordination. In this research study, the author therefore attempts to get a balance between these two structural contexts, and view the analytical coverage of these into a dynamic landscape of virtual innovation project management. The author proposes that an effective management of collaborative antecedents among virtual innovation project teams could help to deliver effective cross-function collaboration processes. As a result, the effective cross-function collaboration thus enhances the virtual innovation team performance and the final project output.

2.4. Integrated Management Model of Virtual Innovation Projects Collaboration

This section introduces a proposed analytic framework, which aims to capture and contextualize the collaboration processes and effectiveness of virtual innovation projects. The constructs and propositions are developed based on an extensive review of related literatures. The constructs and their proposed relationships are described first, followed by the proposed conceptual framework. The proposed conceptual framework demonstrates the research basis and proposes a three-step path analytic model with hypothesized relationships.

In this research study, the author characterizes the cross-functional virtual collaboration processes as in three stages: (1) Input stage of various potential antecedents, (2) Implementation stage of both communication and coordination processes and (3) Output stage as the evaluation of virtual innovation projects. The input stage consists of three main antecedent constructs: (1) adequacy of consensus, (2) organizational contexts and (3) innovation complexities; these constructs intend to elucidate the effects on the attainment of cross-functional collaboration, the preferred alternatives of task systems and the subsequent project outcomes. The implementation stage is the resulting effectiveness of both communication activities and coordination procedures among virtual innovation project team. The output stage serves as a final measurement indicator of the overall virtual innovation projects. The inclusion of both task performance and social-psychological satisfaction provides an overview of virtual innovation teams' accomplishment. Based on extensive literatures, the following sections consist of detailed discussions on the antecedents of cross-functional collaboration, the construct of cross-functional collaboration among virtual innovation projects and the final performance indicator respectively.

2.4.1. Antecedents of Cross-functional Collaboration Effectiveness

A number of contextual factors influence the process and mechanism of collaboration, which affect the virtual innovation team performance correspondingly. These factors are influential to the design of communication and coordination tools for the accomplishment of desirable project outcomes. The author identifies the following constructs as the antecedents of cross-functional collaboration among virtual innovation projects: (1) adequacy of consensus, (2) organizational contexts and (3) innovation work complexities. Details are as follows:

2.4.1.1. Adequacy of Consensus

Researchers (Hall and Andriani, 2003; Mowshowitz, 1997) regard the team involved in an innovation project as a new organizational form, which operates in accordance with the modern process-based organization theory. In this perspective, organization goals are set on collective basis, emphasizing principles of entire team integration, and creating maximum performance in their chained activity tasks. The project team members have to be inter-supportive and ready to reach an understanding on common issues or decisions. The team could therefore realize collaboration through a series of opinion interchange, interests politicking, and underline value consensus of all collaborated parties on types of views, ideas and opinion so that the best possible decision has to be made (Dooley et al., 2000).

According to research on teams consensus and task collaboration (e.g. Huang et al., 2010; Ko et al., 2011; Mathieu, et al., 2000), different levels of consensus may deliver divergent outcomes, including strategic cooperativeness within project teams, group cohesiveness, and teams' ability for reaching consensus in subsequent work tasks. Team collaboration with a high level of consensus acts as an important input for cross-functional innovations and has a significant effect on the task outcome (Huang et al., 2010). Also, the analytical study of mobile telephone operator in Hall and Andriani (2003) highlights the importance of reaching consensus for improving project management. Therefore, to observe and measure the adequacy of consensus is essential for empirically learning their effect on the cross-functional collaboration of virtual innovation teams.

Proposition 1: Better versus worse collaborative systems and communication mechanisms give rise to consensus among well-partitioned functional teams. Complementarily levels of inter-team consensus form a source of knowledge interchange requirements among virtual innovation *project members. Adequate consensus has a positive and significant direct effect on cross-functional collaboration.*

2.4.1.2. Organizational Contexts

Amongst the aspects which help learning organizational collaboration, the development of integrated information and communication technologies, ICTs, is a prominent virtual workplace issue that draws for research attention the most. The concepts involve the processes of disseminating information and knowledge, monitoring the productivity, conducting interdependent work processes and assessing task outcomes. The support of ICTs refers to the organizational support in the availability of IT resources and the extent of such technology sophistication for the execution of innovation projects. The availability of ICTs resources consists of two key elements: technology features designed to support the project team innovation, and the collaboration work pattern allowed by these technology features. Researchers (Aldea et al., 2012; Boughzala et al., 2012; DeSanctis and Poole, 1994; Gressgard, 2011; Poole and DeSanctis, 1990; Venkatesh and Windeler, 2012) suggest that the implementation of different combinations among technology features and collaborative patterns have significant effect on how a group of individuals accomplish a given collaborative task.

Pare and Raymond (1991) refers ICTs sophistication as a joint function of two major factors, which are the level of technological expertise within organizations, and the level of management's understanding and support concerning on ICTs application in achieving innovation objectives. Therefore, an increasing level of ICTs sophistication within an organization might indicate that project team members acquire or disseminate more responsive innovation knowledge in a supportive working environment. Pertaining to types of ICTs support, the author asserts the following proposition:

Proposition 2a: Intensive technology support performs as an enabler of effective collaboration. The technology features combine sorts of communication media, channel platform, integrated knowledge and data structures. Mobile working environments facilitate virtual innovation teams' collaboration more feasibly and responsively. Strong ICTs support likely has a positive and significant direct effect on cross-functional collaboration.

Galbraith and Nathanson (1978), Ljungquist, 2013, Moenaert and Souder (1990), and Pertusa-Ortega et al. (2009) suggest that cautious deployment of rules and procedures could be an effective method for attaining a thriving interdepartmental coordination, especially when the organization is not operating under conditions of relatively certain routine tasks. Without much undesirable restriction of rules and procedures in regulating knowledge and information interchange under organizational hierarchies, teams' interactions become the most important source of creative value for every innovation. An open and dexterous team coordination structure becomes increasingly significant to the success of a virtual innovation project.

In some cases, organizations coordinate their internal and external activities through reinforcing their unique set of rules and procedures. These guidelines help to maintain their organizational structures and constrain the working behaviors of their employees. Therefore, rules and procedures play a significant role in the provision of governance and communication structures, especially for centralized tasks within a single organizational entity. The study of Pertusa-Ortega et al. (2009) also concludes an organizational structure as a critical determinant for effective works coordination and knowledge management.

Further, rules and procedure also refer to the aspects of activities or tasks conducted by the project team that are mandated or controlled. Rules and regulations would fetter both organizations and project teams, by routinizing and standardizing their activities' interactions especially when the teams span across diverse functional boundaries. Forrester (2000) provides empirical evidence in the study of a Japanese automotive firm that adherence to the formal procedures and organization norm limited the teams' working flexibility and restrained the possibility of pursuing ideas and suggestions. As virtual innovation project teams process a series of ill-defined activity tasks, organizational rules and procedure might not be easily discerned, defined and deployed in a contingent and context-specific manner.

Proposition 2b: The implementation of organizational rules and procedure *form a source of impediments against effective collaboration accomplishment in project contexts. Fully compliance of organizational rules and procedure would inhibit the collaboration malleability among multi-organizational project teams. Undesirable organizational rules and procedures impose an interfering and bureaucratic effect on cross-functional collaboration.*

2.4.1.3. Innovation Complexities

Innovation complexities refer to the extent of uncertainty and difficulty that project manager have to handle in a particular innovation context (Ko et al., 2011). From theoretical points of view, innovation complexities are describable in the social, physical, and temporal contextual dimensions. The social dimension might involve both expressed and unexpressed perceptions introduced by the individual's peers, managers or other individuals (e.g., suppliers) towards complex innovation issues. Although organizations act as localities, which bound their employees with a certain set of working behaviors, the project teams also have their own distinguished sets of norms, job routines, and work pattern constituting to distinctive social work contexts (Ancona and Caldwell, 1992). The physical contexts consist of tangible environmental aspects surrounding individuals of the collaborative tasks. Observably, geographical dispersed team members are more aware of the presence technology than teams who are collocated physically together, during the communication and coordination of collaborated work processes.

The constitution of temporal context relates to virtual innovation project members' general understandings on the relationship between time factor and their works. Researchers demonstrate the importance of temporal context from several perspectives. Gersick (1988) examines how differences of inter-teams work paces could affect the product development process; Dougherty (1992) investigates the collaboration process between departments which operated in different time zones; Ancona and Chong (1996) shows how the macro-economic environment shapes the daily rhythms of an organization remarkably and whether the synchronization of work rhythms enable the organizational innovation. Researchers (Cummings and Haas, 2012; Maynard et al., 2012) also examine the association between members' percentage of time allocated to a team and the team performance. Besides, literatures from the product development domain also highlight the timing of new products as a vital criterion of product development performance (Gerwin and Barrowman, 2002). The above discussions on innovation working complexities thus establish the following proposition.

Proposition 3: Complexities of innovation work lay the operating foundations of collaborative project teams, such as, the geographical arrangement, the social behavioral factors and time related working behaviors. Supported by the advanced electronic collaborative system, an appropriate control of innovation complexities can result in a harmonious cooperative working atmosphere among well-partitioned functional teams.

2.4.2. Cross-functional Collaboration

The cross-functional collaboration effectiveness is subject to the extent of how well the cross-functional teams communicate and how smoothly they coordinate their tasks (Wynn and Novick, 1995). Hall and Andriani (2003), and Pinto and Pinto (1990) also show the importance of communication in ensuring both acceptance and effectiveness of innovative working processes across partitioned collaborating parties.

The virtual team structure raises challenges in the communication and coordination effectiveness among cross-functional project teams (DuFrene, 2011). These challenges are rooted in the fact that a substantial amount of cross-functional team tasks disperse geographically or iterate temporally; team members from a single organization might as well work in different regions of the world, and members from different organizations might work together timely for shared interests (To and Harwood, 2000; Ko et al., 2011).

Curtis et al. (1988) indicates that communication and coordination breakdowns are the major hurdles prohibiting project teams from accomplishing their objectives. Therefore, the author examines both communication effectiveness and coordination effectiveness as measuring dimensions of cross-functional collaboration in this research study.

Proposition 4: The total sum of effects resulted from the captioned *antecedents determine the effectiveness of cross-functional collaborative processes, which can be examined by both communication and coordination performance. Cross-functional collaboration acts as a mediating process toward the perceived task performance and socio-psychological satisfaction.*

2.4.3. Outcome of Cross-functional Collaboration

Traditional organizational theory (Pinto and Slevin, 1988) suggests that assessment of implementation outcomes should focus on the task solely. These measurements concern the completion time, budget, and the overall performance, which are tangible and easy to quantify. Researchers (Santos et al., 2014) also investigate the relationship between innovation effort and financial performance. The study of Hackman (1990) and Dalvi and Ebrahimi (2013) further mention the significance of including the intangible dimensions of the work processes into the outcomes evaluation process. Hackman (1990) characterizes the intangible measurements as the socio-psychological outcomes, which are the developed interpersonal network, personal learning and experiences obtained from the novel team activities.

This research study evaluates the implementation outcomes of cross-functional collaboration by considering both team members' socio-psychological satisfaction and tangible perceived task performance. Socio-psychological satisfaction refers to team members' satisfaction level and their learning experiences, regarding the collaboration processes; whereas the tangible task performance refers to the actual implementation of projects, such as: the completion time, the budget, and the final performance, subject to the end-users consumption.

Proposition 5a: The perceived task performance of cross-functional team collaboration performs as indicators for measuring the performance of cross-functional innovation projects. Highly effective cross-functional collaboration has a positive and significant effect on the perceived task performance.

Proposition 5b: The socio-psychological satisfaction of cross-functional team collaboration performs as indicators for measuring the performance of cross-functional innovation projects. Highly effective cross-functional collaboration has a positive and significant effect on the socio-psychological satisfaction.

In spite of investigating whether there are any direct effects of cross-function collaboration effectiveness on both outcomes of cross-functional team collaboration among virtual innovation projects, the author would also like to explore if there are any relationships or reinforcements between both team members' socio-psychological outcomes and tangible perceived task performance.

Proposition 5c: Both outcomes of cross-functional team collaboration interact and strengthen each other as the performance indicator of cross-functional innovation projects. Highly satisfactory perceived task performance has a positive and significant effect on socio-psychological satisfaction of virtual innovation project team members, and vice versa.

2.4.4. Proposed Three-Step Path Analytic Conceptual Model

In a rigorous attempt to generalize the collaboration pre-requisites, infrastructures, impediments, conditions and all contextual influences, the author proposes an analytic framework to capture and contextualize the effectiveness of collaborative innovation under the theoretic rubrics of Actor-network and Absorptive Capacity in strategic organization science (Callon, 1991; Cohen and Levinthal, 1990; Latour, 1992).

Actor-network Theory (ANT) evolves and acts distinctively in social science theories and research studies. In the field of science and technology, ANT recognizes both human actors and nonhuman participants, which act equally in the networks of practices and they are defined relationally as arguments in the network. These definitions lead to a relational epistemology that actors or objects do not exist in themselves prior to any participation in social and semiotic networks of interactions. For instance, this research study proposes that a number of influential factors are indeed affecting the collaboration of virtual innovation project team. As ANT concerns the heterogeneous nature of actors and networks, both the background of virtual innovation projects and all factors should be taken into account.

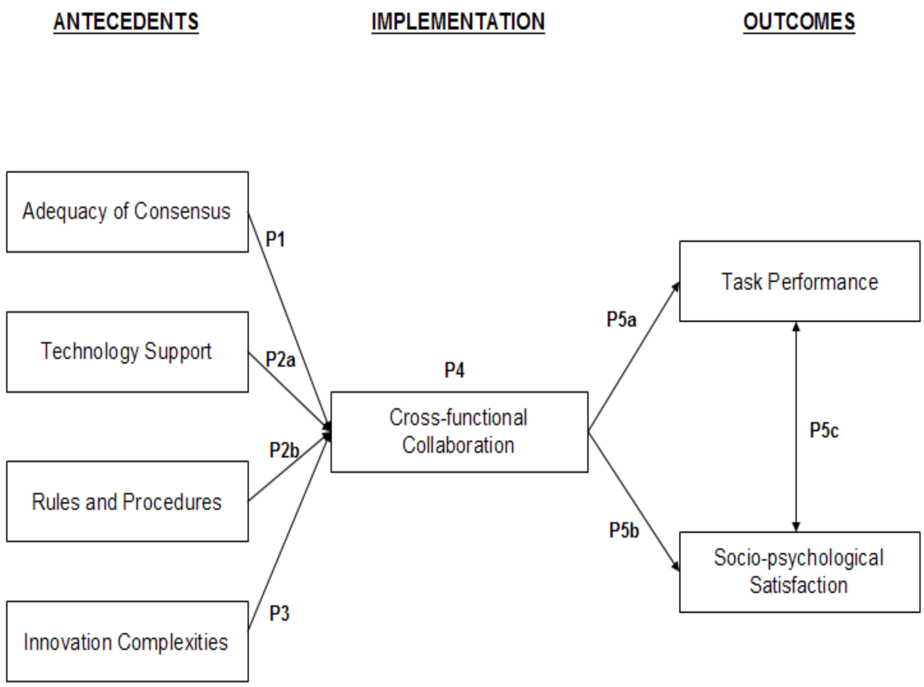
With reference to the theoretic Absorptive Capacity, implementing innovation projects includes a multiplicity of dispersed functional tasks, as the process of developing new products and programs demand combinations of knowledge of multidiscipline functional teams (Cohen and Levinthal, 1990). Geographically dispersed virtual innovation project teams have to avail themselves for efficient communications and knowledge sharing, while maintaining their functional independence and autonomy. Therefore, creating and sustaining a highly cooperative atmosphere and workplace amongst team individuals is important (Adenfelt and Lagerstrom, 2006, 2008; Ko et al., 2011; Snell et al., 1998).

Hence, the author proposes a three-step path analytic model under both theoretic rubrics of Actor-network and Absorptive Capacity. The model is constructed by the propositions which are discussed and extracted from the related literatures. It thus demonstrates the research basis of this study. The author organizes the contextual antecedents into three main groups which are: Adequacy of Consensus, Organizational Contexts (including 'Technology Support' and 'Rules and Procedures') and Innovation Complexities. The author thus suggests that the implementation process of Cross-functional Collaboration represents both communication and coordination work processes among virtual innovation projects. Furthermore, both Task Performance and Socio-psychological Satisfaction are also hypothesized to be of the research interest.

Through the proposed framework, the author aims to study the collaboration process among virtual innovation project teams. This research not only focuses on innovation project teams which are geographically dispersed and collaborate on virtual basis, but also study innovation project teams which have various level of institutional and geographical remoteness and collaborate with the support of virtual ICTs tools.

Therefore, the framework characterizes the cross-functional collaboration processes among virtual innovation projects as in three stages: (1) Input stage of various potential antecedents, (2) Implementation stage of cross-functional collaboration (which includes both communication and coordination processes), and (3) Output stage as the evaluation of virtual innovation projects (See Figure 2.2).

Figure 2.2: the Proposed Three-Step Path Analytic Conceptual Model on Cross-functional Collaboration in Innovation Projects



2.5. Summary

This chapter reviews extant literature and state-of-the-art collaboration systems, and the role of collaboration management in organizations. The chapter introduced collaboration and how the role of collaboration differs from the working processes of routine daily tasks. A definition of collaboration is then explored, followed by discussions on the classifications of various level of collaboration. The author thus elucidates the contextual antecedents among nowadays innovation projects collaboration. It is then followed by a discussion on the proposed analytic relationships of the identified antecedents which influence the management of collaborative processes and the innovation project outcome.

The main focus of this study is to investigate the concept of collaboration processes among virtual innovation projects and identify how these fundamental elements add value and lead to successful project outcomes. The reasons for studying the collaboration issues among virtual innovation projects are as follows. Virtual innovation projects are distinctly different from other kinds of tasks and projects (including hierarchical organizational tasks, conventional projects and virtual projects), which requires being clearly studied and individual research investigation. Moreover, even though virtual innovation projects are widely employed in various industrial sectors, and the collaboration issues among these projects accounts for great importance in terms of effectiveness and project output, most studies have been performed to investigate virtual project teams, innovation issues or collaboration separately. Furthermore, the development of collaboration management is very limited, without well-developed theoretic framework.

In order to demonstrate the relationships of the constructs, the author proposes a three-step path analytic framework for the research purpose. Propositions are also outlined for empirical testing. The three-step path analytic framework includes (1) Input stage of various potential antecedents, (2) Implementation stage of both communication and coordination processes and (3) Output stage as the evaluation of virtual innovation projects (See Figure 2.2). Propositions of the contextual antecedents, their relationships with the collaboration processes and their effects on the project output are proposed based on the extant review of prior literatures.

CHAPTER 3

VIRTUAL COLLABORATION IN TEXTILES INNOVATION PROJECTS: CONTENT ANALYSIS

3.1. Introduction

The literature review in previous chapter provides a preliminary framework for the context of this research. The review includes a discussion of the role and importance of collaboration throughout different stages of the modern management era. It also reveals that there are gaps in the literature concerning the influence of contextual antecedents on the collaboration effectiveness among virtual innovation projects, and how the collaboration processes have their impacts on the final project output. This chapter thus discusses a qualitative approach of the research which was undertaken to address such gap.

This chapter describes the in-depth interviews designed for the exploratory phrase of this research study. Interviews are useful in discovering the underlying issues that might not be shown on statistical data. It also allows the author to gather valuable insights directly from the participants of the research interest. Interviews were conducted with 15 individuals who had experiences of participating in virtual textiles innovation projects. All the interviews were carried out by following a detailed interview guide. Moreover, at the last stage of the interview, pictures of various Information Communication Technologies (ICTs) were shown to the interviewees to stimulate their responses of applying different types of ICTs during the course of virtual innovation projects. Content analysis was used to analyze the social relationships, interaction patterns, participants' concerns and experiences acquired by virtual team members when collaborating in textiles innovation projects.

3.2. Methods

3.2.1. Qualitative approach

As most of the empirical studies on virtual teams are limited to laboratory settings, it is crucial to gather valuable insights from individuals who are actually involved in virtual innovation projects under the real world setting. Nowadays, it is a common practice for organizations to employ projects as a medium to develop innovations jointly. Therefore, to investigate the collaboration processes of virtual innovation projects not only allows us to uncover the underlying contextual factors; it also allows us to determine the collaboration issues, which happened in the real world setting.

In such extent, Textiles industry practitioners also devoted in developing various projects to create innovative products, improve their existing products and increase the effectiveness of their current operations. The author therefore adopts this qualitative research to explore how the textiles industry practitioners collaborate with experts from different professions, and how the complex and vague collaboration processes could be conceptualized into a dynamic and comprehensive picture.

At this exploratory stage, the author employs in-depth interview as the qualitative approach to explore how the practitioners collaborate in textiles innovation projects, how the proposed contextual antecedents affect the collaboration processes and its effectiveness, and to understand the perceived final project outputs in the views of project practitioners. Moreover, the author seeks to obtain practitioners' experiences, thus their personal views on their needs and requirements of ICTs applications during the course of virtual innovation projects.

Content analysis is applied for the examination of industry practitioners' personal experiences and attitudes towards the collaboration contexts during the course of virtual textiles innovation projects. Detailed data of their shared experiences and perceived importance of collaboration processes and ICTs application were categorized as codes, organized and analyzed systematically.

3.2.2. Study Sample

All in-depth interviews were conducted in Hong Kong. The inclusion criteria were as follow: First, participants who have experiences of taking part in textiles virtual innovation projects. Second, participants obtain rich experiences of using Information and Communication Technologies (ICTs) during the project periods. Third, participants acquire rich working experiences in their professional field. These criteria might allow the author to acquire diverse valuable insights on textiles virtual innovation project collaboration from different point of views.

Textiles virtual innovation projects are investigated due to the complex and dynamic nature of its collaboration processes. A pioneering innovation development involves a number of participants who come from various professional backgrounds. Not only does it demand the active involvement of textiles professionals, experts from various professions also play a significant role in sharing their expertise and work experiences. The dissimilar industry practices and the complexity of team compositions therefore lead to more operational and management challenges. Besides, there are lots of possible hurdles during the application of virtual basis collaboration tools throughout the project period.

Based on the principles of qualitative research, the sample size of this exploratory study follows the concept of data saturation (Glaser and Strauss, 1967). The author seeks to carry out sampling to a point at which no new or relevant information shed any further light on the newly constructed framework and redundancy is achieved. Purposive samples are carefully selected based on the aim of this study, which is to understand the perception and experiences among virtual innovation project teams. Researchers (Guest et al., 2006) suggest that twelve qualitative interviews with carefully selected samples are sufficient enough for understanding an issue. Therefore, regarding the complex nature of virtual textiles innovation projects, a sample of 15 good informants who can communicate effectively on their experiences should be reasonably sufficient for understanding the studied phenomenon.

The business scope of the participating 15 organizations covers textiles manufacturing, fashion manufacturing and trading, fashion retailing, branded apparel and apparel merchandising, logistics and education. Among these organizations, some firms carry out integrated activities along their supply chains. And, a number of individuals from various university research teams are invited to take part in this study based on their active involvement in virtual textiles innovation projects. The profiles of organizations and interviewees are shown below in Table 3.1.

The selected participants are involved in textiles innovation projects, which are geographically dispersed. They belong to various organizations and purposely gathered for accomplishing certain project goals. These participants mainly work in offices located in Hong Kong, and are required to make interactions with their geographically dispersed team members.

Furthermore, they are remote in nature and required to travel and work in overseas offices occasionally. Seven out of fifteen participants are research personnel from different research centers in local Universities. Other participants are practitioners from the textiles industries. Such industry distribution allows this study to be applicable to both academic and industry practitioners, as it obtains valuable insights and experiences from diverse parties involved in textiles innovation projects.

Eight out of fifteen interviewees are team members, whereas seven of them are project leaders, advisors or coordinators. And, ten of them are actively involved and performed in multiple textiles innovation projects. Other participants were initially dispersed among varied functional departments of different organizations, but assembled into multidiscipline virtual teams for the implementation of textiles innovation projects.

Referring to the expertise distribution, four out of fifteen participants are engineering experts on the technology development aspect. This group of technical experts is responsible for introducing the innovation concepts, and designing both software and hardware for the implementation of textiles innovation at floor level. Seven participants are responsible for supervising and coordinating the project flow to make sure the textiles innovation projects are within budget and schedule. Other four participants are from various functional departments and were assigned to take part and provide assistance to the corresponding textiles innovation projects. They are responsible for providing industrial information, useful feedbacks and necessary guidance throughout the entire project period.

Eight out of fifteen interviewees are female and seven are male, with a relatively even gender distribution. The working experiences of participants with their corresponding organizations ranged from one and a half years to more than ten years, and the corresponding projects ranged from half year to three years of duration. These participants mainly employ the virtual basis collaboration tools during the project period, thus seldom carry out face-to-face communication.

	Type of Organization	Expertise/ Team Role	Experiences in Participating Innovation Projects	Job Description / Major Responsibilities among Virtual Innovation Projects
1	Textiles Manufacturing Firm	- Project Management Specialist - Project Manager*	12 years	- Identify project opportunities & initiate projects - Manage project timeline and deliverables, and drive for quality excellence for innovation project teams - As Person-in-charge during the collaborative course of innovation projects on behalf of the firm - Recent Project involved: Enhancing the manufacturing process of an oversea plant
2	University	- Technical Development Specialist - Technical Team Leader*	8.5 years	- Provide technical consulting of new innovation projects - Coordinate with senior stakeholders and provide technical guidance to ensure deliverable meeting quality standards and project deadlines - Assign tasks and motivates technical team members on innovations development - Establish effective working relationships with the innovation project team members - Recent Project involved: Consultation project on virtual platform enhancement of an international garment group
3	University	- Project Coordinator*	8 years	- Maintain a detailed project schedule that includes administrative tasks (Including project phases, detailed designs, material procurement, preliminary engineering and review) - Prepare all documents for the progress of the innovation project and budgets - Relay all necessary information between functional teams and the management - Responsible for coordinating all activities and resources in the support of all projects - Recent Project involved: New fabric development project

Table 3.1: the Profile of Interviewees

4	University	- Hardware Engineer - Technical Team Member#	8.5 years	- To lead a small hardware engineering team for electronic product design - Responsible for circuit design including PCB (Printed Circuit Board) layout - Liaise with other functional departments/ external parties for meeting product development timeline - Recent Project involved: Enhancing Resources Management of sportswear manufacturer
5	University	- Software Engineer - Technical Team Member#	8 years	- Develop, implement, evaluate and testing of application software - Technical specification drafting and verification - Carry out system analysis and design based on specified technical requirements - Recent Project involved: Software design for improving the transparency of product flow
6	High-End Fashion Retailer	- Designer - Project Manager*	8 years	- Design and develop high end ladies wear - Responsible for research and analysis of the fashion trend direction - Liaise with buyers and design teammates to develop products - Recent Project involved: Research on new functional fabric that are to be adopted for the next collection styles
7	Supply Chain Management Firm	- Database Administrator - Project Team Member#	6.5 years	- Design and implement enterprise data infrastructure for internal and external use - Perform database backup & restore, application cloning and migration control - Monitor and improve databases status for various projects in the company - Recent Project involved: Improvement of database health status (e.g. Security issue) between the firm and its clients in the textiles industry
8	Garment Manufacturing Company	- Production Manager - Project Team Member*	7 years	- Handle garment manufacturing production in terms of Planning and Management - Responsible for production scheduling, quality management and team building - Utilize resources, improve manufacturing processes, increasing productivity / quality and reducing costs - Recent Project involved: Improvement of garment manufacturing process

9	Multinational Fashion Retailer	- Marketing Manager - Project Team Member*	10 years	- Plan and implement marketing strategy and product launch campaigns across Asia Pacific regions - Coordinate promotion materials and marketing collaterals with creative team - Conduct pre-launch and post-launch analysis - Assist in planning and implement CRM programs and initiatives across Asia Pacific regions - Recent Project involved: Development of a new CRM software
10	University	- Project Advisor* - Textiles R&D	15 years	- Identify project opportunities & initiate projects - Provide professional knowledge and guidance for the development and implementation of innovation projects - Drive for quality excellence for innovation project teams - Recent Project involved: Consultation project on enhancing manufacturing process
11	Fashion Retailing Firm	- Store Manager - Project Team Member#	8 years	- Be responsible for the management of operation and sales of the shop - Identify areas of improvement in daily operation - Motivate sales staffs to employ the enhanced operation systems - Recent Project involved: Testing of new inventory database
12	University	- Project Administrator - Project Coordinator*	6 years	- Co-ordinate with different team member to ensure on-time delivery of project - Handle administrative tasks of multiple projects - Responsible for accounting duties in handling and processing payments, deposits, update and entries to the system, etc. - Liaise with IT team on IT support - Recent Project involved: Research on virtual shopping platform

13	Branded Apparel Firm	- Senior Buyer - Project Team Member#	7 years	- Manage inventory costs, sales forecast, gross profit margin to achieve sales and profit targets - Formulate buying plan in terms of category, size ratio and allocate the merchandise in right location - Analyze merchandise performance to identify bestsellers, potential markdowns products and stock replenishment - Work closely with retail operations, product & design and the marketing department to formulate product mix and marketing strategies - Recent Project involved: Inventory system enhancement project
14	International Trading Firm	- Senior Merchandiser (Fabric) - Project Team Member#	8 years	- Handle innovation projects which require merchandising as well as in-depth technology - Technical discussions with suppliers and factories to be able to choose most suitable product design and production processes for budget control - Follow up project development schedule - Recent Project involved: Fabric development for outerwear
15	University	- Project Executive - Project Team Leader*	6 years	- Lead innovation projects in relation to fiber development - Work with both clients and internal team to gather requirements, create specifications and develop new fiber - To coordinate with production team for effective control on project progress - Recent Project involved: Fiber development for specific purposes

3.2.3. Non-Hierarchical Textiles Innovation Project Team members

Not only geographical dispersion is an important element affecting collaboration processes, the non-hierarchical characteristic of innovation project teams also plays a significant role. The investigation shows that innovation project teams are composed of a number of cross-functional team members and nomadic members from various organizations. It is not surprising that each of them has its own set of work patterns.

Although innovation project members collaborate towards the same project objective, they collaborate differently according to their expertise. Some of them prefer carrying out their project tasks independently, while some of them work with other functional teams interdependently. The collaboration environments of innovation projects are therefore non-hierarchical and extremely dynamic, which greatly influence the capacity of collaborative effort required by innovation project members.

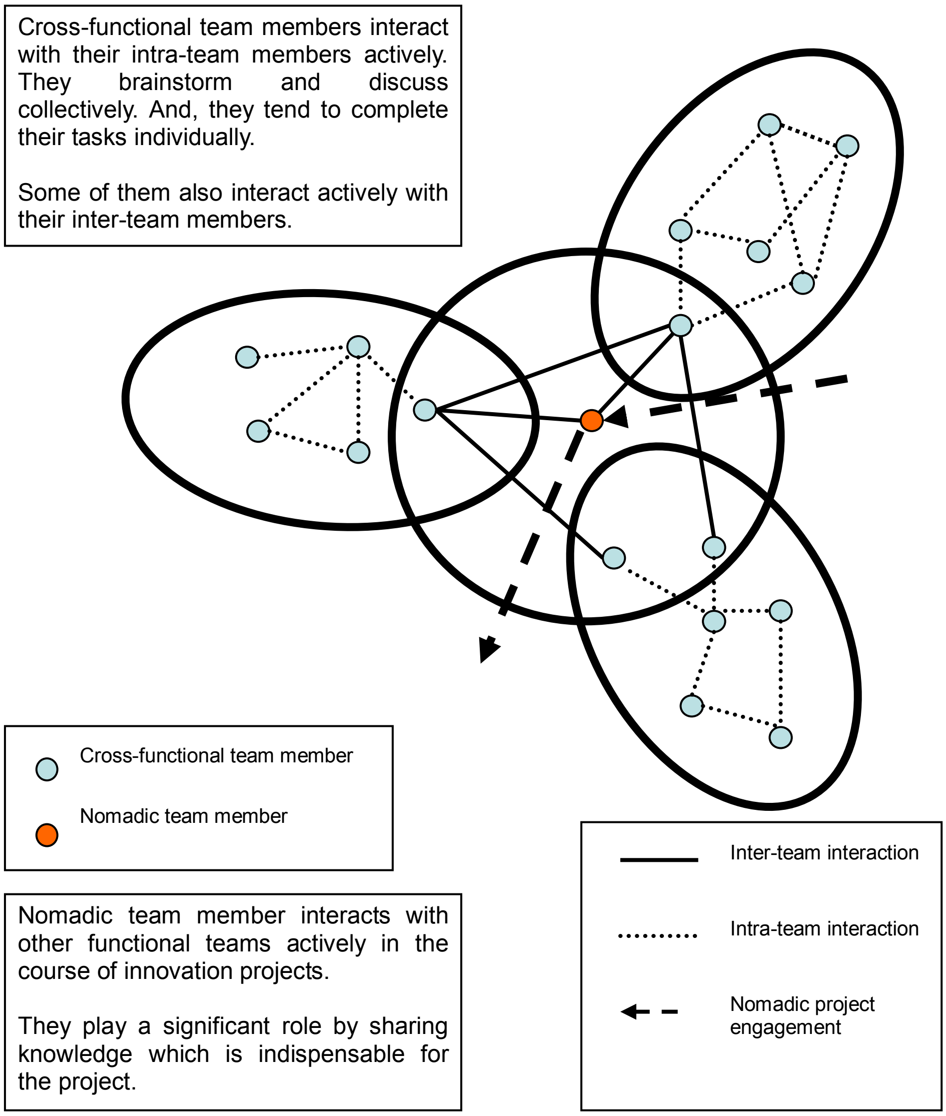
The author realizes that innovation project members are required to interact frequently with team members of their profession and sometimes with inter-team members with great collaborative effort as cross-functional team members. Refer to Figure 3.1, cross-functional team members are project team members who actively take part in every stage of textiles innovation projects. Apart from collaborating actively with intra-team members of the same expertise, some of them also take part actively in the inter-team meetings and voice out their professional viewpoints and knowledge during idea generation stage. They take part in the development stage actively either by developing the innovation with their hands or by providing assistance based on their expertise regarding the innovation in concern. Regarding their great efforts and active collaboration in textiles innovation projects, cross-functional team members are located at the circles which represent different project stages, in which they are well aware of everything that happened throughout the textiles innovation projects.

According to the above team member characteristics, 9 out of 15 interviewees are identified as cross-functional project team members. In order to better illustrate the interrelationship between the non-hierarchical nature of innovation project tasks and the capacity of collaborative effort required, "Interviewee 1" is employed as an example. "Interviewee 1" works in a textiles manufacturing firm. She also acts as a project manager responsible for a number of textiles innovation projects. The major contexts of her innovation project tasks are to coordinate all project tasks and to facilitate a smooth project flow. Such contexts require "Interviewee 1" to be actively involved in the collaboration processes throughout the whole project period. She is required to devote a large amount of collaborative efforts to communicate with the corresponding project team members at different project stages, and to coordinate the project flow efficiently in order to achieve an effective project output.

On the other hand, the author also realizes that some innovation project members are nomadic in nature, and only interact frequently with inter-team members when necessary as nomadic team members. Refer to Figure 3.1, nomadic team members are project team members who collaborate actively with inter-team members during a certain project stage. They do not stay with other cross-functional team members for the whole project period, but present at certain project stage when their assistances are necessary. For example, they take part in the development stage actively by providing assistance based on their expertise regarding the innovation of concern. Nonetheless, they are responsible for collaborating with other team individuals for solutions and improvements if any problems emerge in the innovation implementation stage. Nomadic team members gather information from cross-functional team members for the completion of their delegated project tasks. They also depend on the employment of Information and Communication Technologies (ICTs) for information sharing. Therefore, most of them only collaborate actively when implementing specific project tasks that demanded their efforts.

According to the above team member characteristics, 6 out of 15 interviewees are identified as the nomadic team members. The case of "Interviewee 5" is employed as an example for a better overview. "Interviewee 5" works in the University as a research personnel. He is also a technical team member responsible for software development in a number of textiles innovation projects. The major contexts of his innovation project task are to develop software technical requirements, develop or install the innovation and modify the innovation accordingly. Such contexts require "Interviewee 5" to be actively involved in the collaboration processes of certain project stages, which are the development and implementation stage. "Interviewee 5" stated that he seldom joins a textiles innovation project from the beginning, but mostly joins in after textiles innovation projects were kicked off. Moreover, he mentioned that the ways of gathering necessary information for his project tasks are through emails and from his teammates.

Figure 3.1: the Proposed Interaction Pattern among Textiles Innovation Project Teams



3.2.4. Data Collection Procedure

This study seeks to elicit participants' insights and interpretations of techniques and patterns which were implemented for operating and managing the virtual basis textiles innovation works. In order to gather more valuable viewpoints, in-depth interviews were undertaken to collect the data.

Prior to the main study, a pilot interview was carried out to check the logical flow of questions and the clarity of presentation. In the first stage, aiming to improve the face validity, the questions were checked and approved by a panel of experts either experienced in team studies or textiles industry. The interview questions were also pretested with researchers on the time length and possible answers.

In the second stage, three active participants from different textiles innovation projects were recruited from the same institution for the pilot interview. The respondents of the pilot study found that the questions were relevant to the topic of interests, expressed in appropriate terminologies and easy to understand. Therefore, no major amendments were made to the interview questions.

In the main study, written informed consents were obtained after explanation of the purpose and procedure of the study. Participants' background information was also collected, including demographic data and relevant information on their industrial backgrounds (See Appendix 1).

All interviews took place in a private room at an educational institute and were audio-recorded. The interviews began with some general questions about innovation projects, such as: the number of innovation projects the interviewee participated in, as a warming up session to encourage conversation. It then proceeded to discuss the collaboration processes and difficulties encountered in the operation or management of any specific textiles innovation projects.

This in-depth interview used an interview guide to direct the questions flow in order to minimize possible errors. During the interview, different pictures of commonly used Information and Communication Technologies (ICTs) were shown to each participant in order to encourage answers by means of visual stimulations. The rationales for the chosen ICTs will be explained in the following section.

3.2.5. Validity and reliability

In order to ensure the data collected were valid and reliable, all interviews sessions were carried out by the author to avoid different information source and to make sure consistent questioning techniques. All interviews are conversational based and audio recorded to provide complete and accurate participants' responses. The recorded interviews allowed for later verbatim transcription and minimized the errors generated from researcher's recall of memory. Moreover, the employed qualitative research approach mainly focuses on events in natural settings for obtaining a realistic perspective, which provides distinct data of rich descriptions in real life context. Thus, such data have a strong potential for revealing the complexity of problems (Amaratunga et al., 2002).

The criterion of validity that is used to establish the quality of this qualitative research study and the trustworthiness of qualitative data is grounded on credibility (Lincoln and Guba, 1985). Credibility is involved in establishing believable results of the qualitative research. It emphasizes on the richness of information gathered, rather than the amount of data gathered.

Credibility emphasizes the conscious effort to assure the integrity of data and accurate interpretations of the meaning of data. To ensure the credibility of data, interview sessions were held under a private, neutral and comfortable setting. The setting created a casual and interactive atmosphere for building up trust and rapport between participants and the author, which allows collecting data with an adequate scope of coverage. To ensure the depth of responses, semi-structured questions were asked, which also allows the author to observe participants' responses and to ask follow-up questions regarding to the studied phenomenon.

3.2.6. Data analysis

Content analysis employed in this observation is a systematic and replicable technique for compressing a large sum of unstructured data into fewer content categories based on explicit rules of coding. Thus, it could help in identifying the social relationships, interaction patterns, participants' concerns and experiences acquired by virtual team members when collaborating in textiles innovation projects.

Before applying content analysis, each audio recording of interviews was transcribed into plain text transcript by the same researcher to ensure consistency and validity. The transcribed details were then carefully reviewed by a panel of researchers for identifying categories and phenomenon. The panel of researchers includes four academics who specialized in textiles business. They were invited to develop their corresponding categorization, divergences among their categorizations were later resolved after discussions. This process helps to ensure the inter-coder reliability by minimizing subjective beliefs and individual preconceptions of human coders (Neuendorf, 2002).

Transcripts were carefully coded based on the coding techniques provided in content analysis. The coding was done by processing every line and every incident, in order to identify the relevant content and interaction pattern, which would be meaningful to the research problems (Strauss, 1998). After classifying the relevant data, the author thus sought to capture the recurring themes of these responses and reactions representing patterns in different categories and themes. For example, when the author collected interviewee's perceived values on "Reaching Consensus" in textiles innovation projects, the analysts sought descriptions like "easy", "challenging" (which indicates they might have a positive will and perception on reaching consensus with other team members) or "time consuming", "difficult" (which indicates they might have negative feelings towards reaching consensus). Finally, similar codes were grouped into various categories. The data coding process was an iterative process, which continued until saturation was reached. The propositions of this research study were then formed based on these major categories and their relationships. The major categories and their relationships will be reported in the next sessions of Results and Discussions.

3.3. Results & Discussions

In this chapter, the author reports and discusses the results of in-depth interviews by eliciting the extensive literatures. In addition to reporting the responses from interviewees, the author also tests and discusses the antecedents of virtual collaboration and the corresponding output of textiles innovation projects.

During the course of in-depth interviews, the author investigated team individuals' perceived values towards textiles innovation projects. The research focus was put on the collaboration element within these innovation projects. The author sought to identify antecedents, which were regarded by the interviewees as enablers or impediments towards the collaboration processes of textiles innovation projects. Moreover, the author examined how the collaboration effectiveness affects the self evaluation process of team individuals and the overall project output.

Apart from verbal conversations, the author also applied the method of showing pictures of various Information and Communication Technologies (ICTs) to the participants. It acted as visual stimulus, which was useful in triggering and motivating participants to share their relevant past experiences. The author could therefore evaluate the popularity and different roles of these ICTs, thus find out whether applying them can improve the collaboration effectiveness of innovation projects or not.

3.3.1. Innovation Project Virtuality

Nowadays, the scope of innovation projects is no longer limited as internal activities within an organization. As textiles innovation projects are mainly focused on product breakthrough and process breakthrough, there are often organizations who would like to seek for enhancement in its existing products or production procedures, and organizations from other professions would propose and provide solutions for them. Therefore, most of the innovation projects are carried out across organizational and geographical boundaries.

> *"In order to manage innovation projects, I always need to travel back and forth between Hong Kong and other cities in the Mainland. Today, I am in Hong Kong, and I will be on my way to Shanghai tomorrow. Sometimes, it is important for me to work with other project team members face to face."*
>
> *- Interviewee 1*

> *"Except my colleagues in the university (who are also technical team members), I need to work with people from other organizations. For example, I have meetings with the project manager, who belongs to the organization looking for innovations. And, I have to contact the vendor to make sure they provide the electronic parts that we need."*
>
> *- Interviewee 3*

The context of each textiles innovation project could largely vary from another. It ranges from developing new fabric to meet specific needs of a group of end-users to enhancing the management of a manufacturing factory. Therefore, textiles innovation projects not only require experts from the textiles industry, but also from other professions, such as operation, engineering and software development. Grouping these experts together to accomplish specific tasks is critical for the project success.

> *"My teammates and I specialize in engineering. Our role in textiles innovation projects is to develop technical specifications for innovation development. In order to have a better understanding on the project background, we have to work with experts from the textiles business and the operation staff in the production floor."*
>
> *- Interviewee 2*

> *"There was a textiles innovation project which I took part last year. We aimed to develop a new software system for tracking the products more precisely among different cities. I travelled to a few cities and discuss with my collaborators. Some of them were warehouse manager, operation assistant, and drivers."*
>
> *- Interviewee 7*

From interviewees' feedbacks, textiles innovation project team members are mainly mobile in nature. Even though several team members belong to the same organization, they may be located at different floors or buildings. And, some interviewees stated that they rarely stay at their office partition for a long period of time. Therefore, more effort is required for preparing and coordinating project tasks on virtual basis.

"I seldom stay in the office building. I have to monitor the production floor by going to the plant frequently. Therefore, my teammates can rarely find me on my seat. If it's urgent, they might reach me by calling my cell phone. If not, they might just send me emails and wait for my reply."

- Interviewee 8

"There are four colleagues from my organization working on the same textiles innovation project. Three of us are located at different floors in the same commercial build and the other one is stationed in the Shenzhen office. We normally communicate through emails and telephones."

- Interviewee 14

According to the interviews, 11 out of 15 interviewees mentioned that they needed to travel overseas at least once for carrying out textiles innovation project tasks. Some examples of these project tasks are site visits, kick off meetings, and the installation of technical equipment.

"We often need to go to the factories in China for site visits; we normally starts the brainstorming process and design process after observing the physical environment over there."

- Interviewee 2

"I just travelled once to attend a kick-off meeting in the previous project. It is important to attend the kick-off meetings at the early stage of textiles innovation projects. It provides a valuable chance to meet most of the teammates, and to start building up rapport with them. "

- Interviewee 10

However, interviewees also pointed out that they would only travel overseas when it is necessary. Unless the project tasks must be discussed face to face for a better understanding, otherwise project team members might still collaborate by the means of Information and communication technologies (ICTs). The employment of ICTs helps to cut cost and control the project budget.

> *"Our team often goes to the factories in China for site visits. We normally start the brainstorming process and design process after observing the physical environment over there. Except from that, we use emails and QQ (A popular instant messenger in China) mostly to communicate with team members in the Mainland."*
>
> *- Interviewee 3*

> *"Only one or two representatives from our intra functional team will travel overseas. Budget control is the major reason. And, when it is necessary for all of us to attend the meetings is another main reason. First, my colleague would share his information with me; second, I can request the information through the ICTs employed."*
>
> *- Interviewee 5*

The exploratory findings show that the contexts of textiles innovation projects are more complicated than that of internal innovative activities. According to the participants, the complexity of project teams' compositions leads to a high degree of innovation project virtuality. Innovation project team members have emphasized their reliance on the employment of ICTs (such as: email and instant messenger) for tasks coordination and team communication. The findings on antecedents of the collaboration effectiveness are further presented and discussed in the following session.

3.3.2. Adequacy of Consensus

All participants of in-depth interviews agreed with Hall and Andriani (2003) that it is important to reach consensus with their project team members. Unlike the traditional organization structure, idea generation, development and implementation among textiles innovation projects are on a collective basis. The quality of project works depends greatly on the willingness of project individuals in sharing their opinions and knowledge during the collaboration process.

> *"Taking part in textiles innovation projects is very different from handling regular office works. We don't just perform what we are asked to. The reason is simple - We don't have any standard to follow, no one knows perfectly on how to perform dissimilar innovation works. We have to collaborate with other project members to create the innovation and make it works."*
>
> \- *Interviewee 6*

> *"In order to create something new or to improve the existing products, every expert must contribute by sharing their professional knowledge and know-how during the collaboration. Take the development of improved patients' clothing as an example. Medical experts provide knowledge on patients' needs and textiles expert provide knowledge on textiles development. If either side fails to share useful information, the project output could be unsatisfactory.*
>
> \- *Interviewee 15*

An efficient opinions interchange allows team members to have a better understanding on the innovation background. It gives rise to team consensus and results in an effective collaboration throughout the project period. Therefore, it is crucial to enhance the willingness of project individuals in sharing their opinions and knowledge.

In the study, project team managers and coordinators pointed out that the early development stage of textiles innovation projects is a critical phase for enhancing the willingness of opinions interchange. They believed that opinions interchange can secure adequate team consensus which is necessary for the cross-functional collaboration. However, they also mentioned that the quantity of consensus is hard to adjust and express.

> *"It's impossible to have consensus once the project starts, it may take some time and effort to develop. I think it is better for team members to get to know each other first once the project starts. Informal meetings, such as: lunch gathering or having casual conversation, may allow us to start our relationship in a friendly and causal manner. Such friendly atmosphere will encourage project team members to exchange their opinions and knowledge more willingly."*
>
> *- Interviewee 1*

> *"Normally, we divide an innovation project into various stages. We will have different meetings throughout the project period. And, each meeting serves its specific purposes. For example, we always hold a kick-off meetings at stage one (The early development stage). It is good enough if most of the project team members gather. The main purpose is to introduce ourselves to each other and to exchange opinions on the scheduled project activities."*
>
> *- Interviewee 3*

"The first meeting is especially important not only because project team members can introduce themselves to the team, but they can also have some ideas on the corresponding person-in-charge of various project tasks. It is an opportunity for them to establish good relationships with other team members. Project team members will then be more willing to voice out their opinions and discuss in an open manner…… However, it is difficult to measure to what level of consensus works the best for innovation projects."

- Interviewee 12

Although the ultimate goal of textiles innovation project teams is to deliver a desirable project output, interviewees mentioned that there were indeed some cases of holding back useful information due to the interest politicking issues. Such actions affected team consensus negatively and inhibit the cross-functional collaboration. In order to tackle such problem, interviewees highlighted the importance of emphasizing project success and companies' interests as a whole.

"*I once participated in a textiles innovation project which sought for process breakthrough. At that time, the technical team was not allowed to do any site-visit. We could only acquire the necessary background information by asking them question by question. Such practice not only harm the team morale and collaboration atmosphere, but also affect the implementation of innovation projects negatively…… We were told by our collaborators that only their employees with permissions can enter the plant. I guess they might be afraid that we would be a treat to the interests of their organization."*

- *Interviewee 4*

"It isn't surprising that project team members may have different understandings on the same issue. It is because we are from different professionalisms and even different organizations. But we must know that all of us are hoping for the same – desirable project outputs. I am sure this belief will guide us through."

- *Interviewee 5*

"Although the implementation of textiles innovation projects may sometimes interrupt our daily operation, I value the opportunity of working in an innovation project. It is because the project output might bring enhancements to the organization in the long run. Therefore, I am ready to do what I am capable of for the project success. "

- *Interviewee 9*

Some interviewees stated that the lack of team consensus would cause deficiency in collaboration processes and poor outcomes of textiles innovation projects. They shared some obstacles that they had encountered, which include unwillingness to share information, delay in feedbacks and even worse - failed to deliver satisfactory project outputs.

"Some collaborators didn't participate in the textiles innovation projects actively. In my opinion, they were not being supportive. There were always time delays in replying emails or giving feedback. Everything was on hold when we were waiting. "

- *Interviewee 2*

"If anyone in the team (from other functional area) disagrees on the proposed technical specifications, we need to know why. Is there any foreseeable problems? If they refuse to share their knowledge with us, we can never come up with a better proposal."

- *Interviewee 4*

"Based on the limited information given by my collaborators, I designed a new operating system to enhance their work efficiency. However, the system turned out to be inapplicable as they didn't mention to me that other language options should be included."

\- *Interviewee 7*

The exploratory findings show that team consensus is a critical element leading to effective team collaboration among textiles innovation projects. Participants considered good relationships and readiness to reach an understanding gives rise to team consensus. Also, adequate team consensus can facilitate opinions interchange among project team members, and develop a strong sense of common interests to all the project team members involved. Last but not least, such strong sense of common interest thus further stimulates the information interchange among project team members and promotes the creativeness of team individuals concerning on the innovation project.

As innovation project team members mostly rely on the employment of ICTs during the project period, the kick-off meetings play an important role between these virtually connected team members. The findings on how organizational contexts affect the collaboration effectiveness are presented and discussed in the following session.

3.3.3. Organizational Contexts

Textiles innovation project team members are often composed by specialists of various functional areas, who belong to different organizations. Therefore, such new organization form of innovation project teams is still exposed to the influence of the traditional organizational construct.

All participants of in-depth interviews are employees of organizations or institutions. They perform as textiles innovation projects team members at the same time. During the working hours (not necessarily equivalent to the office hours), they have to accomplish both regular activities and project tasks. The effectiveness of collaboration processes is therefore subject to the impact of organizational contexts on innovation project team members.

- Technology support

During the in-depth interviews, participants emphasized the heavy use of Information and communication technologies (ICTs) when taking part in textiles innovation projects. All of the interviewees mentioned that the travelling costs increase substantially as the level of geographical dispersion between project team increases. Moreover, they revealed that travelling not only costs money, but also costs them time. They prefer to collaborate on virtual basis rather than spending their time on travelling. In order to control budget and time effectively, interviewees revealed that they do not have the preference to collaborate with their team members in the real world setting.

"Although the travelling cost seems to be a small amount of money, it could be added up to a large sum. There are some occasions which we must travel, for example: kick-off meetings, trail session and hardware installation. Sometimes, we may even need to monitor the system if it goes wrong. Regarding to the tight budget and project schedule, we would like to minimize the frequency of travelling."

- *Interviewee 2*

"To be honest, I rather spend my time working in the office than travelling here and there. It's really exhausting to do all the travelling. I believe that a comfortable and familiar working environment, a well-functioned laptop and good network connection enable me to complete the project tasks happily and efficiently."

- *Interviewee 15*

Apart from geographical dispersion, organizational boundary is also a major reason for the highly important role of ICTs throughout the collaboration process of textiles innovation projects. Most of the interviewees mentioned that it is normal for them to handle multi-tasks at the same time. As they had to stay at the office and carry out their routine job during office hours; therefore, they believed that it is more efficient to collaborate with their project team members by employing ICTs provided by their company.

"Although I don't work in the office but work in stores most of the time, I am also an active player in textiles innovation projects. I collaborate with other team members by using the email system of the company. For example, I provide them with the most up-to-date information in relation to the trial which took place in store."

- *Interviewee 11*

> *"Unlike research personnel who spent most of their time working on textiles innovation projects, I have to complete the routine tasks of my job and to carry out project tasks at the same time. It is really important for me to fully utilize the existing ICTs of the company. I can't afford the time to learn and use a new technology other than what I already knew."*
>
> \- *Interviewee 14*

Based on the geographical and organizational boundaries, most of collaboration works of textiles innovation projects rely heavily on the workplace created by technologies. Virtual workplace is essential for project team members to share information and knowledge, for project managers to monitor the project flow, and for project coordinators to collaborate with various team members on the coordination of projects tasks.

It is suggested by the interviewees that the virtual workplace only exists when project team members are provided with necessary equipments with specific technical features. Other than the availability of equipments, it is important for them to be provided with the selected ICTs. Technological supports from technical experts were also preferable if they were not familiar with the employed ICTs.

All participants stated that they were equipped with the necessary hardware (Computers) to carry out their project tasks, but only a few of them said that they were provided with additional equipments regarding textiles innovation projects.

"I have a desktop with two monitors in my office, and also a laptop. I take the laptop with me as I have to travel a lot to coordinate project task. I can work at anywhere with the laptop, even a café can be my mobile workstation…… Nowadays, I tend to use my smart phone to check email when I am out of office, as smart phone is smaller and more convenient. It will be great if I am provided with an extra smart phone, so I can separate my personal life with my work."

- *Interviewee 1*

"It is fine if I just carry out the project tasks in office hours, because I can use the desktop in my office. However, it is insufficient if I need to perform my project tasks during non-office hours…… It will be great if I am provided with an additional laptop or a portable device."

- *Interviewee 14*

"Other than the two laptops provided by the company, I am also equipped with an iPad which I can check and reply emails anytime. It enables me to work with my collaborators in a timely manner. However, I also use my smart phone to employ certain ICTs, such as Skype, weChat and QQ. I believe it becomes a trend for project teams to employ such communication applications in their smart phones or portable device."

- *Interviewee 9*

Other than the availability of equipments, it is important for project team members to be provided with the selected ICTs. Participant also mentioned that technological supports from technical experts were also preferable if they were not familiar with the ICTs employed in the textiles innovation project.

> *"Members of textiles innovation projects often carry out the project tasks independently, later share our outputs and collaborate through Information and communication technologies (ICTs). In a recent innovation project, our team share information, uploading semi-completed tasks and discussing through emails. All these collaboration activities are carried out on the virtual platform. Therefore, it is necessary for organizations to ensure the access of these virtual collaboration tools is smooth and stable. "*
>
> *- Interviewee 12*

> *"In order to collaborate with my team members, I have to be equipped with a pc, which allows me to access the internet. Even better, if it is already installed with the most popular ICTs, such as: Outlook and Skype. If the project manager decided to employ less popular ICTs, I will appreciate if I can get some help from the IT department."*
>
> *- Interviewee 15*

All participants of in-depth interviews agreed that technology support is an important enable for an effective collaboration process of textiles innovation projects. Resourceful technology support helps to create the virtual workplace, which is crucial for geographically and organizationally dispersed project team members. And, most of the participants pointed out that using smart phones and portable devices to collaborate with collaborators became more popular and will soon be a trend.

- Organizational rules and procedures

All of the participants agreed that the organizational rules and procedures inhibit the collaboration effectiveness of textiles innovation projects. They all pointed out that they have experiences of encountering difficulties in the collaboration process as the negative consequences of implementing intractable organizational rules and procedures.

> *"Most of the organizational rules and procedures are old fashioned, it somehow stand in the way of developing innovative ideas. Members of textiles innovation project need an open-minded to think out of the box. However, the implementation of rules and procedures limit the mindsets and creativity of some team members."*
>
> *- Interviewee 4*

> *"Rules and procedures are important for organizations to coordinate its routine operations, as these routine works are well-structured and defined for the subordinates. However, every textiles innovation project has its unique context. And, innovation works are ill-defined and full with uncertainties. Therefore, rules or procedures cannot function effectively as they are in bureaucratic organizations."*
>
> *- Interviewee 10*

Interviewees mentioned that some of their project team members had not shared critical information with them at the early stage of innovation projects, which caused defects to both collaboration processes and project deliverables. The underlying rationale of not sharing certain information is the fear and pressure of violating organizational rules and procedure.

"Once, we were asked to design a new system for enhancing the production performance. We designed the program based on the data provided by our teammates who worked in that production plant. However, the trial didn't work well. We couldn't find out what's wrong with the program until our teammates told us that there's actually some data missing. They explained that they weren't allowed to disclose some data and they could provide us with some dummy data……"

\- *Interviewee 7*

"When some project team members come to the plant for site visit, they will ask the frontline staff about their experiences of employing the traditional machines. Those frontline staff may not tell them the real situation as they are not sure if they are allowed to. Such situation can be resolved if I join the discussion with them, they will then be more open up to voice out their needs or problems encountered."

\- *Interviewee 8*

"Some project team members don't participate actively in knowledge and information sharing, because they are not sure if they are in the right position to disclose the information. They always ask their managers for permissions before sharing knowledge. Such fears of violating rules and procedure led to time delay and inhibit the collaboration processes of innovation projects. "

\- *Interviewee 12*

Some participants revealed that they tend to hold some meetings internally before discussing their project tasks with team members who are from other organizations. And, they added that discussing among colleagues from the same company is a norm, and an underlying procedure.

"It is important for us (the technical team) to discuss face to face on those technical issues first. We did it all the time. One of our current

projects is to seek for progress enhancement. First, we need to come up with some new and workable ideas, later carry out some trials on those ideas and finally propose the workable ones to others (Team members in the same textiles innovation project, but from another company)."

- *Interviewee 5*

"I am not sure if the organization enforced its employees to carry out internal meetings before discussing with others. It is just a fact that we are carrying out this practice for a long period of time. I have to discuss my design with another designer (my colleague who is also a team member) before sending it to other project team members who work in another company."

- *Interviewee 6*

All participants of in-depth interviews consider organizational rules and procedures as a restraint to the collaboration process of textiles innovation project teams. The implementation of rules and procedures is also viewed as a barrier of knowledge interchange. The effectiveness of collaboration processes is therefore negatively affected by the interfering nature of organizational rules and procedures.

3.3.4. Innovation Complexities

The interviewees stated that most of the textiles innovation projects are with high extent of uncertainty, which increases the difficulties for managing the collaboration processes. Interviewees agreed with Dougherty (1992) that the collaboration process is influenced when innovation project team members work in dissimilar time zones. They mentioned that they had to employ specific Information and Communication Technologies (ICTs) to facilitate the collaboration process. First tier project members also highlighted that they are required to work in non-office hours and even at midnight. So they could carry out synchronous communication with members who located in different time zones. Although project tasks could be completed, the work efficiency of project teams might be affected.

> *"When I collaborated with project team members who located at the United States, different time zones was really a huge problem. If we decided to have synchronous communication, such as video conferencing, one of us needed to stay up late at night and did it in home office. "*
>
> *- Interviewee 2*

> *"Normally, our team members employ email to communicate with each other. However, when there are some issues we need to discuss on a timely basis, either members in Hong Kong work till midnight, or members in Los Angeles start working in early morning. I believe the work efficiency is affected in either way."*
>
> *- Interviewee 6*

Apart from dissimilar time zones, interviewees mentioned that team members with diverse functionalities often have a unique set of work patterns and work speeds. Although such diversity is one of the major inputs for innovation projects, it is also a potential drawback, which might lead to conflicts and deficiency of project tasks coordination.

> *"Unlike other innovation project team members, the work pattern in the plant is routine and tightly scheduled. Therefore, my job routine is quite pack up with less flexibility. Other innovation project team members may have sent me a number of emails, before I return to my office from the production floor. Such work pattern differences may lead to communication delay."*
>
> *- Interviewee 8*

> *"Once I collaborated with team members from the accounting professionalism, they named a number of technical specifications to me and my colleagues. They also asked us to deliver the prototype in two day, which neglected our work schedule……Although some of those opinions were sound, not all of them could put into practice. We need to seize and look for a better mix of specifications…… We asked for a longer time period rather than explaining too much. We'd like to avoid unnecessary conflicts."*
>
> *- Interviewee 7*

Project managers and project coordinators revealed that the high complexities of innovation works have caused them to face a more challenging project environment of collaborative works. They believed that an adequate amount of understandings and communications among team members could ease the pressure among innovation project teams. Also, they thought that an employment of a mix of appropriated Information and communication technologies (ICTs) could create a healthier collaborative environment between dissimilar team members and leading to an effective cross-functional collaboration among textiles innovation projects.

3.3.5. Cross-functional Collaboration

As the contexts of Textiles innovation projects are different, cross-functional collaboration processes between project teams also vary. Participants of in-depth interviews pointed out that they have to adapt to different sets of tasks coordination and communication patterns among different innovation projects.

All interviewees emphasized the importance of communication throughout the textiles innovation projects. They stated that it is a common practice for them to brainstorm on ideas first, followed by discussing and testing them among their own company. After finding a possible solution, the innovation project team would come together again for discussions in order to arrange for on-site testing. These collaboration processes of textiles innovation projects demand a large amount of effort in communication and coordination between various parties. And, the most important collaborative task is to build a mutual understanding between project team members on the goal of innovation projects and the ways to achieve it.

Regarding the effort spent in communication and coordinating throughout an innovation project, all the interviewees revealed most efforts were devoted at the early stage of innovation projects. It is important for all decisive project members to achieve an adequate understandings and consensus on project development and planning, however, it is difficult to measure these elements quantitatively. Some respondents mentioned that such aspects are determined by their personal experiences, which are gained from the participation of textiles innovation projects.

> *"I believe that effective team communication at the early stage of textiles innovation projects is the most important. Project team members must discuss on aspects like: expectations of what the innovation may achieve, timeline and budget of the innovation development and the measurement of the project output. These issues greatly affect the planning, execution and the deliverables of projects. "*
>
> *- Interviewee 3*

> *"It is essential to obtain an effective communication throughout the innovation project, in order to ensure an effective information flow and opinions interchange. The impact of poor communication process is huge, as we may fail in acquiring specific requirements for developing the innovations. Any misunderstanding could cause an undesirable project outcome."*
>
> *- Interviewee 15*

On the other hand, task coordination is also critical for increasing collaboration effectiveness in innovation projects. However, interviewees stated that the complexity of textiles innovation projects increases the difficulties in coordinating project tasks.

“There are many uncertainties in the development of textiles innovation projects. Most of the time, tasks are dispersed all over the country or even across countries. It is challenging to coordinate project tasks which are carried out by team members with different working patterns. And, it is even more difficult to solve functional problems, as it requires experts who located in different time zones to collaboration on real –time basis. ”

- Interviewee 1

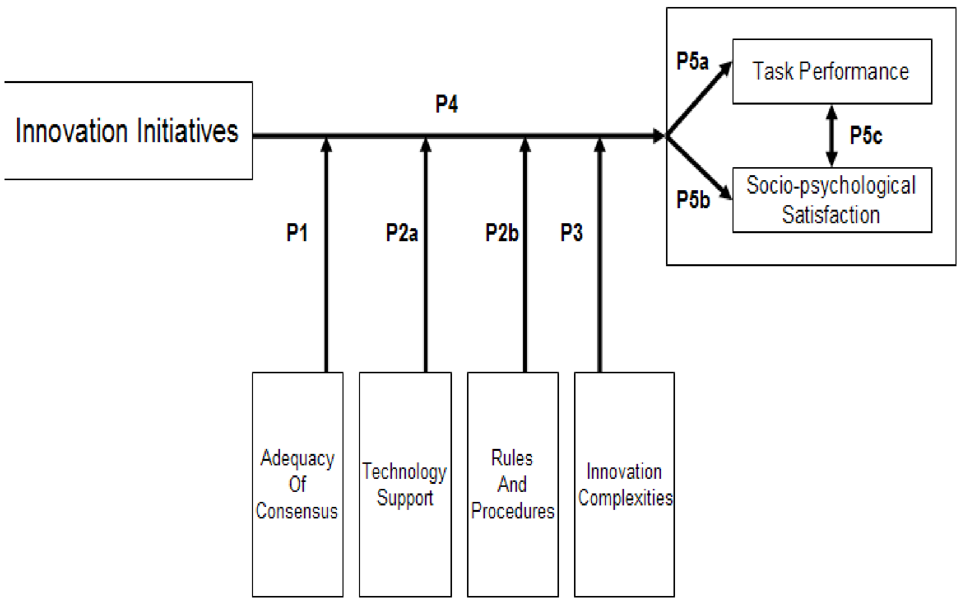
“Coordinating project tasks effectively isn’t as easy as it seems. It requires the project coordinator to have good control of project schedules. If any of the project tasks cannot be completed on time, it will lead to a delay of input to the next task. Such delay may cause an increase in budget, even a failure to deliver the project on-time. Therefore, I usually use a combination of communication tools to keep track team members’ work progress.”

- Interviewee 12

All participants of in-depth interviews stated that both communication and coordination processes are important factors of the collaboration process of textiles innovation project teams. The implementation of a mix of Information and Communication Technologies (ICTs) is also considered as a mean of facilitating the collaboration effectiveness of innovation project teams. Interviewees also regarded the effectiveness of collaboration processes as the antecedent of positive project output.

Regarding to the above discussions on antecedents of innovation projects collaboration, the author summarized the findings in Figure 3.2. Dispersed team members with various professionalisms are gathered to carry out innovation development. They collaborate in various patterns in order to develop innovation initiatives into innovation. During the course of innovation projects, there are a number of factors affecting the collaboration effectiveness among innovation project members. These important elements are Adequacy of Consensus, Technology Support, Organizational rules and procedures and Innovation Complexities. According to the interviewees, the contexts of these elements will greatly affect the collaboration processes of textiles innovation projects. The collaboration effectiveness of textiles innovation projects will therefore determine both tangible task performance and intangible socio-psychological satisfaction. These two indicators thus interact with each other and signify the effectiveness of innovation projects.

Figure 3.2: the Proposed Theoretical Model of Textiles Innovation Projects



3.3.6. Effectiveness of Textiles Innovation Projects

Regarding the measurement of textiles innovation project, all participants of in-depth interviews first mentioned that the most obvious measurement is whether they could or could not accomplish the expected project goal. If the innovative product is produced or certain procedure is enhanced at the end of project, they might regard the textiles innovation project as a success and the virtual collaboration processes is therefore a delight. However, they said that if they failed to deliver the expected project output, they would feel depressed and hoped to find out what went wrong during the collaboration process.

Therefore, the effectiveness of textiles innovation projects indicates the satisfactory level reached by innovation project teams. There are two measurements commonly used by innovation project team members, they are: Task performance and socio-psychological satisfactions.

- Task performance

Participants of in-depth interviews regarded tangible task performance as an important indicator for textiles innovation projects. It can be measured by the completion time, budget and deliverables of innovation projects. Task performance is viewed as the most convenient way to evaluate the project output, because it can be carried out by project members individually on timely basis.

"The most direct way to measure project outcomes is to compare them with the goal set at the beginning of innovation projects. The project goal was shared among all team members, so everyone should be able to evaluate by themselves. It is obvious that everyone will call the innovation project a success if it delivers what it is expected to."

- Interviewee 14

"Some projects may fail to meet the expected completion time which was set at the beginning of innovation development stage. It is important for the innovation project team to dig in for the reason of failure and to find out the bottleneck of the innovation project during the evaluation stage…… But the final project performance will still be reviewed and measured."

- Interviewee 13

- Socio-psychological satisfaction

Apart from the tangible project deliverables, all participant of in-depth interviews reflected that the innovation project itself brought them a sense of excitement and accomplishment. Some of the participants also mentioned that they enjoyed the process of learning and developing new knowledge during textiles innovation projects. They also valued the chance of enlarging their personnel network during the project period.

> *"Be able to deliver the project output makes me most excited. And, I will also be happy if I can learn some new knowledge when participating in textiles innovation projects. I cannot learn all of those by carrying out routine tasks in an organization."*
>
> *- Interviewee 4*

> *"I felt so happy and proud of myself when I was selected to take part in the textiles innovation project. I regard it as the recognition of my ability. Although taking part in it demands a lot of time and effort, I enjoy and value the opportunity of collaborating with various expertise."*
>
> *- Interviewee 11*

> *"It is obvious that everyone will call the innovation project a success if it delivers what it is expected to. And, we will also be happy to evaluate the collaboration process as a whole. It is beneficial for us to verbalize what we have learnt during the project period, so we will be able to utilize our new knowledge in the next innovation project."*
>
> *- Interviewee 14*

All participants of in-depth interviews stated that they evaluated both task performance and socio-psychological satisfaction. They believed that an effective virtual collaboration of innovation project teams will lead to positive project output, and vice versa. While the evaluation of tangible task performance normally takes place at the project end, socio-psychological satisfactions are formed during the collaboration processes of textiles innovation projects. Both effectiveness indicators influence each other by strengthening the level of accomplishment or disappointment.

3.3.7. Employment of Information and Communication Technologies (ICTs)

In the above session, all participants of in-depth interviews had put emphasis on the importance of Information and communication technologies (ICTs) throughout the virtual collaboration processes of textiles innovation projects. The most popular ICT among the participants is Email, which includes organizations' internal email system and email system, such as, Gmail and Hotmail. However, there are disadvantages for all kind of ICTs, some interviewees pointed out the disadvantages of using Email for innovation collaborative works.

> *"The selected ICTs for each textiles innovation project varied. The one I frequently employ is Email. It is convenient and easy to use. However, there are some drawbacks of using it. It is really frustrated when team members never replied to your email. And, it is annoying when some of them keep carbon copied everything to everyone. Therefore, it is important to set certain rules on the usage of ICTs among project teams."*
>
> \- *Interviewee 15*

> *"I like to implement Email when coordinating project tasks and communicate with my project team members. The main reason is to keep a record for everything. Team members can search the necessary information whenever they cannot recall them in their memories…… However, there could be too many redundant emails which bombed your inbox and you have to spend some extra time on deleting the unwanted ones."*
>
> \- *Interviewee 3*

Apart from Email, some participants mentioned that they sometimes employ Instant messengers (IM) such as, Skype and QQ, to communicate with their project team members. Such tools are not as commonly employed as Email, as the participants believed that IM is a more casual communication tool which is more suitable to communicate with friends rather than colleagues and project members. Therefore, they do not employ IM unless the collaboration processes are faced with serious communication problems, such as: the existence of firewalls or files could not be sent through Email.

> *"Whenever we need to send a set of technical specifications or documents with a large file size to our inter-team members, we may employ instant messengers, such as Skype. It is convenient to use and we can ensure the file is sent out."*
>
> *- Interviewee 5*

> *"Sometimes, I cannot send Email to my collaborators who located in the Mainland China. They told me that it is because of the restriction of network and strong firewalls. Thus, they asked me to install an instant messenger named as QQ. QQ is a commonly employed communication tools in the Mainland. By using QQ, I can send files to my collaborators and we can also have discussions on a real-time basis."*
>
> *- Interviewee 13*

In order to carry out synchronous communication with geographically dispersed team members, some interviewees mentioned the employment of Video-conferencing (such as: Skype, Openmeetings and Cisco WebEx). Video-conferencing software not only allows project members to meet and discuss with each other on a face-to-face basis, but also provides team members with an opportunity to clarify their problems and work on the innovation project effectively.

> *"We need to hold a number of meetings throughout innovation projects, and it is really hard to physically gather all members at one spot. So we employ video conferencing or phone conferencing the most. It allows us to describe our problems in a detailed manner. We also use emails frequently to communicate with others, as it is easy to track back what was said and who said it."*
>
> \- *Interviewee 12*

> *"Unlike Email, video-conferencing allows our team to build rapport by saying hi with each other with emotions or a smile on our faces. It also helps us to save a lot of travelling cost and time."*
>
> \- *Interviewee 13*

All participants of the in-depth interviews emphasized on the employment of Information and Communication Technologies during textiles innovation projects. ICTs not only play a significant role in organizational technical support, it becomes an indivisible element in the collaboration processes of textiles innovation projects. Thus, the employment of ICTs should be varied to the contexts of innovation projects and the characteristics of innovation project teams.

3.4. Summary

This chapter presents a qualitative study employing the in-depth interviews techniques, and the explorative findings of the research interests. Fifteen experienced individuals from Textiles innovation project teams shared their valuable experiences and knowledge on the topic of virtual collaboration, which includes the antecedents of virtual collaboration processes, the challenges of collaborating with cross-functional project team members and how innovation project team members evaluate the project output. Their imperative insights provide the author with solid exploratory data for validating the propositions. The interview results are summarized in Table 3.2.

Table 3.2: the Summary of Interview Results

Propositions	Affirmative or not?	Supporting arguments
P1 Adequate Team consensus ↓ Cross-Functional Collaboration	Affirmative	Adequate team consensus secures the foundation of opinions and knowledge interchange. Some project managers think that the adequacy of team consensus is difficult to be measured and adjusted.
P2a Technology Support ↓ Cross-Functional	Affirmative	The composition of innovation project teams leads to the great importance of technology support.

Collaboration		Technology support is necessary for the creation of virtual workplace. Same as the technological trend in the society, virtual workplace becomes very mobile in nature. Some team members think that electronic gadgets (such as: Smartphone and iPad) may allow them to work effectively with higher mobility, and urge for the provision of such devices.
P2b Organizational Rules & Procedures ↓ Cross-Functional Collaboration	Affirmative	Organizational rules and procedures inhibit the cross-functional collaboration processes. Limited empowerment of team members may lengthen the time taken for carrying out project tasks. Hierarchical organizational structure limited the feasibility and flexibility of innovation project teams.
P3 Innovation Complexities ↓ Cross-Functional	Affirmative	Innovation complexities describe the operating foundations and background of cross-functional

Collaboration		collaborative project teams. Appropriate set of ICTs and management mechanism are needed to create a harmonious collaborative environment among innovation project teams.
<u>P4</u> Effectiveness of Cross-functional Collaboration	Affirmative	The sum of collaborative antecedents determines the effectiveness of cross-functional collaboration of innovation project teams. Both communication and tasks coordination act as the indicator of innovation collaborative works.
<u>P5a</u> Cross-functional Collaboration ↓ Task performance	Affirmative	Effective cross-functional collaboration has a positive effect on the tangible task performance. Task performance (such as: the completion time of projects) is tangible and measurable. So it is the most commonly used indicators for assessing the effectiveness of innovation projects. And, it is also the first indicator pops up in

		team members' minds.
P5b Cross-functional Collaboration ↓ Socio-psychological satisfaction	Affirmative	Effective cross-functional collaboration has a positive effect on team individuals' socio-psychological satisfaction. Socio-psychological satisfaction is intangible. It represents team members' sense of excitement, enjoyment and attainment which gained from innovation projects. It doesn't not only show up at the end of innovation projects, but develops throughout the cross-function collaboration process.
P5c Task performance ↕ Socio-psychological satisfaction	Affirmative	Satisfactory tangible task performance has positive and direct effect to the socio-psychological satisfaction of innovation project members. Satisfactory socio-psychological satisfaction which built up during the cross-functional collaboration process also increases the possibility of achieving a satisfactory tangible task performance.

All participants of in-depth interviews believed that an adequate amount of team consensus secures the foundation of opinions and knowledge interchange. However, the quantity of adequate team consensus is difficult to be measured and adjusted. Project managers and project coordinators think that the adequacy of team consensus varies in different innovation contexts, and there is no such thing as standard amount of team consensus.

Regarding the organizational context, participants believe that the composition of innovation project teams leads to the great importance of technology support. As many project team members are geographically dispersed nowadays, technology support becomes necessary for the development and maintenance of virtual workplace. Alongside with the updated technological trend, the virtual workplace for innovation project teams becomes very mobile in nature.

Moreover, the complexities of innovation contexts describe the operating foundations and background of cross-functional collaborative innovation projects. Therefore, an appropriate mix of ICTs and management mechanism should be employed to create a harmonious collaborative environment for innovation project members.

The overall performance of collaborative antecedents determines the effectiveness of cross-functional collaboration. Both communication and coordination efficiency are the indicators for measuring the effectiveness of innovation collaborative works. Effective cross-functional collaboration has a positive effect on the tangible task performance and team individuals' intangible socio-psychological satisfaction. Tangible task performance is the most commonly used indicator for assessing innovation projects. And, it is also the first indicator that pops up in the team members' minds. Rather than assessing at the project end, socio-psychological satisfaction is accumulated throughout the cross-function collaboration process. Satisfactory tangible task performance have strong, positive and direct effect to the socio-psychological satisfaction of innovation project members, whereas, satisfactory socio-psychological level also increase the possibility of achieving a satisfactory tangible task performance.

Thus, this content analysis of in-depth interviews has provided the author with practitioners' experiences on how they collaborate in textiles innovation projects, and how the proposed contextual antecedents affect the collaboration processes and its effectiveness. The author also understands the precedence of perceived final project outputs in the views of project practitioners. Moreover, the author acquires valuable insights on practitioners' personal views on their needs and requirements of ICTs applications during the course of virtual innovation projects. In the next chapter, the author carries out further investigation in a case study to study the influence of proposed contextual antecedents in textiles innovation projects.

CHAPTER 4

A CASE STUDY: VIRTUAL INNOVATION PROJECT COLLABORATION IN TEXTILE INDUSTRY

4.1. Introduction

From 2009 to 2010, the author conducted fieldwork with the assistance from a local innovation project team, which included the researchers and technical experts from the Hong Kong Polytechnic University and a leading textile corporation in the Asia Pacific Rim. The selected research target is a process innovation project, which consisted of team members across geographical and institutional boundaries. The implementation of such innovation project thus requires extensive use of information and communication technologies (ICTs). The effectiveness of its collaboration processes is particularly challenging and crucial for determining the project output.

The fieldwork was mainly conducted through on-site observation. The Hong Kong Polytechnic University, and the corporation with which the author was affiliated, offered tremendous help through the Hong Kong Government supported project on process innovation with local textile industry participators.

In this chapter, the author first describes the research design of this qualitative research; the research approaches employed in this case study are also stated. Thus, the author describes the case in terms of the industrial motivation and the evolved innovation system. Followed by the case background, the author depicts the fieldworks done and the research procedures in detail. The author thus reports and discusses the empirical observations made during the extensive period of textiles innovation project. Nonetheless, the author illustrates the interrelationship between innovation projects and the intensity of their contextual factors throughout the collaboration processes.

4.2. Research Design

4.2.1. Purpose statement

The purpose of this study is to direct the investigation of how the dispersed innovation project team collaborated, how was such collaboration managed, what problems were encountered and the lessons learned.

4.2.2. Research Question

The Primary question is how dispersed innovation project team's collaboration could be managed and modeled, and how the progress of a virtual innovation project could be monitored. There are several secondary questions to be investigated, including:

- To explore the participants' differences in different collaboration contexts and how these related to the operation and performance of innovation project teams

- To investigate the relative significance for knowledge sharing in a virtual innovation project team of similarities and differences of organizational-demographic variables and how these relate to the characteristics of control mechanism pursued

- To propose possible solutions for improving project success and enhancing the team effectiveness

4.2.3. A Qualitative Ethnographic Research

The emphasis in this study is put on the authentic business situation of the local setting. The research focus is on a naturally occurring phenomenon embedded in context, which is one of the major features of qualitative research (Miles & Huberman, 1994). There are some other important features of qualitative research, which have also been considered as important criteria for choosing the qualitative approach for this study. These important features are rich data and holistic descriptions dealing with a dynamic and complex problem structure, and the handling of little-known phenomena (Marshall and Rossman, 1999; Miles and Huberman, 1994).

Qualitative research strategy was employed for the collection and representation of data in this study, as researchers (Amaratunga et al., 2002) determined that this approach mainly focuses on events in natural settings for obtaining a realistic perspective, which provides the author with distinct data of rich descriptions in real life context. Thus, such data have a strong potential for revealing the complexity of problems.

In theoretically underdeveloped fields of study, it is premature to quantify the data when phenomena are new and largely uncertain. Thus, Strauss and Corbin (1990) suggests that qualitative research methods convey the complicated details of phenomena more effectively. Qualitative approach analyzing the project as a whole was therefore selected for the investigation of social phenomenon in this research study.

It is significant to study the collaboration issues regarding an innovation project. However, the interrelationships among members' interaction, technology integration and workflow design accentuate the complexity of this exploratory study, a qualitative research approach was then prioritized and adopted for the research design. The adoption of qualitative approach allows the author and industry practitioners to reveal "how all the parts work together to form a whole." (Merriam, 1998). As collaboration issues are mostly hidden within the work processes of innovation projects, the author decided to uncover these hidden issues and explore the insightful knowledge through ethnographic observation.

4.3. Research Approach

4.3.1. Case study Approach

This study uses a case study approach to investigate 'how' the virtual innovation project team collaborated, 'why' team member encountered obstacles during the process of technology integration and 'how' possible solutions could be suggested for enhancing the collaboration effectiveness. The author can employ various methods to collect data and carry out analysis, as case study does not specify the use of any particular data collection or analysis methods (Gummesson, 2000; Hamel et al., 1993; Merriam, 1998; Yin, 1981).

The qualitative research of this study is an organizational case study, as it enables the author to capture the social context and dynamics of cross-functional team members among innovation project for exploration.

This research study benefits from the advantages of implementing an organizational case study. The author can reveal the nature of a particular phenomenon through the richness and realism of data in the organizational study. However, there are some drawbacks in employing this approach, such as the low level of researcher control over variables and it would be difficult to analyze and interpret all data gathered (Yin, 1989). In spite of these disadvantages, the author believes that organizational case study is the most appropriate research approach for this study.

The unit of analysis is emphasized as the critical factor for the case study approach (Yin, 1989). In this study, the author employed the innovation project as the unit of analysis, which obtains board dimensions covering the arena of project management, technology integration process, and the processes of virtual team communication and coordination.

4.3.2. Interpretive Approach

This case study utilized an interpretative construction framework. The interpretive approach is different from positivism as it does not impose predefined dependent and independent variables on the research process, but emphasizes the complexity of human decisions in a particular setting (Klein and Myers, 1999).

This research approach strengthens the author's ability to uncover human thoughts and action in social cultural and organizational context from the participant's view not just in an observer manner (Johnson and Duberley, 2000). The author aims to employ interpretive approach to learn the meaningful or relevant elements of the innovation project team members being observed (Trauth, 2001). Thus, it enhances the author's understanding regarding to the phenomenon within the cultural and contextual boundaries among innovation projects.

4.3.3. Ethnographic Approach

Ethnographic approach is employed in this case study analysis. The ethnographic research is an in-depth research method, requiring the author to act as an ethnographer and spends a significant amount of time in the field (Myers, 1999). The author aims to obtain a deep understanding of the people, the organizations, the innovation projects and the board context of collaboration works through employing the ethnographic research approach.

The author acquires an extensive amount of data on human interactions, innovation projects and collaboration works in where the ethnographic research method is carried out. These data then contribute a rich, concrete and textual portrayal of the analysis of working practices being observed (Hughes et al., 1995). The author can observe activities as social actions embedded within a socially organized domain, as the application of ethnographic method reveals the social aspects of work practices in a naturalistic setting,

4.4. Case Background

The case under investigation in this research study is the managing and modeling of advanced technology systems integration in a leading textile corporation in the Asia Pacific Rim. The leading textile corporation has a well established vertical integrated operations consisting of spinning, knitting, dyeing, printing and finishing. Moreover, it offers a wide range of products from dyed yarn to garments. The enterprise plays an important role in the global apparel market, as a major fabric supplier and garment manufacturer in over 40 countries.

This study concerns the process in which the enterprise and the project team endeavor to integrate an advanced technology system into the organization's established production framework. The innovation project aims to enhance the operation effectiveness by upgrading the transparency level of the organization's inventory control system. The well-developed technology system, Radio Frequency Identification (RFID) system, might be feasible for implementing into the enterprise's existing inventory control system for tracing and tracking purposes.

4.4.1. Industrial Motivation

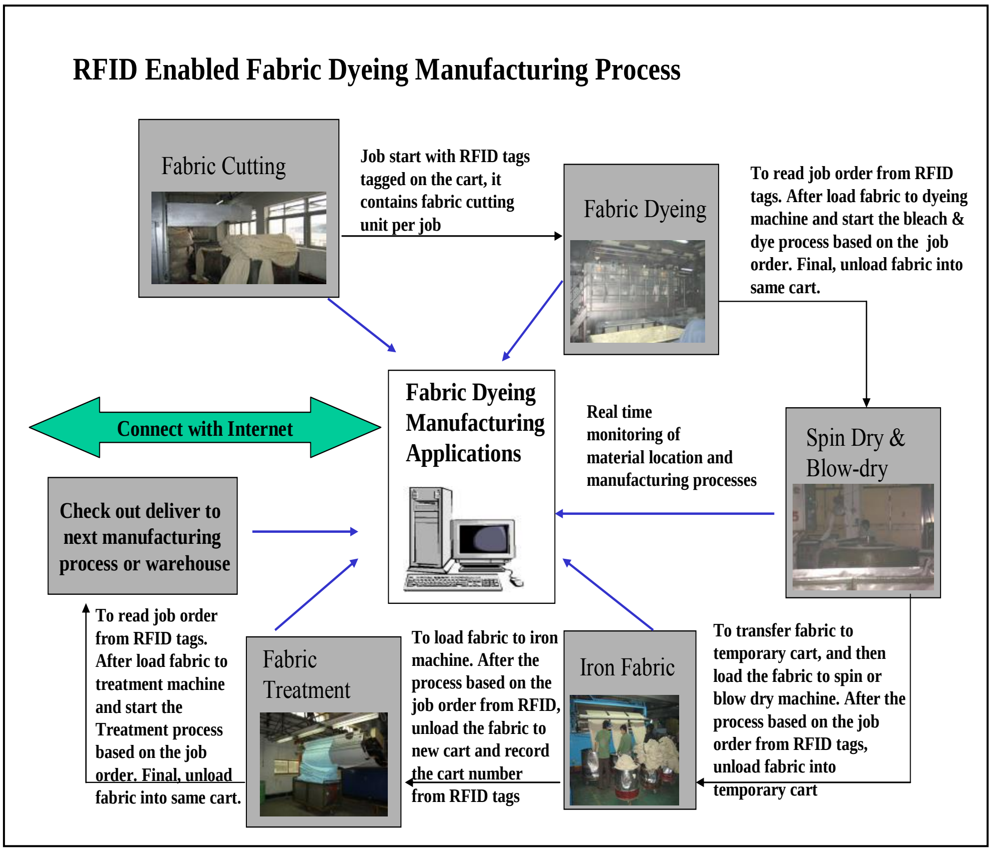
The Hong Kong Textile and apparel industry is now facing significant challenges regarding its industry players' competitiveness, management approaches and operation development, these challenges are in relation to various issues of concern. Firstly, manufacturing firms are at present suffering from the elevating operational costs based on the fact of mounting energy costs and hidden inefficient operation workflows. Secondly, difficulties are faced in speeding up the production process to cope with the shorter product life cycle of their end products, which aim at achieving high customer satisfaction. Thirdly, the increasing environmental concerns thus alert enterprises to modify their operational procedures in a certain extent to build up environmental friendly corporate images. Nonetheless, they are facing more uncertainties when engaging into the global business horizons both politically and economically, obstacles might as well aroused in the distant communication process with their overseas clients and business partners.

To cope with the challenges evolved in the textile and apparel industry, research efforts have been devoted to justify the feasibility of integrating advanced technologies into the textile manufacturing process. Such technological integration aims to unify the tracking system of its operational process as a whole, from the raw materials storage to the finishing process, and finally to the delivery service. The success of such technology integration might indicate an important technological break through. A highly effective real-time basis inventory control system (which specialized for the raw materials of fabric manufacturing, semi-finished fabric and garment, etc.) would be developed. Moreover, valuable information would also be available for exchange among the manufacturing site, the coordinating office and the customers. To accomplish the above missions, a well-developed technology application Radio Frequency Identification (RFID) system is examined for this evolutionary integration. Such industrial applied technology is not available yet, though similar technology integration had been successfully took place in other industries, such as: Apparel Retailing and Jewelry tracking. In fact, those industries obtained entirely different environmental elements, product characteristics and problems to concern from the textile manufacturing industry.

The purpose of this case is to implement an advanced technology system into the established operational processes of an organization. Both the enterprise and the project team committed to the cooperation. Such technology adoption aims to achieve advancement in the real time behavior and transparency level of the existing inventory control system. The project team had visited the manufacturing factory, located in the Mainland, to observe the complete operations workflow and assess the feasibility for implementing advanced technologies into the enterprise established inventory control system.

Regarding to an ongoing project of HKRITA, experts recommended a data capturing framework to overcome environmental constraints concerning the fabric dyeing manufacturing process (See Figure 4.1). It suggested how data could be captured throughout the manufacturing process and how information could be shared among different parties.

Figure 4.1: the RFID-Enabled Fabric Dyeing Manufacturing Process (Ngai et al., 2006)



In this study, the author observed the implementation of advanced technology systems in an international knitted fabric manufacturing organization. The knitted fabric manufacturing enterprise has a well established vertical integrated operations consisting of spinning, knitting, dyeing, printing and finishing. Moreover, the enterprise plays an important role in the global apparel market, as a major fabric supplier and garment manufacturer in over 40 countries by offering a wide range of products from dyed yarn to garments.

The innovation project team experienced a number of obstacles from their visits for flexibility pre-assessment. These obstacles occurred due to the significant differences between the collaboration contextual behaviors among the human factors in the project, including top management level of the enterprise, operation level in the manufacturing factory and engineering/ technical expertise from the university. These contextual differences have negative impacts on both communication effectiveness and coordination effectiveness of the project, which are indeed negatively influential to the innovation project performance.

4.4.2. Technical environment

4.4.2.1. RFID in Adverse Manufacturing Environment

The Radio Frequency Identification (RFID) technology was originally developed in the 1940s. This technology has been applied commercially for more than thirty years. In industrial settings, RFID is commonly employed in the automation of routing materials, identifying containers and tracking equipments. The adoption of RFID provides its greatest value in a range of situations, when the traceability of products through its manufacturing process is required, when there are high labor costs or frequent data errors related to the item identification and handling process or when labor constraints exist in the identification process, the handling process or the replenishment process.

Unlike the supply chain implementation of RFID, where the coordination with supply chain partners is highly demanding and challenging. RFID provides a quick return on investment (ROI) in various manufacturing sites and warehousing industrial operations. Manufacturers, who desire traceability or experiences bottlenecks in its operations constantly or who would like to lessen the labor intensity associated with its materials management and replenishment process, are indeed preferable candidates for implementing RFID to save their operational costs.

Most of the industrial applications in concern (such as: work-in-process tracking, materials replenishment and assets management, etc.) are closed looped operations, technology standards are not necessarily coordinated with its customers, suppliers or other business partners. This allows manufacturing operators to have a higher flexibility in RFID integration by which they can gain a rapid return on RFID investment.

4.4.2.2. RFID systems among Innovation Projects

There are three components in a typical RFID tag, which are the chip, the antenna and the enclosure. The chip acts as a data storage device associated with the tag. The antenna functions as a query signals receiver from a tag reader and as an internal data transmitter from the chip, whereas the enclosure is the packaging and external protector of the above electronic components.

RFID tags are categorized into passive and active types. The passive chip is created within a unique identification number, in which the contents could never be changed. Its identity number would be released to the reader during queried, it would then be transferred into a computerized database system in which the identity number is associated with specified product characteristics. On the contrary, the active chip might contain more information, which could be rewritten by an external reader/ writer device. The active chip is capable to function as a container of transactions history, in which progress could be tracked by using the reader/writer device. Although the RFID technology system appears to be simple and direct, the operational framework is indeed complicated with certain limitations and weaknesses for industrial applications.

In this study, experts and technical team from the university might face challenges related to the limitations of frequency transmission, interferences from the operation environment or other radio frequency (RF) devices, accuracy or reads, etc. Detailed technical investigation on the technology framework and engineering processes would not be included in this study as these are outside the research scope of this study. However, the research is focusing on what human interaction would be taken place in the dispersed innovation project, how the differences in collaborative contextual factors affect the team performance and how the collaborative processes of this innovation project could be managed and modeled by a latter proposed system interface.

4.5. Fieldwork

4.5.1. Direct Observations

The author applied direct observations technique as the major tool for the collection of primary data in this study. Gummesson (2000) demonstrates that the use of observation method was considered to be the most sufficient among the available research methods for investigating processes in the management field. Thus, the author uses observation based on a number of supporting reasons concluded by Merriam (1998), and they are as follows:

1. It allows the author to understand the context of investigated phenomena as outsiders.
2. The author is capable to use own knowledge or experience for interpreting what was observed.
3. When participants avoid certain topics or may not be comfortable to talk about some issues.

Researchers (Cooper and Schindler, 2003) define the direct observation method as the situation where "the observer is physically present and personally monitors what takes place". The adoption of the observation method in this case study allows the author to gather primary data and knowledge from the real world context in real time manner, with the absence of potential distortion from other verbal description sources (Lee, 1999). Distortion might still occur when the observer is physically present on sites (Yin, 2003); this could be overcome by establishing trust between the author and participants (Lee, 1999).

The purpose of implementing the direct observation method as the data collection tool in this study is to acquire understandings and knowledge from the collaboration context and phenomena of the case study innovation project team. Moreover, the author would also like to discover the implicit collaborative issues between the participated human factors during the process of advanced technology integration.

In this study, the direct observations are carried out by field visits to the case study sites with the technical team during the collaboration processes. The observations are made in the following natural settings:

- By attending the field trips to the manufacturing site with the technical team from the university
- By attending the video conference between the top management level of the enterprise, the operation level in the manufacturing site, and the expert & technical team from the university
- By attending the meetings between the top management of the enterprise and the expert & technical team from the university
- By attending the meetings of the expert & technical team from the university

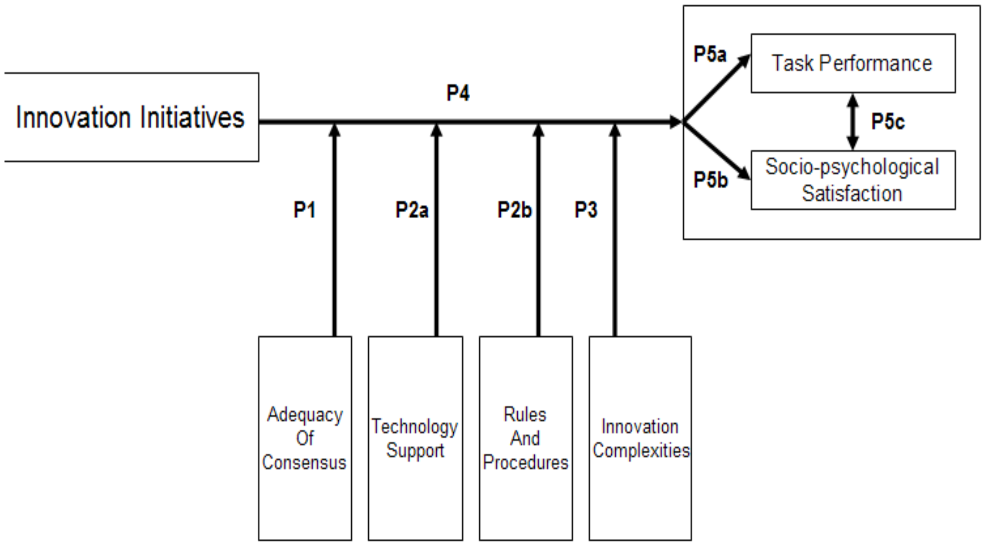
The role of the author as an observer would be notified to participants before the observations. The author will not participate in any discussions of meetings or other collaborative activities to insure the role as an ethical observer, which record authentic data in a bias reducing manner. The author will thus record the observations in a descriptive format for references.

4.5.2. Interviews

The author conducted interviews with various stakeholders of the innovation project being studied. These stakeholders included management personnel and engineering staffs from the enterprise, and the research personnel from the university research centers. In addition, consultants and academics were interviewed regarding to the collaboration processes for the innovation investigation. Interviews were carried out confidentially on an individual basis under a private setting. The author minimized the bias behavior of interviewees and to build up rapport by ensuring the confidentiality.

During the interviews, both semi-structured and open-ended questions were employed to uncover various aspects of virtual innovation project team's collaboration management. Questions were based on the theoretical model of textiles innovation projects proposed in Chapter 3. Figure 4.2 shows the interviewing focus of the semi-structured interviews. Interviewees were asked to review the collaboration processes of participating in textiles innovation projects. The author put the focus on "how" team members collaborate in order to transform innovation initiatives into innovation. The author also investigates team individuals' feedbacks and opinions on the contextual differences of team members during the course of cross-functional collaboration among innovation project.

Figure 4.2: the Proposed Theoretical Model of Textiles Innovation Projects



4.6. Research Procedure

To illustrate the significance of the collaboration framework, the author observes a virtual innovation project for a large-scale textile manufacturing processing system in Hong Kong and Pearl River Delta Region of Mainland China. This section provides a methodological note concerning the case research.

In this virtual innovation project, a leading textile corporation in the Asia Pacific Rim attempts to develop a novel cross-country networked, real-time production monitoring system throughout all organizational levels. The success of such system might indicate a technology breakthrough, thus providing a benchmarking model for the industry. In specific, the innovation concerns an advancement of production monitoring processes of a leading textile processing manufacturer. The enterprise maintains a distinguished reputation in the industry, supplying fabric to apparel manufacturers for renowned retail brands over 40 countries. The enterprise's worldwide sales have reached US$900 million in the fiscal year 2007. The organization has headquartered in Hong Kong, and invests more than 2,860 sets of machines and equipments for various production facilities. These production facilities are located in Jiangsu and Guangdong provinces of the Mainland China, Sri Lanka, and Indonesia. The enterprise has marketing and representative offices in eight countries with approximately 20,000 staff force globally.

Remarkably, the enterprise is a longstanding leading player in the global textile market through the well established vertical integrated operations consisting of spinning, knitting, dyeing, printing, and finishing. The enterprise's daily processing outputs could reach to 250,000lb textile products which included a wide range of cone dyed yarns, yarn-dyed auto-stripe fabrics, knitted fabrics, printed fabrics, dyed fabrics, and finishing.

During the course of innovation, the enterprise and the project team endeavor to integrate its resources monitoring and control systems into an organization's common virtual platform. The system aims at developing a plant-wide seamless data capturing network, and allows cross-border information synchronization. Upon the final stage of project, the established network would enable all relevant production progress and inventory information to embed automatically into the enterprise's current resources planning and control system, which helps to retain a minimum effort of manual inputs for auditing. Thus, headquarter staffs could check, record, update, and analyze the on-floor production status and possible discrepancies from different geographical points on the real time basis.

On such premises, three major groups of dispersed project participants teamed up collaboratively. The first group was top management of the enterprise concerned with the deficiency of current process monitoring system, which could not disclose organizational silos drilling tremendous hidden processing costs. Such deficiency is mainly resulting from human errors and low traceability of work-in-process. The second group included engineering staffs from the enterprise's manufacturing sites, prudent in the possible unknown impacts, which resulting from such novel technology innovation. A small portion of participants from this group were not as optimistic as the top management to the innovation potentials. In addition, two university research centers acted as technology providers in this innovative investigation, and introduced the innovation concept as an ad-hoc spin-off research commercialization project. This group designed and tested the feasible solutions for implementing an innovating system at floor level.

During different phases of the innovation works, researchers recorded data related to the inter- and intra-team communication, interactions, work patterns, and information interchanges. Most of the data were elicited through conducting direct observations, and a part of the data collection was elicited through follow-up interviews among the virtual innovation team. The author observed on site regarding to the daily operations and interaction patterns of the virtual innovation team. Concerning different organizational policies, the author thus selected members from the innovation team as the key informants for follow-up interviews. The selected participants are in the right position with authorities to provide insightful information of virtual innovation projects management.

4.7. Empirical Observations & Discussions

The case study context is described as an innovation project related to a technology breakthrough in the textile and apparel industry. The innovation project aims to develop a novel set of tracking system for tracing the location of each fabric lot during its manufacturing processes, by which a highly efficient and effective production process would be facilitated.

In this study, an international knitted fabric manufacturing enterprise has committed to participate in the collaborative innovation project. This enterprise plays an important role in the global apparel market as a major fabric supplier and garment manufacturer. As the enterprise offers a wide range of products from dyed yarn to garments with a large volume of production, it is crucial to develop a high level traceability inventory control system to eliminate the bottleneck caused by the existing labor intensive inventory control pattern. This innovative project of technology integration is expected to help the enterprise for attaining lower inventory costs and achieving a more transparent system of inventory control.

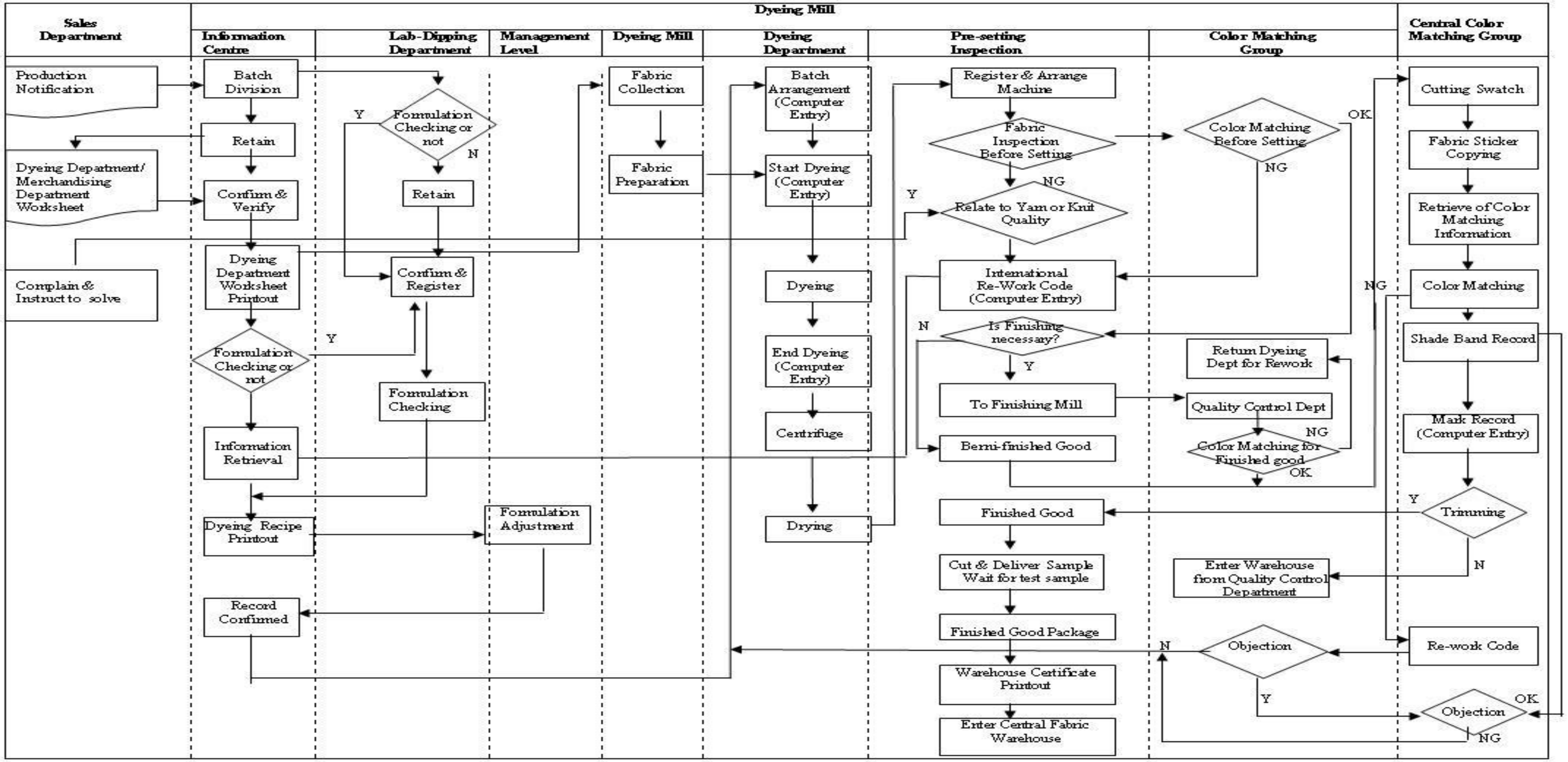
There are three major groups of collaborative participants included in this dispersed innovation project team. Based on the previous mentioned commitment with the textiles and apparel manufacturing enterprise, two groups of participants are come from the company. First, top management level of the enterprise are involved, who are concerned with modifying the established operations system to overcome the bottlenecks of rising operational costs and unsatisfactory inventory control system due to the high human error rate and low traceability of fabric lots. Second, operation level from the enterprise's manufacturing site are involved, who emphasize the possible negative impacts, which would be caused by such technology integration. It is observed that a small portion of participants from this group were not as supportive as the top management level were.

Nonetheless, the experts and technical teams from the university contribute as another important group of collaborative participants in this innovative investigation of technology breakthrough, in which they examine the feasible methods for implementing the RFID system into the particular industrial application under a tremendously challenging environment.

It is important to note that the key focus of observation is on the human interactions among the above major groups of participants during the collaboration processes. The process of integrating an innovative application into an established industrial practice as in this case is complicated and challenging as the existing enterprise application integrated frequently across departmental and geographical boundaries.

As shown in Figure 4.3, the flow chart below demonstrates the workflows involved in the dyeing mill operation. It thus illustrates the cooperative relationships among different functional departments. Further exploration is required for studying the collaboration process during the data capturing and sharing processes.

Figure 4.3: the Dyeing Mill-chart landscape



It had been observed that the enterprise's existing application incorporated a range of organizational departments and operational areas, which might impose certain difficulties for the implementation of technological innovation based on the complexity of technology and the highly challenging environmental factors. Therefore, the technical teams and experts dedicated lots of efforts in understanding the organization's environment and brainstorming on the appropriate solutions for implementation.

In particular, effective team communications and coordination are critical to the collaborative effort (Akkermans and van Helden, 2002), for overcoming the obstacles and complexity of technology integration imposed by the established system and characteristics of manufacturing processes.

In this study, an international processing manufacturing enterprise has committed to participating in the collaboration analysis of innovation projects. The key observation focuses on the human interactions among the major groups of participants during the collaboration processes. The project involves a large number of interdependent functional parties, such as: network experts, information system engineers and programmers, textile processing engineers, administrative executives, cost and project auditors, and plant architects. The innovation study period lasts for more than a year and 6-months across two countries in the Asia Pacific Rim.

Table 4.1: the Significant Contextual Issues in the Observed Innovation Project

Antecedent	Facilitator
Adequacy of Consensus	● A virtual-based technology platform that enables innovation project team members to communicate, exchange ideas, attain understanding on sorts of ill-structured, changing innovation information and requirements. ● A management platform that allows project manager and coordinator to facilitate the opinion exchange between team members, and synchronize difference opinions into a consensus.
Organizational Contexts	● An integrated technological supports provide the innovation project team with common data and knowledge structures to process the large amount of computerized data. ● The organizational infrastructure, such as: contingent rules and coordination procedure, well-developed internal and external documentation system, helps to guarantee a consistent flow of innovation progress and performance.
Innovation Complexities	The choice of team management structure and project control mechanism affects the definite performance in a large extent.

Table 4.1 refers to those significant antecedents that lead to an effective cross-functional collaboration. In the case study, the virtual innovation team often lacks of real time and synchronous communication. Such deficiency results in various extents of uncertainty or inadequacy of information updating and sharing during the cross-functional collaboration processes. Consensus among project team members is therefore imperative for assuring an adequate level of mutual understanding through sharing individual personal judgments, perceptions, and experiences. The benefit of reaching a

prevailing team consensus is to reduce conflicts and induce fast, effective cross-functional decisions and actions. Therefore, the results of case study support the proposition (1), suggested in the theoretical model of Chapter 3. A high level of inter-team consensus constitutes as a source of collaboration pre-requisites, encouraging the sharing of knowledge and information interchange among virtual innovation team members. In addition, project mangers and coordinators are responsible for encouraging opinion interchange among team members during the collaboration processes. It is thus important for them to lead innovation teams to reach for a consensus; otherwise it is possible that team members might spend too much time to discuss on certain issues.

Technological support is another critical issue for proceeding innovation works virtually in the case study. A thorough ICTs infrastructure is necessary to support the continual connection between all points of contact. It is imperative for innovation teams to select specific ICTs which could be used across organizations and countries. Sufficient training and employees' willingness to adopt technologies are as well essential for the project team operations.

Pertaining to the case observations, organizational rules and procedures could not effectively maintain optimal information interchange and interactions, even though the enterprise imposes administrative standards to regulate the provisions and sharing of opinion and views. At the early stage of the innovation project, most of the project requisites and technical requirements were still vague and ill-structured. Virtual innovation project team members needed to interact in an unfettered and non-routine collaborative working atmosphere. They managed to be free from sets of bureaucratic rules and procedures so as to promote a high level of work autonomy in their individual knowledge domains, as elucidated in both the proposition (2a) and (2b). The intensive use of ICTs allows an enabling platform for appropriate information processing and sharing, and effective cross-functional collective decisions, coexisting with dissimilar characteristics of virtual innovation teams. However, undesirable organizational rules and restrictive procedures form as a source of limitations that prohibits the collaboration malleability among multi-organizational project teams, especially at the early stages of virtual innovation projects.

In regard to the observed physical and temporal contextual issues, innovation project team members could maintain a high level of contact through congruent coordination mechanisms and information tools. Past studies (Mowshowitz, 1997; Townsend et al., 1998) on virtual organizations place special emphasis on information technologies, which accommodate dispersed team members in a virtual interaction working environment. From managerial perspectives, this environment enables dispersed organizations and teams to access and utilize a wide array of information resources and expertise. As in the past, managers might fail to team up their best possible staff in a timely manner to deal with sorts of uncertainty and technical complexity during innovation process.

Virtual workplaces indicate that limitations resulting from space, time, and organization boundaries disappear as project teams can rapidly form, reorganize, and dissolve according to the dynamic demands in end marketplaces. Individuals with diverging competencies thus become more accessible across time, space, and cultures (Kristof et al., 1995; Mowshowitz, 1997; Townsend et al., 1998). The major components that contribute to the virtual team formation comprise of: dispersed team locations, skewed working hours, temporary reporting structures, and multi-organizational teams (Haywood, 1998; To et al., 2009).

Typically, interacting teams in virtual workplace are set up as in changing structures to accomplish a set of contingent tasks; or they may work nomadically and seldom, if ever, meet in face-to-face setting (Townsend et al., 1998). Virtual works often involve professionals working remotely from home or from other non-headquarter locations using networks and the internet (Raghuram et al., 2001). Virtual employees work with minimal supervision and rely heavily on their own sense of judgment, expertise, and initiative to perform their tasks.

The case observed in this study asserts the proposition (3) of the proposed theoretical model of which innovation-work complexities play an influential role in team collaboration processes. An appropriate mix of information systems, such as web-conferencing and synchronized documentation, helps to create a harmonious cooperative working atmosphere among cross-functional innovation teams. However, the innovation team has experienced considerable challenges in the virtual environment as direct information interchange may not enable mutual understanding easily at a higher level of thought and tacit knowledge. Yet today's technology supports socializing communication and promotes team interactions in a more casual and harmonizing manner.

Informal communication is an essential source of information and knowledge transfer for individuals' tacit knowledge. This casual interaction not only furnishes team members with an opportunity to be socially involved, but also cultivates their willingness of information sharing and their dexterity of understanding explicit knowledge in an unplanned environment setting. However, such source of informal interchange is weakly supported under the innovation team setting. As virtual innovation team members are not physically located at the same work place, but geographically nomadic, the lack of face-to-face interaction prohibits team members from socializing in a casual manner.

Very often, nonverbal communications like body gesture/ language that have a vital function in communication processes cannot avail themselves for innovation project teams. The engagement of psychological elements is also weak in virtual communication. If innovation teams choose to rely on e-mail type collaboration approach, members might tend to compose their explicit knowledge into extensive textual messages, which attempt to ensure team members understand and exchange sufficient information. However, because of such, lengthy message would contrarily lead to misunderstandings and confusion among team members. Innovation project teams thus dispose themselves into the interruptions of massive and unorganized textual messages streaming in anytime.

The study examines that innovation project members exchange their ideas by adopting both synchronous and asynchronous communication approaches. Synchronous communication refers to the communication which occurs at the same time between individuals located in different places. Synchronous communication technologies, including phone conversations, instant message, and web-conferencing, are effective as they allow participants exchange their ideas spontaneously without time delays. Although the spontaneous nature of synchronous communication is effective by enabling immediate exchange of responses, participants might sometimes face difficulties in clarifying the reason behind their ideas.

On the contrary, asynchronous communication indicates the communication which neither occurs at the same time nor in the same place. As innovation team members disperse over the globe, they might have little chances to communicate synchronously resulting from the time zones variation. Asynchronous communication, such as e-mail, consumes heavy resources of enterprise-wide message storage and retrieval (Berry, 2011). Participants possess sufficient time to structure their messages and information. Electronic database systems store these messages, which permits tracing of the idea generator, decisions making progress and actions made.

Although the discussions concern mainly the collaboration processes of innovation project team, task definition, work scheduling, and progress control also play a significant role. These collaborative elements vary according to different combinations of contextual antecedents; their effectiveness is conducive for determining the corresponding outcomes of virtual innovation projects. The case study therefore epitomizes and asserts proposition (4) of the proposed theoretic model in analysis, that both communication and coordination project works contribute and result in the collaboration processes of innovation projects.

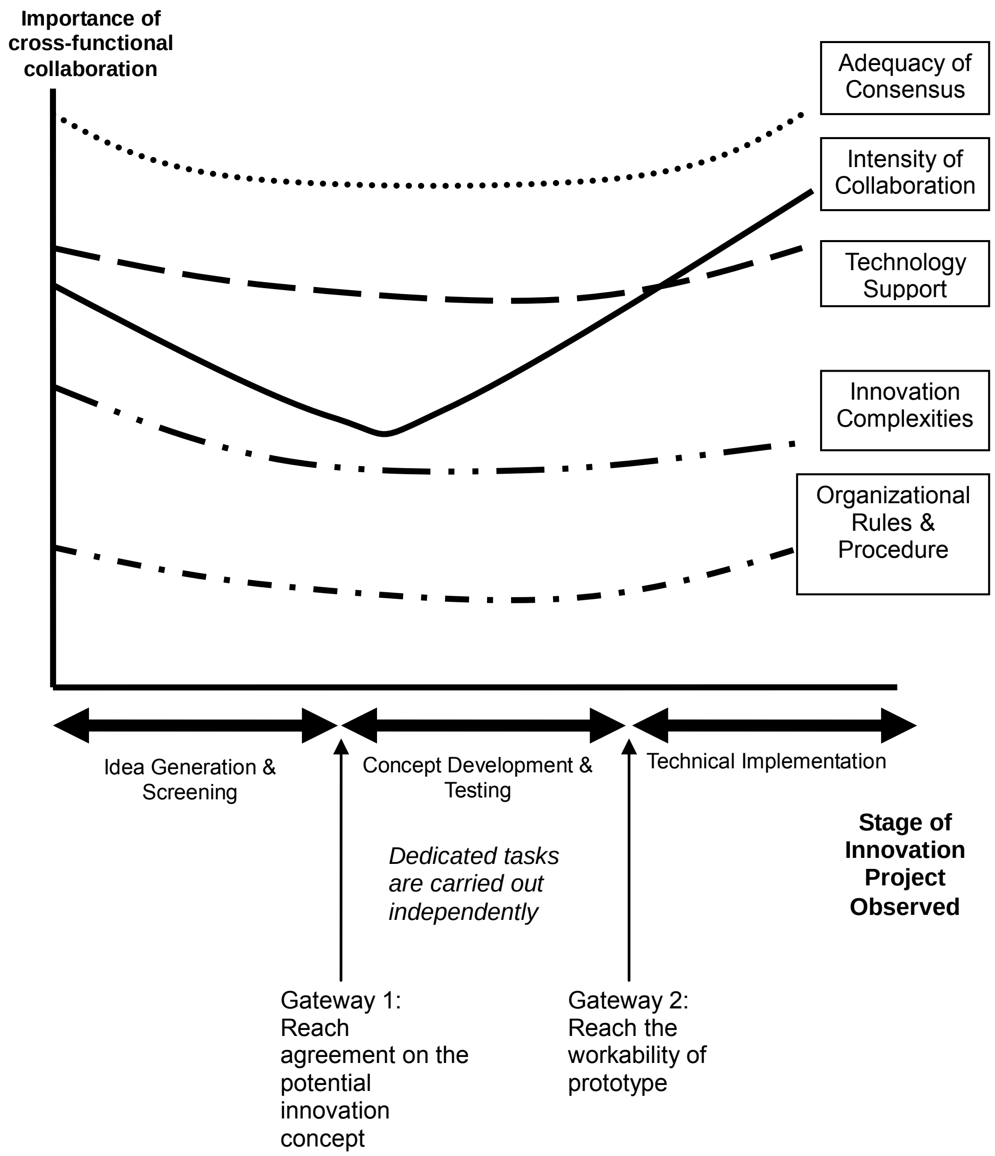
Pertaining to the follow-up interviews with innovation project team members, they mentioned that the effectiveness of cross-functional collaboration influenced the effectiveness of innovation projects. Selecting an appropriate mix of coordination system and communication patterns, according to the characteristics of each virtual innovation project, was therefore critical. Once the innovation project was completed, team members would evaluate their performance immediately based on the actual and tangible task performance, such as: the completion time, budget, and the consumers' satisfaction level. Team members of the observed innovation project stated that innovation project members are more likely to evaluate their socio-psychological satisfaction after they evaluated the actual task performance. Innovation project members would then assess their experiences, personal learning, knowledge gain and social network, which were established during the course of innovation projects. Therefore, the results of case study support proposition (5) suggested in the theoretic model in Chapter 3, which the performance of cross-functional collaboration act as indicators for measuring the achievement of virtual innovation project teams. Team members evaluate both tangible task performance and intangible socio-psychological satisfaction respectively.

4.8. Relationship between Textiles Innovation Projects and Cross-functional Team Collaboration

Based on the case study observed, the author has developed insights about the pattern of cross-functional team collaboration underlying textiles innovation projects. Thus, Figure 4.4 illustrates the moderating effects on the relationship between innovation projects and cross-functional collaboration processes. The x-axis represents various stages involved in the observed textiles innovation project. The three stages are: the idea generation and screening stage, the concept development and testing stage, and the technical implementation stage. Whereas, the y-axis indicates the importance of cross-functional collaboration processes in relation to the undergoing project at different stages.

Each curve represents one particular contextual collaborative behavior of innovation project teams. The position of these curves indicates the relative importance and intensity of the corresponding contextual collaborative behavior when comparing with each other. The higher the position of the curve, the more important the contextual behavior will be, and the higher the intensity it will be among innovation projects. The shape of curves thus represents the change of importance and intensity of contextual behaviors among various project stages.

Figure 4.4: the Illustration of the moderating effects on the relationship between Textiles innovation projects and Cross-functional collaboration



The relationship between the intensity of cross-functional collaboration and innovation project is affected by the project stages of innovation development. Based on the in-depth interviews in Chapter 3, the author proposes that there are a number of collaborative antecedents which influence and contribute to the collaboration effectiveness among innovation projects. In this case study, the author observed that the intensity of these proposed collaborative antecedents changed against the course of innovation project. Detailed discussions are as follows:

- The Idea Generation and Screening Stage

During the stage of idea generation and screening, various innovation project team members must come together, in order to discuss on the potential plans and solutions regarding to the innovation initiatives. Team members must reach consensus on goal setting and other project issues (such as: project scope and duration). Functional team members are also required to come up with some potential innovation possibilities and discuss with each other on the workability of these suggested ideas. Thus, reaching an adequate level of consensus is especially important in this stage. An adequate level of consensus allows project teams to develop an overall framework of innovation projects and build up a foundation for innovation project teams to follow in latter stages.

Technology support is also regarded as an important enabler in this stage, as it provides a virtual platform for innovation project teams to coordinate tasks and communicate with each other. Team members depend on the implementation of Information and communication technologies (ICTs) to make arrangements for the kick-off meeting. Some dispersed team members might as well implement other electronic aids (such as: video-conferencing) to facilitate the collaboration processes of innovation project.

Throughout the whole innovation project period, innovation complexities are at its highest level in the idea generation and screening stage. Project managers are facing great challenges of team collaboration at this stage as dispersed team members just gathered from different organizations and have not committed to any common set of work patterns and collaboration behaviors yet. Project managers must assist project team members to build up a common set of work patterns and collaboration behaviors for latter implementation. For example, "how" team members communicate with each other, "which" ICTs are more suitable for the collaboration of innovation project teams, and "when" is the best timing for project team members to collaborate with each other.

Last but not least, organizational rules and procedures are of the least importance to the collaboration processes of innovation projects. Therefore, its curve is at the lowest position comparing with other contextual factors. Throughout the whole project period, it is yet at its peak position in the idea generation and screening stage. The author observed that as team members were just gathered from their corresponding organizations, they have withheld most of the rules and procedures which they learnt from the enterprises. They thus treated those organizational rules and procedures as the preliminary guidelines of participating innovation project on behalf of their organizations.

As a result, the intensity of collaboration is in a moderate level during the kick-off stage of innovation projects. And, its intensity continues to descend due to the fact that innovation team members may not continue to communicate intensively after they reach consensus on the committed work patterns, as well as the overall framework of innovation projects. Determined by the task nature, team members may start to work on their corresponding project tasks interdependently or on individual basis.

- The Concept Development and Testing Stage

Once innovation project teams have made an agreement on the selection of innovation concept, they will first start to develop the potential innovation concept and carry out testing on the developed concept later. This is thus the critical gateway for the second stage of innovation projects.

Although reaching consensus among team members is still an important issue during the concept development and testing stage, it is less important when comparing with that when the innovation project first started. At the second stage, functional team members must reach consensus on the work patterns of each team individuals, as functional team members start to work on the dedicated project tasks on hand. They either carry out their tasks individually or work interdependently through knowledge interchange. If there were too much emphasis on reaching consensus for every project tasks, the efficiency of innovation development would be inhibited at this stage. Therefore, reaching consensus is not at its most importance in this stage throughout the whole innovation project. It is thus observed that reaching an optimal level of consensus during the concept development and testing stage thus becomes a very challenging task for project managers and coordinators.

Based on the dispersed and nomadic characteristics of innovation project members, technology support still has its important role during the collaboration processes of stage two. However, it is observed that the intensity of technology support is less emphasized in this stage as the preferred mix of virtual platform and coordination tools has already been selected and implemented in the previous stage. As functional team members focus on their individual project works, there are less collaborative activities which required the use of ICTs for team communication. It is thus observed that project managers and coordinators employ ICTs more frequently for coordinating project tasks among various functional members in order to ensure an effective project flow.

During the course of innovation project, project managers have already built up a common set of work patterns and collaboration behaviors with their team members. Innovation complexities thus start to lessen in the concept development and testing stage. However, as nomadic team members may join the innovation team anytime, the set of work patterns and collaboration behaviors is still subject to change. Innovation project members thus need to acquire understandings on the work patterns of nomadic project members and adapt to them during the collaboration processes. Thus, the decreasing rate of innovation complexities is very slow in the concept development and testing stage.

During the concept development and testing stage, organizational rules and procedures are still the least preferable contextual factor in the collaboration processes of innovation projects. The author observed that the presence of organizational rules and procedures acts as friction between cross-functional team members. Due to the fear of violating organizational rules and bureaucratic procedures, functional team members may have avoidance behavior towards the innovation project and become passive collaborators. Resulting from the inactiveness of team members' participation, the lead time of project tasks completion becomes longer. Hierarchical rules and procedures thus create a bottleneck in the collaboration processes of innovation project, its intensity thus at its trough in this stage throughout the whole project period.

As functional team members focus on their dedicated tasks individually on developing the innovation concept, the curve of collaboration intensity thus reached its lowest point during the concept development and testing stage of innovation projects. Its intensity starts to ascend again when the project manager begins the coordination works between various innovation team members after they work on their independent project tasks. They are required to communicate intensively in order to explain and merge the individual project tasks into an innovation concept as a whole. Thus, innovation project teams could carry out the testing process with a variety of experts and professionals backing up.

- The Technical Implementation Stage

After innovation project teams have developed the potential innovation concept and finished testing on the developed concept. A prototype of the innovation is thus developed and ready for implementation. Innovation project team thus joins functional team members on the operation floor to install the enhanced electronic system, also provide them with training and technical support. Therefore, the presence of a feasible prototype acts as a critical gateway for the third stage of innovation projects.

Reaching consensus among team members is still the most important issue during the technical implementation stage, and it becomes more important when comparing with that when the innovation is under development. At this stage, functional team members must reach consensus on the work patterns of technical implementation. As there are a number of functional team members with dissimilar characteristics who are involved in this process, reaching consensus is particularly challenging. Apart from the technical team, operation teams and marketing team are actively involved in the technical implementation stage. The author observed that reaching an optimal level of consensus during the technical implementation stage is especially difficult as the operational-level team members are used to the application of previous system, they might need more technical assistance and training when applying the newly introduced innovation system.

Based on the intensive knowledge sharing between innovation project members, technology support maintains its important role during the collaboration processes in the technical implementation stage. It is observed that the intensity of technology support is more emphasized in this stage as innovation project team might have to redefine a new mix of communication platform among the implementation environment. As functional team members mainly focus on the installation and implementation of innovation prototype in the field, the employment of ICTs needs to be practically fit with the project environment in concern. There are thus more collaborative activities, such as technical support and information sharing, which required the use of ICTs for team communication in this stage.

Innovation complexities are more intensive in the technical implementation stage, as operation-level team members are actively involved in this stage. Functional team members face a challenge that these operation-level team members are often with less flexibility in work arrangements and procedures, they are more likely to work according to the book. Therefore, project managers must fine-tune the selected set of work patterns and collaboration behaviors to be employed by functional team members in the field. The author observed that the most obvious adjustment is the time arrangement for innovation team collaboration, as the operation-level team members have a regular and rigid work schedules bounded by the organizations. It is therefore impossible to stay with the round-the clock work pattern during the technical implementation stage.

Nonetheless, the curve of organizational rules and procedures starts ascending again in the technical implementation stage. As the innovation prototype needs to be installed and put into practice, innovation project team are therefore required to follow the rules and procedures employed in the corresponding enterprise. The author observed that as functional team members need to install the prototype in the field, therefore they must follow all the rules imposed in that particular field without exception. And, they have to collaborate in a sense that not violating those regular procedures which are out of the innovation scope.

As a result, the curve of collaboration intensity reaches its highest point during the technical implementation stage of innovation projects. And, the intensity continues to ascend due to the fact that technical team members are required to pay a number of visits to the operation floor to install and recover the developed innovation, and to provide technical support. It is thus observed that there was intensive communication between the innovation project team. Not only the technical team participates actively at this stage, team members on the operation floor are also responsible for applying the innovation output and providing feedback backward for innovation enhancement. These participants thus need to reach consensus on a common set of work patterns which are employed in this stage. Innovation team members at the same time implement the developed innovation on individual basis, and exchange opinions and technology know-how interdependently.

4.9. Summary

The results of this qualitative study provide us with insightful viewpoints on how innovation team members collaborate in the new business era. It has revealed a series of human interactions taken place in the textiles innovation projects, these interactions provide us valuable insights on how the differences in collaborative contextual factors affect the team performance and how the collaborative processes of this kind of virtual innovation project could be managed. Nevertheless, this case study provides a solid foundation on the development of theoretic conceptual model for the effectiveness of innovation collaboration. The author thus discusses the observations made on the relationship between the intensity of suggested collaborative antecedents and different stages of innovation projects.

CHAPTER 5

UNDERSTANDING THE EFFECTIVENESS OF TEAM COLLABORATION AMONG INNOVATION PROJECTS: A QUANTITATIVE STUDY

5.1. Introduction

The working affiliation between multifunctional expertise during innovation projects has long been recognized as a concerning issue for top management. Project failures often associate with the low levels of alliance and ineffective communication within cross-functional project team. From the standpoint of organizational studies, researchers (Gupta et al., 1986; Cooper and Kleinschmidt, 1987; Moenaert et al., 1994; Griffin and Hauser, 1996) often relate new product failures to the poor integration of Marketing function and Research & Development function. In addition to the difficulties aroused by departmental alliance, team individuals also face with various collaborative challenges during the development of innovation projects.

Collaboration is therefore a key constituent of innovation project management as it enables intensive technical and social interactions among team members. These interactions are essential to tackle complex innovation problems under a nomadic and virtual project environment. However, collaborative challenges may result from the reengineering of technical interdependencies, such as product module dependencies and engineering capabilities, or from the disputes of social and organization interdependencies for a wide array of functional expertise, task scheduling and communication channels. A better understanding of collaboration effectiveness in the innovation setting will allow for areas of enhancement such as advancing working processes, modification of supportive tools, minimizing negative outputs of innovation activities and improvement of project performance.

In an attempt to extend the measurement theory and practice beyond a focus on output performance, the author aims to provide further empirical support for understanding the determinants of collaboration effectiveness among innovation projects. Several key variables that emphasize contextual behaviors and collaboration relationships emerged from the prior qualitative research studies regarding the management of textiles innovation projects. These key variables include team consensus, innovation complexities, technology support (including management support and IT support) and constraints imposed by organizations and team level. In this chapter, the author examines the emerged factors, which are considered as influential to the collaboration effectiveness of innovation projects. This study thus evaluates the effect of these dynamic elements on team collaboration effectiveness in the context of innovation projects.

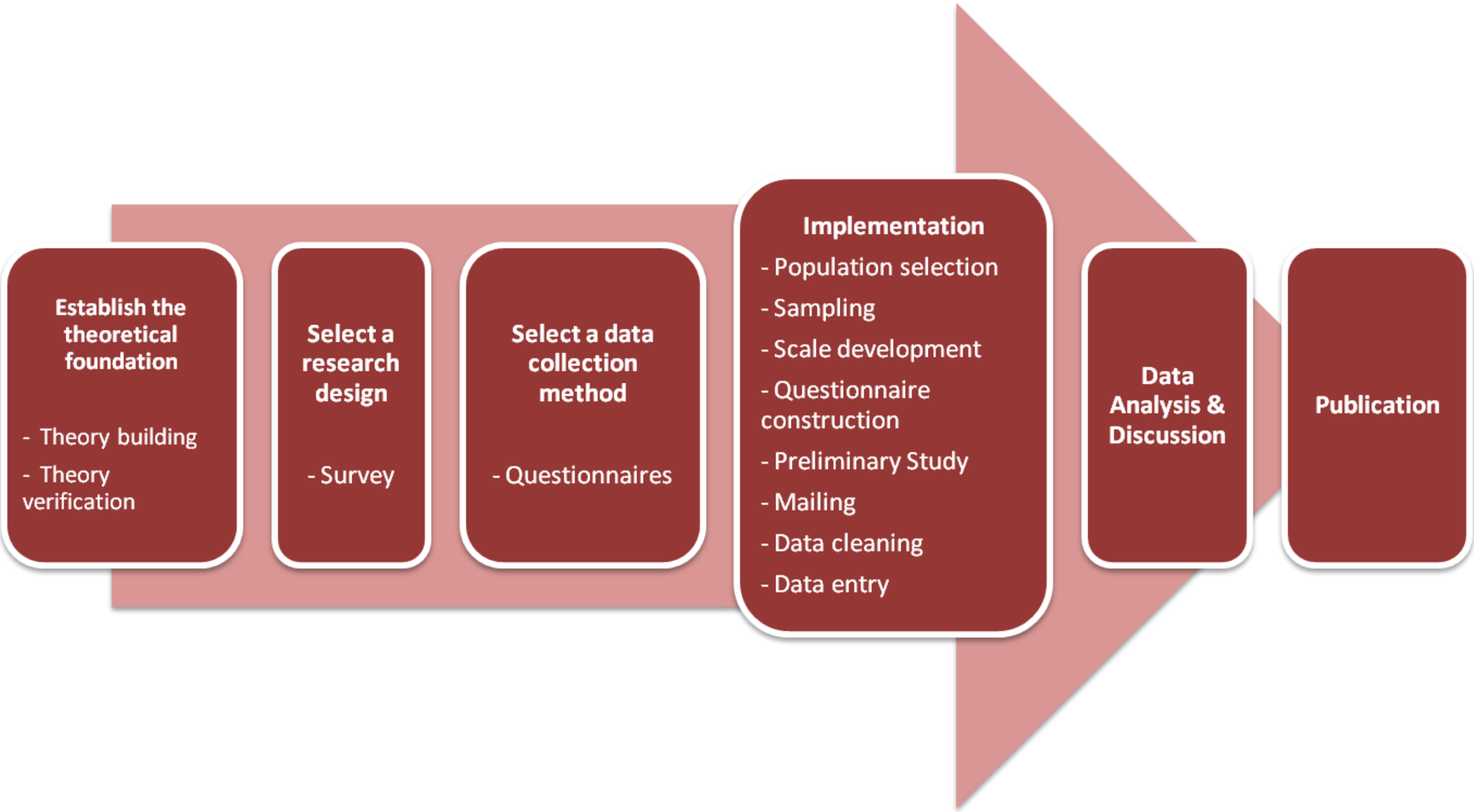
This chapter follows and modifies the suggested process for conducting business empirical research (Flynn et al., 1990). Referring to Figure 5.1, the author first introduces the research design of survey, and the selection of questionnaires as data collection method. The author thus describes the sampling strategy and the scale development processes of contextual constructs. The questionnaires construction and data analysis strategies are also described.

Second, the author collected data and responses from respondents to evaluate the development of operational measures and questionnaires in the preliminary study. The author thus carried out data analysis to refine and justify the construct of items and the survey instrument.

Third, the author describes the data cleaning and screening process for the mass industry survey, which ensures that the data do not suffer from any statistical bias. Descriptive statistics of main variables of interests and analysis of respondents are also provided.

Last but not least, the author describes a thorough quantitative analysis on the proposed conceptual framework using the mass survey data, and reports the findings. The author also reports the reliability and validity of the measurement model, and presents the hypothesis testing procedures and results using structural equation modeling (SEM).

Figure 5.1: the Modified Approach for Business Empirical Research (Flynn et al., 1990)



5.2. Survey Instrument

In this study, the author investigates the interrelationship between the contextual antecedents and the collaboration processes of innovation projects, and how these antecedents influence the collaboration effectiveness among innovation project teams. Moreover, the author also examines how the collaboration effectiveness affects the effectiveness of innovation project.

Through the extant review of literatures, a list of contextual antecedents which influencing team collaboration among innovation projects was summarized. Following the literature review, the author conducted an in-depth interviews study and an ethnographic observation case study for further empirical tests. Thus, the author seeks to employ a quantitative approach to study the proposed theoretical model of constructs concerning on the collaboration of innovation projects.

Survey is selected as the research design of this quantitative study because it is a useful tool for measuring the vital facts of people, and their beliefs, opinions, attitudes, motivations and behavior (Kerlinger, 1973). The survey method can also be used to gather data regarding to demographics and lifestyle characteristics of respondents.

There are three major advantages of employing survey research, which are ease, reliability and simplicity. First, questionnaires are relatively easy to administer. Second, the use of multiple choice questions helps the author to get fixed-response from the respondents. This thus enhances the reliability of responses by minimizing variability and influences of the interviewer. Third, survey also simplifies the processes of data coding, data analysis and interpretation of data.

The development of this survey research is based on the following steps:

1. The constructs of this quantitative study are built on the foundations of literature reviews, the in-depth interviews study and the ethnographic case study.

2. To achieve face validity, the preliminary questionnaire is pretested by a group of industrial practitioners and academics who are specialized in project management and team studies.

3. The author examines the reliability of scales in the preliminary study, thus modifies the corresponding measurement items and questionnaires.

4. The author thus conducts the mass survey among innovation project team members whose organizations are based in Hong Kong.

5. The confirmatory factor analysis (CFA) and structural equation modeling (SEM) are performed in data analysis of the main study to examine the proposed relationships among constructs: Collaboration effectiveness of innovation projects and its contextual antecedents; Collaboration effectiveness of team members and the innovation effectiveness.

5.3. Data Collection Strategy

Questionnaire is one of the many types of measuring instruments that contains of a formalized set of items for obtaining information from respondents. It is therefore selected as the data collection method for this research because the aim of this study is to explore the views of innovation team members in their natural work setting.

Moreover, questionnaires are especially useful to uncover respondents' personal attributes, behaviors, beliefs and their attitudes. These constructs are difficult to measure and observe in large-scaled research studies. It is very time-demanding and difficult to observe only one case study of collaboration processes among innovation projects. Therefore, the author aims to study innovation teams collaboration based on the data collected via questionnaires.

In chapter 3 and 4, qualitative research studies (such as: Case study) provided the author with better understanding and insights. However, it is believed that results from this quantitative research study is more representative with a wider innovation projects population when comparing with that of a case study. The data collection method of questionnaires is more representative because it allows the author to collect a large amount of data by using the standardized instrument.

However, the questionnaire data collection method is still subject to certain limitations. Some limitations are as follows: poor response rate will fail to achieve valid generalizations; the author must be able to reach and encourage target respondents to complete the questionnaires; omission of replies to certain questions can happen; and it cannot be applied in situations where spontaneous responses are needed. As the questionnaire is a self-administered method of data collection, misunderstanding of questions may lead to inaccuracies in the data. Therefore, the author matched the language used in the questionnaire with the education level of respondents, and words used are also with the same meaning for innovation team members; at last, the questionnaire is pretested with a group of experts in order to ensure it is well-structured and easy to understand.

5.3.1. Web-Based Surveys

The major techniques used for data collection is the web-based surveys. There are two ways to prepare for electronic surveys, which are email surveys and web surveys (Dillman, 2000). As the author is provided with a non-commercial list of innovation project teams by a government research center, therefore questionnaires can be mailed electronically to respondents included in the sample. The author can also increase the response rate by sending electronic reminders to the respondents as well. Web-based surveys are becoming a popular form of surveys because they are flexible and inexpensive. Respondents can conduct the questionnaire whenever and wherever they are, without time and geographical restrictions. At the meantime, such loss of control in environment may also be a potential disadvantage.

Although email surveys approach has an important drawback if the respondents do not have access to the internet, it will not be the case in this research study. It is because the target population of this quantitative research has a high rate of internet use. Therefore, the web-based surveys can provide various advantages, such as: fast, effective and no interviewer bias, to this research study.

As a result, a pre-tested and self-administered questionnaire is addressed to the project team members of innovation projects through Email. The questionnaire was designed according to the objective of this study, which is to discern precedents, which leads to an effective collaboration process of innovation projects. The author then sent the questionnaire to the respondent's email address as an attachment. The author thus used the cover letter as email messages to introduce this research, and provided guidelines to complete the questionnaire. Ethical issues and confidentiality were also described to the respondent. In addition to the email address, the author's contact information was also stated in the email for any enquiries about the survey.

5.4. Sampling Strategy

Sample selection must be consistent with the objective of research study, and addresses to the problem definition practically. This research study is focused on the investigation of innovation projects collaboration, and its influence on the effectiveness of innovation projects. Therefore, the target population for this research study is project team individuals with experience in conducting innovation projects.

Respondents must fulfill a number of selection criteria in order to be qualified for information provision, these selection criteria are listed as follows:

1. The respondent must have 3 years or above working experiences in the development and implementation of innovation projects

2. One of the main duties of respondents must be related to the implementation of innovation projects

3. The respondent must be known of having expertise, which is essential for the development and implementation of innovation projects

4. The respondent acts as a gatekeeper, his or her advises are regarded as an essential input for the innovation progress

In order to develop a target population with sample representativeness, the author built the sample frame based on a non-commercial list of innovation projects. The non-commercial list of innovation projects was provided by a government research center. It has gathered email addresses of project managers/ coordinators and teams' members who take part in innovation projects. The list consists of a representative sample of innovation projects which are conducted by Hong Kong based enterprises and the tertiary institutes. The author thus sent emails to those project managers/ coordinators and team members included in the list, and invited them and their project teams to participate in this research study.

Respondents of this research study can be divided into two main types, which are functional team members from Hong Kong based enterprises and research personnel from tertiary educational institutes. All respondents are experts with diverse functional backgrounds, and have been involved in at least one virtual innovation project within the recent three years. They are also embedded with valuable experiences gained from significant interaction with other parties during the innovation project.

There are minimum requirements for the sample size appropriated for achieving statistical significance among multivariate data analysis. Both exploratory and confirmatory factor analysis are subject to the effects of sample size. Hinkin (1995) suggests that a sample size of 150 should be sufficient for an accurate solution in exploratory factor analysis, whereas a minimum sample size of 200 for the confirmatory factory analysis.

Regarding the sample size for structural equation modeling, researchers (Garver and Mentzer, 1999; Hoelter, 1983) propose a "critical sample size" of 200. Therefore, sample size around 200 is understood to provide sufficient statistical significance for data analysis.

Concerning on the sample size for this quantitative study, 267 participants are randomly selected from the sampling frame. It is therefore appropriate for the multivariate data analysis of this research study, which are exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and structural equation modeling (SEM).

5.5. Scale Development for Variables

Aiming at achieving a satisfactory outcome of research study, it is essential to develop a reliable and valid device for measurement. As a validated survey instrument for investigating the relationship among the three major constructs of collaborative innovation project team did not exist, a questionnaire was therefore designed through the combination of two ways. Most of the validated measures have individually been used in previous research and adapted in this study (See Table 5.1). Some of the new measures were created based on the results of preliminary qualitative studies. The questionnaire consists of three main constructs that with highest interests in this study, which were: a set of collaborative antecedents, the complex collaboration processes and the corresponding innovation team performance.

Given the novel nature of the theme of this research study, most of the variables measured are adapted from previous academic measurement approaches based on various IT adoption model and project management studies, which were identified to be interrelated with the innovation collaborative studies (See Table 5.1). The reliabilities of each corresponding construct, from previous studies, were carefully looked at. And, only measures with acceptable reliabilities are employed in this study. Items of these corresponding constructs were reworded and the reliabilities for each measure will be recalculated in this study. Apart from the measures that are adapted from previous research studies, there are six out of twelve constructs which are formed for this study. They are created based on the supports of previous literatures and the preliminary qualitative studies.

Subject to the applicability of measurements in this research study, both newly developed measurements scales and pre-tested measurement items from prior empirical literatures are adapted and employed in the questionnaire. With the exception of the demographics, all items from the corresponding constructs are measured in a 5-point Likert scale. The scales are ranging from 1 (strongly disagree) to 5 (strongly agree). In some cases, the option Not Applicable and Nil are also provided as an option to the respondent. Respondents are expected to give further explanations if they have chosen the choice of Not Applicable.

Table 5.1 below shows a list of measurement constructs, with their corresponding definition, number of items used, as well as the section they appear in the questionnaire, and their corresponding references of prior literatures.

Table 5.1: the Matrix of constructs and corresponding measurement references

Constructs	Definition	Section in the Questionnaire	Numbe r of items	Measurement references
Availability and Popularity of Information and Communication Technologies (ICTs)	Describes the ICTs available for innovation team members and their frequency of use	Section 1 ICTs Availability	13	Nil
Group Norms in ICTs Implementation	Determines the establishment of communication norms among innovation team members	Section 2 ICTs Usage	6	Feldman (1984)
Adequacy of Team Consensus	The extent to which innovation team members achieve their group consent	Section 3 Consensus	6	Dooley et al. (2000); Hall et al. (2003); Mathieu et al. (2000)
Perceived Management Support	Indicates the perceived level of general support provided by top management	Session 4 Management Support	8	Igbaria (1990)
Perceived IT Support	Reflects the level of sophistication in IT application and resources availability	Session 5 IT Support	6	Iacovou et al. (1995)
Perceived Organizational & Team constraints	Indicates the perceived boundaries of rules and procedure imposed on innovation project team	Session 6 Rules and Procedures	6	Pinto et al. (1993); Denison et al. (1996)
Communication Effectiveness	Measures the quality of communication strategies	Session 7 Collaboration Effectiveness	6	Hoegl et al. (2001)
Coordination Effectiveness	Measures the quality of coordination strategies	Session 7 Collaboration Effectiveness	4	Hoegl et al. (2001)
Physical Proximity	Reflects the workplace arrangement of innovation project teams	Section 8 Proximity	2	Pinto et al. (1993)
Temporal Arrangement	Indicates the perception of innovation team members on time-related issues	Section 8 Proximity	3	Ancona et al. (1992); Dougherty (1992); Gersick (1988)
Task Performance	Reflects the level of satisfaction with project results	Session 9 Innovation Team Performance	9	Pinto et al. (1993); Hoegl et al. (2001)
Socio-psychological Satisfaction	Measures the level of satisfaction with innovation project works	Session 9 Innovation Team Performance	8	Hoegl et al. (2001); Denison et al. (1996)

5.5.1. Adequacy of Team Consensus

The items from the adequacy of team consensus construct are self-developed subsequent to the consulting of previous research literatures (Dooley et al., 2000; Hall et al., 2003; Mathieu et al., 2000). These measurement items are as well determined by the main concepts brought up in the priori qualitative research interviews that have been conducted. It is believed that the self-development of such construct can shed the light in the structure of collaboration effectiveness among innovation project teams. Again to my knowledge, the adequacy of team consensus has not been measured in any collaborative innovation project models. However, due to the nature of innovation collaborative work setting, it is identified as one of the crucial antecedents for both collaboration effectiveness and innovation team performance. Such construct is renamed as consensus to avoid the respondents' judgment on the word "adequacy".

Table 5.2: the Initial Items for Consensus (CON)

Code	Item
con1	We can always obtain a shared agreement in a short time interval
con2	I believe it is necessary to have commitment to others' performance in the innovation project environment
con3	We spend a lot of effort to overcome different barriers in order to attain a shared decision
con4	We stick to a set of clearly-stated administrative procedures when tackling problems
con5	I think our information processing procedures along tasks are consistent and seamless
con6	We set our goal among our innovation team members on collective basis

5.5.2. Perceived Management Support

The perceived management support construct is derived from the model developed in Igbaria's study (1990). The construct is renamed as management support to avoid the ambiguity of the word "perceived" as well. Igbaria's model focuses on the examination of analytical factors which influence the acceptance level of personal computing in small firms. While the proposed model in this study intends to examine whether and to what extent management support affects the dispersed innovation team's collaborative effectiveness, thus influence the ultimate project performance. The items from Igbaria's model (1990) are modified and re-worded for the purposes of this research study.

Table 5.3: the Initial Items for Management Support (MS)

Code	Item
ms1	Management aware of the benefits that can be achieved through the use of information and communication technologies for innovation project works
ms2	Management always support and encourage the use of information and communication technologies for innovation project works
ms3	Management has provided most of the necessary help and resources to facilitate people in using information and communication technologies for innovation project
ms4	Management is really keen to see that people are satisfied with use of information and communication technologies in innovation project
ms5	Management provides good access to various types of software for innovation project
ms6	Management provides good access to hardware resources for innovation project
ms7	Management regards the use of information and communication technologies as a high priority for innovation project works
ms8	Management identify the use of information and communication technologies for innovation project as part of the company's mission

5.5.3. Perceived IT Support

The perceived IT support construct is renamed as IT support and adapted from the study of Iacovou et al. (1995). Iacovou et al. (1995) propose an electronic data interchange (EDI) adoption model, which integrated a construct of organizational readiness. Such construct of organizational readiness is a combination of both financial and technological resources which are available to a firm. In particular, the availability of technological resources is identified as an appropriate construct in the present proposed research framework for measuring the collaboration effectiveness of innovation project team. Therefore, the priori measurement items are adapted and re-worded in six questionnaire items, in order to fit the information and communication technology used among innovation collaborative project teams.

Table 5.4: the Initial Items for IT Support (ITS)

Code	**Item**
its1	The organization possesses a good telecommunications infrastructure
its2	The organization possesses a categorized electronic data exchange system
its3	The organization possesses the necessary infrastructure to support remote communication
its4	The organization possesses a rapid internet/ intranet access
its5	The organization possesses adequate videoconferencing systems
its6	The organization possesses adequate collaborative software systems

5.5.4. Perceived Organizational and Team Constraints

The items from the perceived organizational and team constraints construct are adapted from organizational rules and procedures scale (Pinto et al., 1993) and the cross-functional teams questionnaire (Denison et al., 1996). Pinto et al.'s (1993) study has examined the influential effect of organizational rules and procedures on both cross-function cooperation and perceived task outcomes, under the context of traditional project team. Thus, organizational rules and procedures are identified as a proper construct for the proposed model in this research study, it can provide insights for measuring its effects on the collaborative effectiveness and perceived task outcome among innovation project teams.

Moreover, the perceived organizational and team constraints construct is also derived from the construct norms in Denison et al.'s (1996) diagnostic model which studies the cross-functional teams in organizations under the team process domain. Again the construct is renamed as rules and procedures to avoid the ambiguity of the word "perceived" and the respondents' judgment on the word "constraints". Items that are identified as relevant in this study are selected and re-worded to fit the model proposed in this research study.

Table 5.5: the Initial Items for Rules and Procedures (RAP)

Code	Item
rap1	For most problems that arise on this project, there are rules and procedures for dealing with them
rap2	It is clear in our organization what is acceptable and what is not acceptable
rap3	The innovation team has its own rules and procedures to facilitate the project progress
rap4	It is clear in our team what is acceptable and what is not acceptable
rap5	Our team has a very orderly working behavior and pattern – it is clear what members are expected to do and they do it.
rap6	Our team has clear standards for the behavior of team members

5.5.5. Collaboration Effectiveness

The collaboration effectiveness measures for this proposed research model is divided into (1) Communication effectiveness and (2) Coordination effectiveness. Both constructs of communication and coordination effectiveness are adapted from the study of Hoegl and Gemuenden (2001). The theme of Hoegl and Gemuenden's study (2001) is to investigate the relationship between teamwork quality and project success in the innovative projects domain. The measurement scales for effectiveness and efficiency are originally based partly on the scales used by Gemuender and Lechler (1997) in their large-scale project management study in Germany. Hoegl et al.'s model is based on the innovative projects' success factor, while the present proposed model intends to examine whether and to what extent collaborative effectiveness is affected by the set of antecedent constructs, thus influence the ultimate project performance. The communication effectiveness construct is modified and constituted six items in the questionnaire and the construct coordination effectiveness is made up of four items in questionnaire for the purposes of this research study.

Table 5.6: the Initial Items for Collaboration Effectiveness (COE)

Code	**Item**
coe1	There are frequent communications within the innovation project team
coe2	I often communicate with other team members in spontaneous meetings or through implementing information and communication tools (such as: Phone, Email, etc.)
coe3	Project-relevant information is shared openly by all team members
coe4	Our team members are happy with the timeliness in which We received information from other team members.
coe5	Our team members are happy with the accuracy of the information received from other team members.
coe6	Our team members are happy with the usefulness of the information received from other team members.
coe7	The work done on subtasks within the project is harmonized
coe8	There are clear and fully comprehensive goals for subtasks within our team
coe9	The goals for subtasks are accepted by all team members
coe10	There are conflicting interests in our team regarding subtasks/ sub-goals

5.5.6. Perceived Innovation Complexities

The perceived innovation complexities measures for this proposed research model is composed by the constructs of (1) Physical proximity and (2) Temporal arrangement. The physical proximity construct is adapted from Pinto et al. (1993), who measure this construct in cross-functional project teams. This construct not only reflects the workplace arrangement of innovation project teams, but also assesses the respondents' perception of proximity with their team members. While the measurement items of temporal arrangement are derived after consulting various literatures on project management (Ancona et al., 1992; Dougherty, 1992; Gersick, 1988). These scholars had discussed the importance of time dimension on project team performance in their research studies. The construct of temporal arrangement can reflect innovation team members' perceptions of whether and to what extent proximity affects their collaborative effectiveness and project outcome. Therefore, the measurement items are modified and reworked to fit with the proposed research model into five measurement items in the questionnaire. The construct is also renamed as proximity to avoid the ambiguity of the word "perceived" and the respondents' judgment on the word "complexities".

Table 5.7: the Initial Items for Proximity (PRO)

Code	Item
pro1	All of our team members are conveniently located in our working location
pro2	Our team shares a same set of consistent and regular work paces
pro3	Some of our team members are dispersed across different countries
pro4	We share a similar set of rhythm when processing our daily tasks
pro5	From our team's perspective, the time scale of project development is of great importance

5.5.7. Perceived Innovation Team Performance

By consulting various literatures on project management (Hackman, 1990; Pinto et al., 1993), the innovation team performance construct for this research framework is divided up into (1) Task performance and (2) Social-psychological satisfaction. The inclusion of both tangible and intangible dimensions of implementation outcomes can lead us to a more dynamic picture of innovation team collaboration.

The task performance construct is adapted from the measures of perceived task outcomes (Pinto et al., 1993) and the team performance scale (Hoegl et al., 2001). The measurement items are adapted and reworked to fit the proposed model in this research study with nine items in the questionnaire.

The construct social-psychological satisfaction is adapted from the study of Hoegl et al. (2001), the learning scale from Denison et al.'s (1996) study and the learning scale from Hoegl et al.'s (2001) research. Hoegl et al. (2001) assume that satisfaction with working in teams could lead to increased motivation for participating future projects. Hoegl et al. (2001) and Denison et al.'s (1996) also ask respondents to evaluate their learning experiences in a personal manner and team manner respectively; however, these items are relevant to this research study. The measurement items are modified and constituted eight items in the questionnaire to fit with the proposed research model in this study.

In order to avoid the ambiguity of the word "perceived", this construct is renamed as innovation team performance.

Table 5.8: the Initial Items for Innovation Team Performance (ITP)

Code	Item
itp1	According to the results, this project can be regarded as successful
itp2	From the company's perspective, all project goals are achieved
itp3	The project result is highly satisfactory
itp4	The team is satisfied with the project result
itp5	From the company's perspective, the project progress satisfactorily
itp6	Overall, the project is done in a cost-effective manner
itp7	Overall, the project is done in a time-efficient manner
itp8	The project is within schedule
itp9	The project is within budget
itp10	Overall, our team earns a positive balance for themselves in the project
itp11	Our team has gained from the innovation project
itp12	Our team would like to perform innovation collaborative works again
itp13	I have acquired important know-how through working in this project
itp14	Our team learns important lessons from this project
itp15	Our team sees this project as a technical success
itp16	I have developed many new skills from working with members from other functions
itp17	I have learned things working in this project that I will use in other groups

5.5.8. Popularity of Information and Communication Technologies (ICTs)

The items from the availability and popularity of information and communication technologies (known as ICTs in below) are newly suggested through priori qualitative studies. These items are frequently mentioned by the innovation project team members as the common tools for their daily collaborative works. This construct is renamed as ICTs availability in the questionnaire to avoid prejudice in the word “popularity”. These measurement items can provide us with the insights of ICTs users’ habits, as well as the availability of ICTs in diverse organizations and industries.

Table 5.9: the Initial Items for ICTs Availability (ICTA)

Code	Item
icta1	Collaborative Software; facilitate the multiple authorship of documents, joint development of databases, spreadsheets, and other information resources
icta2	Computer conferencing; Real-time on-line discussion (e.g. MSN)
icta3	Electronic bulletin board
icta4	Email
icta5	Fax
icta6	Group Support Systems (GSS); designed to create and environment for brainstorming, focus group work, and group decision making
icta7	Telephone
icta8	Telephone conferencing
icta9	Videoconferencing (Dedicated room)
icta10	Videoconferencing (Desktop)
icta11	Voice mail
icta12	Face-to-face interaction

5.5.9. Group Norms in ICTs Employment

The group norms in ICTs employment construct is renamed as ICTs usage in the questionnaire. And, this construct is adapted from the study by Feldman (1984). The theme of Feldman's study is to examine various ways of establishing group norms in the organizational context. It is noteworthy to determine the establishment of group norms in relation to the ICTs usage among the respondents' project-based context. Items that are identified as relevant in this study are selected and reworded to fit the model proposed. In my knowledge, group norms in ICTs employment has never been used in any of the study among the collaborative innovation project domain. This construct will help to identify the reasons why innovation team members use specific ICTs during the course of innovation projects.

Table 5.10: the Initial Items for ICTs Usage (IU)

Code	Item
iu1	Through explicit statements or requirements by the team leader
iu2	Through precedents created within the team during critical events
iu3	Through repetitive usage patterns that simply emerged from the team
iu4	Through collaborative team efforts to develop acceptable standards or norms for communication
iu5	Based on my prior experience before becoming a member of this team

5.6. Questionnaire Construction

The beginning of the questionnaire provides with the background information of this research study. Therefore, respondents can understand the subject matter by going through the stated research purposes and objectives.

Part I of the questionnaire deals with the theme of information and communication technologies (ICTs), the objective of this part is to understand the types of information and communication technologies implemented. First, ICTs availability is used to indicate both availability and popularity of information and communication technologies during their innovation collaborative works. Respondents were asked to rate their frequency of use in relation to the available information and communication technologies through the use of a 5-point Likert scale ranging from (1) Seldom to (5) Frequently. They were also given the choice of using Nil for any items that was not available in the respondents' working situation. Another construct, group norms in ICTs implementation, is referred simply in the measurement instrument as ICTs usage.

Part II of the questionnaire focuses on the theme of organizational contexts, the objective of this part is to understand the extent of support and boundaries, which are imposed by the organization. This part of the questionnaire aims at capturing significant information regarding to respondents' perceptions on both support and constraints that they have experienced in those collaborated innovative works. The constructs of perceived management support, technological support, and perceived organizational and team constraints are measured in this part.

Part IV of the questionnaire deals with the theme of collaboration effectiveness, this part aims to measure the quality of both communication and coordination strategies that employed in collaborated innovative tasks. Both constructs of communication effectiveness and coordination effectiveness appear as collaboration effectiveness in the questionnaire for simplicity.

Part V of the questionnaire deals with innovation complexities, which is also known as the proximity issues of dispersedly collaborated innovation team. The objective of this part is to measure respondents' perceived value on both distance and time dimensions of collaborative innovation works. Two constructs of physical proximity and temporal working arrangement are referred simply in the measurement tool as the dimension of proximity.

Part VI of the questionnaire deals with the outcome variables of dispersedly collaborated innovation projects, the objective in this section is to measure the innovation team performance identified. Respondents were asked to rate their performance through the use of a 5-point Likert-type scale ranging from (1) Strongly Disagree to (5) Strongly Agree. The construct task outcome, work satisfaction and personal learning are measured and appeared as innovation team performance in the questionnaire for simplicity.

Part VII of the questionnaire deals with demographics and is intended to collect background information from each respondent as well as the team and organization they work for.

5.7. Data Analysis Strategy

The author collected the questionnaires from respondents through email, and entered the collected data in SPSS. The author thus conducted data editing, coding, and cleaning in order to prepare data for further analysis. All measured variables are from the perspective of innovation projects and the unit of analysis is innovation team member.

Based on the research objectives, the author thus explored the collected data and came up with ideas of data analysis techniques. Certain data analysis techniques are chosen based on the characteristics of data and the properties of statistical methods.

The author first applied SPSS 16.0 for windows to carry out the preliminary data analysis. Descriptive statistics, reliability and validity tests, and factor analysis were then performed. Followed by the hypothesis testing, the author employed IBM SPSS AMOS 21 to carry out structural equation modeling to test validity and the propositions.

5.7.1. Preliminary Data Analysis

Descriptive statistics of quantitative research study summarizes a given data set, and describes the main features of the total sample (Mann, 2006). The measures for describing the data set include means, percentages, frequencies, variance and standard deviation. In this research study, the author employs descriptive analysis to provide the profile of the samples, summarize and describe the data set.

Factor analysis was used in the preliminary study to identify the dimensions of measurement variables. Exploratory factor analysis (EFA) was performed to orderly simplify a set of interrelated measurement items. The author used EFA to explore the possible underlying factor structure of a set of variables (contextual antecedents, collaboration effectiveness and innovation team performance) without imposing a preconceived structure on the outcome (Child, 1990). Therefore, the author carried out data reduction to obtain a smaller set of variables from a large set of variables.

Thus, the author found the eigenvalues (which are the variance on factors that were extracted), and used the scree test to plot a graph on the eigenvalues associated with each constructs against their ordinal number. Generally, the graph shows the magnitude of successive eigenvalues drops sharply and tends to level off. The author thus retained the number of factors at the point where the eigenvalues level off (Hair et al., 1998).

The aim of performing rotations in factor analysis is to better clustering variables in fewer numbers of factors. The author therefore applied varimax rotation to simplify the columns of factor loading matrix, as each factor will tend to have small number of variables with large loadings. Moreover, the author only considered and retained factors with factor loadings larger than 0.55, as researchers (Comrey and Lee, 1992; Tabachnick and Fidell, 2007) suggested that cut-off at 0.55 is considered as good when the items have different frequency distribution.

Confirmatory factor analysis (CFA) is commonly used in social research (Kline, 2010). It is performed to test whether data fit with the proposed theoretic structure of variables. The author employed CFA to verify the factor structure of a set of variables, and to test the proposed relationships among variables of contextual antecedents among innovation projects and their underlying latent constructs exist.

The author selected the Chi-square test as the good-of-fit indices used in the confirmatory factor analysis. A good model fit between the model and the data indicates as credible model. The Chi-square test helps the author to indicate the adequacy of measured constructs to a model. The closer the chi-square value to zero, the better the data fit to the model. The author thus treated chi-square value above 0.85 to be acceptable.

5.7.2. Hypothesis Tests

Structural equation modeling (SEM) is a comprehensive statistical approach to test hypotheses about relations among measured and latent variables (Hoyle, 1995). It also tests hypothesized patterns of directional and non-directional relationships among these variables (MacCallum and Austin, 2000). The author thus performed SEM to understand the patterns of correlation among the set of variables, and to explain as much of their variance as possible with the model specified (Kline, 1998).

In this research study, SEM was performed to determine if the estimated population covariance matrix of the proposed model was consistent with that of the measured covariance matrix. IBM SPSS AMOS 21 was employed to configure path diagrams, evaluate model fit and carry out parameter estimation.

The author employed the maximum likelihood estimation in the SEM analysis, because maximum likelihood is always the default for many model-fitting programs. Maximum likelihood estimation methods are appropriate for non-normally distributed data and small sample size. In order to determine if the proposed theoretical model is consistent with the pattern of variances in data, the author used some fit indices in SEM for measurement. For example, small Chi-square value indicates better fit, whereas larger nonnormed fit index (NNFI) and comparative fit index (CFI) indicate better fit of the model.

5.8. Multivariate Data Analysis

The preliminary study was conducted by email survey, and the respondents were drawn from the target sampling frame. The objectives of this preliminary study are as follows:

1. To gain better understandings from subjects about the questionnaire, for example, the appropriateness of questionnaire design and choice of words

2. To gain better understandings on the data analysis results by surveying respondents from the target population, rather than by convenience sampling

3. To get prepared on the response rate by conducting the preliminary study, and to adjust the number of email surveys had to be sent in the mass survey

4. To modify or delete the item statement by testing scale reliability and validity

5. To refine the measurement instrument and use those refined measurement items in the mass industry survey, which is particularly important to validate the constructs designed for this research study

6. To justify the measurement items and methods employed in this research study

Therefore, the preliminary study provides the author with an overlook on how the research study may process. It also helps the author to discover if any potential problems and difficulties exist, and to prevent them from happening in the mass survey.

5.8.1. Descriptive statistics

The sampling frame came from a non-commercial list of innovation projects supported by a governmental funded research center. In the preliminary study, 200 emails were sent and 154 innovation team members agreed to participate in the study. The questionnaire was sent to team individuals with a cover letter as email content, which indicated the purpose of study and assured respondent anonymity and information confidentiality. Non-respondents received one further round of email with questionnaire reminding them of the importance of their participation. Such collection procedures resulted in 142 usable responses, with a net response rate of 71%. The relatively high response rate may indicate that innovation team members employ the email addresses for their project tasks and they are interested in the objectives of this research study. Yet, the reasons, which may lead to no responses from the targeted sample, are as follows:

1. The innovation project team members may be very selective when checking their emails, and refused to reply to the email invitation

2. They may have a redundancy to complete an email survey when there is no immediate incentives given to them

Refer to Table 5.11, 68 out of 142 total respondents are males (accounts for 47.9%) and 74 respondents are female (accounts for 52.1%). Respondents who are in the age group between 26 and 35 years old accounted for 59.9%

of the sample, followed by the age groups of 18 and 25 at 26.8%, the age groups of 36 and 45 at 12.0%, and the age groups of 46 and 55 at only 1.4%. Lower age allocation at older age groups may due to the fact that they are in the managerial level of enterprises rather than participating actively among innovation project. Regarding the respondents' team positions, 11.3% of the respondents are team leaders and 88.7% of the respondents are team members of innovation projects.

Refer to Table 5.12, 47.2% of the sample are engaged in product development innovation projects, 21.1% are engaged in system development projects and the remaining 31.7% are focused on process advancement innovation projects.

Refer to Table 5.13 on the functional area of respondents, Research & Development personnel has accounted for 60.6% of the sample, 8.5% are engineering personnel, 14.8% are manufacturing/ production personnel, 6.3% respondents are responsible for general management tasks, 5.6% are information system expertise, marketing and sales specialists have accounted for another 3.5%, and the remaining 0.7% of respondents are human resources personnel whom recruited and selected expertise from the globe.

Table 5.11: the Gender and Age Characteristics of the Respondents

Gender/ Age/ Team Position	**Number of Respondents**	**%**
Gender		
Male	68	47.9
Female	74	52.1
Age		
18-25	38	26.8
26-35	85	59.9
36-45	17	12.0
46-55	2	1.4
Team Position		
Team Leader	16	11.3
Team Member	126	88.7

Table 5.12: the Innovation focus of the Respondents' teams

Innovation Focus	**Number of Respondents**	**%**
Product Development	67	42.2
System Development	30	21.1
Process Advancement	45	31.7

Table 5.13: the Function area of Respondents

Functional Area	**Number of Respondents**	**%**
Marketing & Sales	5	3.5
General Management	9	6.3
HR Personnel	1	0.7
Information Systems	8	5.6
Manufacturing & Production	21	14.8
Engineering	12	8.5
R&D	86	60.6

5.8.2. Scale Reliability

Cronbach’s alpha is performed to determine the internal consistency of measurement items in this research study to measure the reliability. A low coefficient alpha indicates that the measured item is not consistent with the construct, and the item which performed poorly can be removed from the construct. If there is more than one poorly performed items in a construct, the author will first remove the item with a higher adjusted value of cronbach’s alpha, followed by conducting the reliability test again and remove another poorly performed item from the measure if necessary.

Thus, the Cronbach’s alphas of items in this research study were examined correspondingly. Refer to Table 5.14, the measured items are team consensus, technology support, rules and procedures, innovation complexities, collaboration effectiveness and innovation team performance. In order to achieve a better Cronbach’s alpha value, the author thus deleted those poorly performing items from the corresponding measures.

As a result, the item “We spend a lot of effort to overcome different barriers in order to attain a shared decision”, the item “We set our goal among our innovation team members on collective basis”, and the item “We can always obtain a shared agreement in a short time interval” are deleted from the measure of “team consensus”; whereas, the item “All of our team members are conveniently located in our working location”, the item “Some of our team members are dispersed across different countries”, as well as the item

“From our team’s perspective, the time scale of project development is of great importance” are deleted from the measure of “innovation complexities”; and the item of “There are conflicting interests in our team regarding subtasks/ sub-goals” is removed from the measure of “collaboration effectiveness”.

The Cronbach’s alpha improves after removing all the above items with low Cronbach’s alpha. Table 5.14 thus lists out the calculation results of Cronbach’s alpha before and after the item adjustment.

Table 5.14: the Coefficient Alpha Calculation Results

Measures	Factors	Cronbach's alpha		Number of items		Item adjusted
		Before adjusted	**After adjusted**	**Before adjusted**	**After adjusted**	
Team Consensus		0.584	0.670	6	3	• Deleted variable con3, i.e., "We spend a lot of effort to overcome different barriers in order to attain a shared decision". (→ 0.637) • Deleted variable con6, i.e., "We set our goal among our innovation team members on collective basis". (→ 0.657) • Deleted variable con1, i.e., "We can always obtain a shared agreement in a short time interval". (→ 0.670)
Technology Support	**Management Support**	0.880		8		
	IT Support	0.773		6		
Rules and Procedures		0.867		6		

Innovation Complexities	**Proximity**	0.332	0.611	5	2	• Deleted variable pro1, i.e., "All of our team members are conveniently located in our working location". (→0.507) • Deleted variable pro3, i.e., "Some of our team members are dispersed across different countries". (→0.555) • Deleted variable pro5, i.e., "From our team's perspective, the time scale of project development is of great importance". (→0.611)
Collaboration Effectiveness		0.787	0.865	10	9	• Deleted variable coe10, i.e., "There are conflicting interests in our team regarding subtasks/ sub-goals".
Innovation Team Performance	**Task outcome**	0.907		9		
	Socio-psychological Satisfaction	0.900		8		

5.8.3. Exploratory Factor Analysis

The testing of Cronbach's alpha values enables the author to ensure the internal consistency of scales. Then, the author conducted exploratory factor analysis (EFA) in the preliminary study to simplify the set of interrelated measurement items by reducing poorly performed items. Principal component analysis (PCA) with varimax rotation was first applied to the variables of contextual antecedents (team consensus, management support, IT support, rules and procedures, and proximity). Apart from PCA, the author also assessed the data through the Kaiser-Meyer-Olkin (KMO) value and the value of Bartlett's test of Sphericity.

In this study, the author retains factors with eigenvalues greater than 1 (Kaiser, 1960), and items with factor loadings at least 0.55 (Comrey and Lee, 1992; Tabachnick and Fidell, 2007). Such assessments help to retain factors, which explain more variance than the average amount explained by an original item. The author also extracted factors by using the scree plot analysis. Measurement items with factor loadings greater than 0.4 in more than one component were removed to avoid cross loading (Hair et al., 1987).

As a result, the item "Our team has clear standards for the behavior of team members" was deleted from the measure of "Rules and Procedures"; the item "The organization possesses a good telecommunications infrastructure", the item "The organization possesses a rapid internet/ intranet access", and the item "The organization possesses a categorized electronic data exchange system" are deleted from the measure of "IT support"; whereas, the item

“Management regards the use of information and communication technologies as a high priority for innovation project works”, and “Management identify the use of information and communication technologies for innovation project as part of the company’s mission” are deleted from the measure of “Management Support”.

Refer to Table 5.15, it summarizes the result of exploratory factor analysis of the contextual antecedent factors. The KMO value is 0.832 for the contextual antecedents of innovation team collaboration, which indicates that sampling of this research study is satisfactory for the factor analysis. The Bartlett’s test of sphericity is statistically significance (p=.000), which suggests the presence of correlation (Hair et al., 1987). Both values indicate the adequacy of data for exploratory factor analysis.

The exploratory factor analysis results suggest a solution with five factors based on the eigenvalues, which collectively explain 64.341% of the variances. The factor solution is therefore consistent with the proposed conceptual model. Table 5.15 illustrates the results of exploratory factor analysis.

Table 5.15: the Summary of Exploratory Factor Analysis Results of the Contextual Antecedents

Factors and items	Factor loading	Eigenvalues	% of variance
Management Support		3.652	19.223
Management aware of the benefits that can be achieved through the use of information and communication technologies for innovation project works	.745		
Management always support and encourage the use of information and communication technologies for innovation project works	.775		
Management has provided most of the necessary help and resources to facilitate people in using information and communication technologies for innovation project	.754		
Management is really keen to see that people are satisfied with use of information and communication technologies in innovation project	.706		
Management provides good access to various types of software for innovation project	.711		
Management provides good access to hardware resources for innovation project	.683		
Rules and Procedure		3.237	17.038
For most problems that arise on this project, there are rules and procedures for dealing with them	.712		
It is clear in our organization what is acceptable and what is not acceptable	.838		
The innovation team has its own rules and procedures to facilitate the project progress	.748		
It is clear in our team what is acceptable and what is not acceptable	.820		
Our team has a very orderly working behavior and pattern – it is clear what members are expected to do and they do it.	.625		

IT Support		1.849	9.734
The organization possesses the necessary infrastructure to support remote communication	.699		
The organization possesses adequate videoconferencing systems	.741		
The organization possesses adequate collaborative software systems	.743		
Team Consensus		1.838	9.675
I believe it is necessary to have commitment to others' performance in the innovation project environment	.759		
We stick to a set of clearly-stated administrative procedures when tackling problems	.757		
I think our information processing procedures along tasks are consistent and seamless	.619		
Proximity		1.647	8.671
Our team shares a same set of consistent and regular work paces	.794		
We share a similar set of rhythm when processing our daily tasks	.772		

The exploratory factor analysis was also conducted for the collaboration effectiveness construct. The KMO value of sampling adequacy is 0.767 and The Bartlett's test of sphericity is statistically significance (p=.000), indicating the dataset is sufficient enough for factor analysis (Hair et al., 1987). Items with factor loadings at least 0.55 (Comrey and Lee, 1992; Tabachnick and Fidell, 2007), and measurement items with factor loadings greater than 0.4 in more than one component were removed to avoid cross loading (Hair et al., 1987). Refer to Table 5.16, it shows that one factor is extracted; therefore collaboration effectiveness was a one-dimensional construct. It explained 59.483% of the total variances with the eigenvalues of 2.974.

Table 5.17 shows the results of the exploratory factor analysis result for innovation team performance. The KMO value is 0.867 and The Bartlett's test of sphericity is statistically significance (p=.000), indicating the dataset is sufficient enough for factor analysis (Hair et al., 1987). Variables which had a low correlation with other items and low factor loadings were removed. Two factors are extracted in this construct based on the eigenvalues, which collectively explain 68.064% of the total variances. The factor solution is therefore consistent with the proposed conceptual model.

As a result, the exploratory factor analysis enables the author to refine items under each construct, and put forward that the scales need no further modification. The author thus applies the refined constructs in the main study for hypothesis testing.

Table 5.16: the Summary of Exploratory Factor Analysis Results of the Collaboration Effectiveness

Factors and items	**Factor loading**	**Eigenvalues**	**% of variance**
Collaboration Effectiveness		2.974	59.483
Our team members are happy with the timeliness in which We received information from other team members.	.771		
Our team members are happy with the accuracy of the information received from other team members.	.834		
Our team members are happy with the usefulness of the information received from other team members.	.808		
The work done on subtasks within the project is harmonized	.775		
There are clear and fully comprehensive goals for subtasks within our team	.657		

Table 5.17: the Summary of Exploratory Factor Analysis Results of the Innovation Team Performance

Factors and items	Factor loading	Eigenvalues	% of variance
Task Performance		3.340	33.401
Overall, the project is done in a cost-effective manner	.814		
Overall, the project is done in a time-efficient manner	.789		
The project is within schedule	.862		
The project is within budget	.796		
Overall, our team earns a positive balance for themselves in the project	.635		
Socio-psychological Satisfaction		3.466	34.664
Our team would like to perform innovation collaborative works again	.774		
I have acquired important know-how through working in this project	.804		
Our team learns important lessons from this project	.813		
I have developed many new skills from working with members from other functions	.787		
I have learned things working in this project that I will use in other groups	.805		

Table 5.18: the Summary of modified items for later analysis

Code	Item
con2	I believe it is necessary to have commitment to others' performance in the innovation project environment
con4	We stick to a set of clearly-stated administrative procedures when tackling problems
con5	I think our information processing procedures along tasks are consistent and seamless
ms1	Management aware of the benefits that can be achieved through the use of information and communication technologies for innovation project works
ms2	Management always support and encourage the use of information and communication technologies for innovation project works
ms3	Management has provided most of the necessary help and resources to facilitate people in using information and communication technologies for innovation project
ms4	Management is really keen to see that people are satisfied with use of information and communication technologies in innovation project
ms5	Management provides good access to various types of software for innovation project
ms6	Management provides good access to hardware resources for innovation project
its3	The organization possesses the necessary infrastructure to support remote communication
its5	The organization possesses adequate videoconferencing systems
its6	The organization possesses adequate collaborative software systems
rap1	For most problems that arise on this project, there are rules and procedures for dealing with them
rap2	It is clear in our organization what is acceptable and what is not acceptable
rap3	The innovation team has its own rules and procedures to facilitate the project progress
rap4	It is clear in our team what is acceptable and what is not acceptable
rap5	Our team has a very orderly working behavior and pattern – it is clear what members are expected to do and they do it.
pro2	Our team shares a same set of consistent and regular work paces

pro4	We share a similar set of rhythm when processing our daily tasks
coe4	Our team members are happy with the timeliness in which We received information from other team members.
coe5	Our team members are happy with the accuracy of the information received from other team members.
coe6	Our team members are happy with the usefulness of the information received from other team members.
coe7	The work done on subtasks within the project is harmonized
coe8	There are clear and fully comprehensive goals for subtasks within our team
itp6	Overall, the project is done in a cost-effective manner
itp7	Overall, the project is done in a time-efficient manner
itp8	The project is within schedule
itp9	The project is within budget
itp10	Overall, our team earns a positive balance for themselves in the project
itp12	Our team would like to perform innovation collaborative works again
itp13	I have acquired important know-how through working in this project
itp14	Our team learns important lessons from this project
itp16	I have developed many new skills from working with members from other functions
itp17	I have learned things working in this project that I will use in other groups

5.9. Factor Structural Analysis

5.9.1. Data Cleaning and Screening

The quality of data declines if there is missing information or invalid data. Thus, the author performed data cleaning and screening to check for incompleteness and inconsistencies of dataset to ensure the accuracy and precise of data.

The author had a preliminary check on the coding of variables; any identified coding errors are handled by a proper recoding. Then, the author identified the missing response by conducting descriptive statistics. If the missing response is in the sections of key variables, the author treated them by employing likewise deletion. All cases with a missing value on any variables would be excluded from data analysis under Likewise deletion. Although Likewise deletion causes a loss of data by removing all data from respondents who completed part of the questionnaire, it is indeed the most popular method for handling missing values (Byrne, 2001). As a result, 15 cases are likewise deleted as there were missing values in the sections of key measurement items.

The author also excluded 9 cases provided by respondents who gave the same score to all measurement items, as it is unreasonable for an individual to rate diverse contextual antecedents at the same score. This might happen when a team individual refused to disclose the details of team collaboration among innovation projects, because of the conserving behavior.

Moreover, the author carried out data screening to make sure the data were useful, logical and reliable. For example, “cost-effective manner” should be of similar scores with “within budget”. The author might exclude these respondents’ dataset if they failed to demonstrate such logical consistency. Nonetheless, the author carried out descriptive statistics to make sure variables were normally distributed, rather than be too extreme.

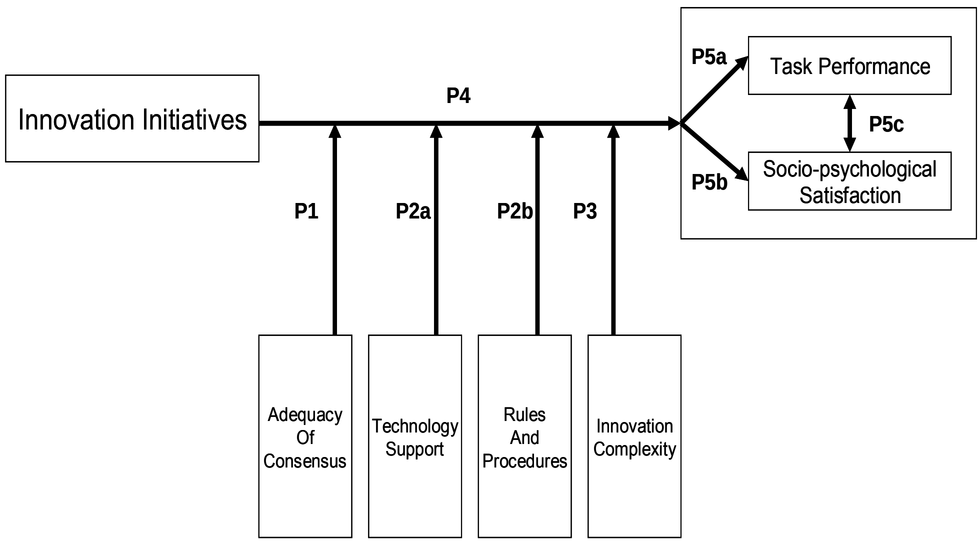
In total, the author obtained 293 out of 380 questionnaires, and the overall response rate was approximately 77%. There were 267 useable cases after the data cleaning and screening processes. The relatively high response rate might indicate that team collaboration is of team members’ concerns. Therefore, they are willing to spend their valuable time to do the self-assessment.

5.9.2. Descriptive Statistics

First of all, the questionnaires help to collect general information about the respondents, their project team and organizations that they belonged to. Thus, the author conducts the frequency distributions in SPSS to analyze the demographic information of respondents.

Second, the author describes the mean scores and standard deviations for the variables studied in this quantitative research (See Figure 5.2).

Figure 5.2: the Proposed Theoretical Model of Collaboration among Innovation Projects



5.9.2.1.Profile and Analysis of Respondents

In order to have a clear picture on the profile of respondents, the author conducted the frequency distributions on the data of team individuals, their innovation projects and the organizations that they worked for. The profile of respondents is presented in Table 5.19 – Table 5.22.

As shown in Table 5.19, 135 out of 267 respondents are males (accounted for 50.6%), and 132 are females (accounted for 49.4%). The number of males and females are nearly the same, which indicates that the gender of innovation team members may not be a matter of concern in team compositions.

Respondents groups aged between 26 and 35 years old accounts for 62.9% of the sample size. Followed by respondents groups aged between 18 and 25 years old which accounted for 21.3% of the sample, and respondents groups aged between 36 and 45 years old which accounted for another 14.2%. Only three respondents are in the age group between 45 and 55 years old (accounted for 1.1 %), and just one respondent is over 55 years old (accounted for 0.4%).

It is not surprising that most of the innovation team members are aged between 26 and 35 years old, as their working experiences in the industry better equipped them to make contributions in the development of innovation projects. Respondents groups aged between 18 and 25 years old is the second largest group in the sample, which indicates that it becomes a trend for organizations to request its employees with at least three years of working experiences to take part in innovation projects.

Respondents aged above 36 accounted for 15.7% of the sample, among which 1.5 % are above the age of 46 who are treated as senior staff in the organization. These senior members of the organization tend to be occupied in carrying out the managerial and decisive tasks in enterprises; and they seldom take part actively in the development processes of innovation projects. These two reasons help to explain the lowest response rate from this age group.

Table 5.19: the Characteristics of Gender and Age of the Respondents

Gender/ age/ Team position	Number of respondents	%
Gender		
Male	135	50.6
Female	132	49.4
Age		
18 – 25	57	21.3
26 – 35	168	62.9
36 – 45	38	14.2
46 – 55	3	1.1
Over 55	1	0.4

Table 5.20 shows the team role that the respondents have taken in their corresponding innovation projects, 232 out of 267 respondents (accounted for 86.9%) are team members, 29 of the respondents are team leader (accounted for 10.9%) and only 6 of the sample are project advisor or supporter among innovation project teams.

The author is not surprised with such compositions of team role, as it matches with the team composition in actual innovation projects. There can be more than 20 team members dispersed around the globe who contribute to the same innovation projects. And, there will only be 1 or 2 project coordinators/ managers/ team leaders in each innovation projects who are responsible for managing and facilitating their team members. On the other hand, project advisor/ supporter does not take an active role among innovation projects. Indeed, the author is quite surprised with and appreciated the involvement of these project advisors in this research study.

The author is interested to investigate if there is any interrelationship between the senior team individuals who are aged above 45, and team role as project advisor/ supporters. After checking the data, the author discovers that among six advisors/ supporters, one of them is aged over 55, three of them are aged between 46 and 55 and two of them are in the age group of 36 and 45. Thus, it shows that these senior team members are responsible for giving professional advice and network, which are essential for the development of innovation projects.

As shown in Table 5.20, 197 out of 267 respondents are in the functional area of R&D, which accounted for 73.8% of the sample. The majority of respondents regard themselves as specialized in research and development, other functional groups only accounted for less than 10 % each of the sample. Twenty three respondents are in the functional area of Manufacturing/ Production (accounted for 8.6%), 13 respondents regard themselves as in the information systems functional area (accounted for 4.9%); whereas, there are 12 respondents from both functional areas of General Management and Engineering respectively, each accounted for 4.5% of the sample. There are 8 respondents who work in the functional area of Sales & Marketing (accounted for 2.9%). For Accounting field and Human Resources field, there is only 1 respondent from each of these function area, each accounted for 0.4% of the sample.

The majority of respondents identify themselves as working in the R&D functional area. It may be due to the fact that these team individuals' job allocation is mainly focused on innovation development and implementation. It also makes sense that respondents from the functional areas of Information Systems and engineering are key players among innovation projects. The composition of respondents' functional area indicates that not only research personnel are involved in innovation projects, efforts devoted by team individuals from other domains are also critical to innovation projects.

Table 5.20: the Characteristics of Team Role and Functional Areas of the Respondents

Team Role/ Functional Area	**Number of respondents**	**%**
Team Role		
Team member	232	86.9
Team leader	29	10.9
Advisor/ Supporter	6	2.2
Functional Area		
R&D	197	73.8
Manufacturing/ Production	23	8.6
Information Systems	13	4.9
General Management	12	4.5
Engineering	12	4.5
Sales & Marketing	8	2.9
Accounting	1	0.4
HR Personnel	1	0.4

As shown in Table 5.21, 123 out of 267 respondents report that their innovation project teams focus on product development (accounted for 46%), 84 respondents belong to innovation team which focus on process advancement (accounted for 31.5%), and 60 respondents report that their innovation project teams focus on system development (accounted for 22.5%). The distributions of team focus are not extreme, which indicates that collaboration issues among various team focus are all taken into account in this research study.

Table 5.21 also lists out the distributions of primary business area of organizations to which the respondents belong. Eighty eight out of two hundred sixty seven respondents reveal that the primary business area of the organization they belong to is educational institutes, which accounted for 33% of the sample. Seventy respondents report that the primary business area of the organization they belong to is manufacturing enterprises, which accounted for 26.2% of the sample.

Thirty two respondents (accounted for 12% of the sample) come from organizations which are in the software production businesses; whereas 27 respondents (accounted for 10.1% of the sample) come from organizations which are in the hardware production businesses. The author combines the number of respondents from both software and hardware production businesses into production business, which accounted for a total of 22.1% of the sample.

Apart from the business areas of education, manufacturing and production, other primary business area only accounted for less than 10% each of the sample. 19 respondents belong to companies in the business area of Sales & Marketing (accounted for 7.1%), 16 respondents regard their companies as in the Health care sector (accounted for 6%); whereas, there are 10 respondents belong to organizations in the Public sector, which accounted for 3.7% of the sample. And, there are only 5 respondents who work in organization with primary business area in financial services, which accounted for 1.9% of the sample.

Table 5.21: the Characteristics of Team focus and Primary Organization's Business of the Respondents

Team Focus/ Primary Organization's Business	Number of respondents	%
Team Focus		
Product Development	123	46
System Development	60	22.5
Process Advancement	84	31.5
Primary Organization's Business		
Manufacturing	70	26.2
Health Care	16	6
Educational	88	33
Public Sector	10	3.7
Financial Services	5	1.9
Software Production	32	12
Hardware Production	27	10.1
Sales & Marketing	19	7.1

As shown in Table 5.22, the author also collected information concerning the number of team members that the respondents have. The number of team members has a mean score of 10.44, which indicates that the average of team members they have is 10. The smallest scale of innovation team has the minimum score at 2, which indicates a two-member innovation project team; whereas, the largest scale of innovation team is at the maximum score of 30, which indicates an innovation project with 30 team members. The results reflect that although the number of team members varies, the collaboration issue is still of their concerns.

Table 5.22 also summarizes the figures on the percentage of working time which the respondents devote to innovation projects. The mean score is 80.45%, which indicates that the average working time spent on innovation projects accounted for 80.45%. It thus shows that innovation projects become a norm among organizations, the employees therefore require to spend a substantial of time working on these innovation projects. The lowest percentage of working time on innovation project is at the minimum score of 5%, which indicates that some team members may not be devoted as much time as other team members; whereas, the highest percentage of working time on innovation project is at the maximum score of 100%, which indicates that some team members devoted all of their working time on pursuing innovation projects. The variance of working time devoted to innovation projects is consistent with the interview results, in which some team members are responsible for taking part throughout the whole innovation projects, whereas some nomadic team members just participate when their expertise are crucial for a certain stage of the innovation project.

Table 5.22: the Characteristics of Innovation Projects of the Respondents

Number of Team Members	
Mean	10.44
Minimum	2
Maximum	30
Percentage of Working Time on Innovation Project	
Mean	80.45%
Minimum	5%
Maximum	100%

In addition to the profile analysis of respondents, the author also reports the results of descriptive analysis on the variables of ICTs Availability and ICTs Usage. As these two variables are not the main variables of interest, detailed discussions are depicted in Chapter 6 Discussion and Conclusion.

As illustrated in Table 5.23, the item "Email" has the greatest mean score (Mean = 4.66; Standard Deviation = 0.767). The mean scores of the item "Face-to-face interaction" (Mean = 4.49; Standard Deviation = 0.696) and the item "Telephone" (Mean = 4.29; Standard Deviation = 0.936) are relatively high as well.

Followed by the item "Collaborative Software" (Mean = 3.05; Standard Deviation = 1.324) and "Computer conferencing; Real-time on-line discussion" (Mean = 2.56; Standard Deviation = 1.858). The mean scores for three items “Group Support Systems (GSS)” (Mean = 1.73; Standard Deviation = 1.187), “Telephone conferencing” (Mean = 1.79; Standard Deviation = 1.399) and “Voice mail” (Mean = 1.63; Standard Deviation = 1.307) are quite similar.

Followed by the item “Electronic bulletin board” (Mean = 0.92; Standard Deviation = 1.193) and “Videoconferencing (Dedicate room)” (Mean = 0.85; Standard Deviation = 1.399), and the items “Fax” and “Videoconferencing (Desktop)” have the least mean score at 0.76.

Table 5.23: the Descriptive Statistics on the ICTs Availability Items

Code	Item	Mean	Standard Deviation
icta1	Collaborative Software; facilitate the multiple authorship of documents, joint development of databases, spreadsheets, and other information resources	3.05	1.324
icta2	Computer conferencing; Real-time on-line discussion (e.g. MSN)	2.56	1.858
icta3	Electronic bulletin board	0.92	1.286
icta4	Email	4.66	0.767
icta5	Fax	0.76	1.206
icta6	Group Support Systems (GSS); designed to create and environment for brainstorming, focus group work, and group decision making	1.73	1.187
icta7	Telephone	4.29	0.936
icta8	Telephone conferencing	1.79	1.399
icta9	Videoconferencing (Dedicated room)	0.85	1.193
icta10	Videoconferencing (Desktop)	0.76	1.076
icta11	Voice mail	1.63	1.307
icta12	Face-to-face interaction	4.49	0.696

As illustrated in Table 5.24, the item "Through explicit statements or requirements by the team leader" has the greatest mean score (Mean = 4.01; Standard Deviation = 1.024). The mean scores for three items "Through precedents created within the team during critical events" (Standard Deviation = 0.964), "Through repetitive usage patterns that simply emerged from the team" (Standard Deviation = 0.831) and "Based on my prior experience before becoming a member of this team" (Standard Deviation = 0.840) are 3.57. The item "Through collaborative team efforts to develop acceptable standards or norms for communication" has the least mean score (Mean = 3.33; Standard Deviation = 0.798). The results show that most of the respondents think that ICTs usage is largely determined through explicit requirements by team leader.

Table 5.24: the Descriptive Statistics on the ICTs Usage Items

Code	**Item**	**Mean**	**Standard Deviation**
iu1	Through explicit statements or requirements by the team leader	4.01	1.024
iu2	Through precedents created within the team during critical events	3.57	0.964
iu3	Through repetitive usage patterns that simply emerged from the team	3.57	0.831
iu4	Through collaborative team efforts to develop acceptable standards or norms for communication	3.33	0.798
iu5	Based on my prior experience before becoming a member of this team	3.57	0.840

5.9.2.2.Descriptive Analysis of the Main Variables of Interest

The author examines three major research questions in this research study, which are as follows: (1) What are the contextual antecedents affecting the team collaboration effectiveness of innovation project teams? (2) In what extent does collaboration effectiveness affect performance of innovation teams? (3) Do the proposed innovation team performance indicators affect each other?

As shown in Figure 5.2, the proposed theoretical model illustrates six constructs for addressing to the above questions. There are five independent latent variables measuring four constructs which addressed to Question 1. These five independent latent variables are: Team consensus, Management Support, IT Support, Rules and Procedures and Proximities. Another three dependent latent variables addressed to Question 2 and 3 are Collaboration Effectiveness, Task Performance and Socio-psychological Satisfaction. Each latent construct includes two to six statements of item. Table 5.25 – Table 5.32 shows the mean scores and standard deviations for these variables examined in this research study. And, the mean scores of all items are positive and rated above 3.

As shown in Table 5.25, the item “I believe it is necessary to have commitment to others’ performance in the innovation project environment” has the greatest mean score (Mean = 4.16; Standard Deviation = 0.898). The two items “We stick to a set of clearly-stated administrative procedures when tackling problems" and "I think our information processing procedures along tasks are consistent and seamless" have lower mean scores, which are 3.76 and 3.77 respectively. Lots of people agree that making commitments to others' performance is important for collaboration among innovation projects, as outputs from one team member contribute as input for another. Moreover, respondents also indicated concern on consistency of both administrative and data processing procedures of innovation projects, as these two items affect the collaboration processes between innovation team members.

Table 5.25: the Descriptive Statistics on the Team Consensus Items

Code	Item	Mean	Standard Deviation
con2	I believe it is necessary to have commitment to others' performance in the innovation project environment	4.16	.898
con4	We stick to a set of clearly-stated administrative procedures when tackling problems	3.76	.963
con5	I think our information processing procedures along tasks are consistent and seamless	3.77	1.014

As illustrated in Table 5.26, the item "Management aware of the benefits that can be achieved through the use of information and communication technologies for innovation project works" has the greatest mean score (Mean = 3.96; Standard Deviation = 0.760). Followed by the item "Management provides good access to hardware resources for innovation project" (Mean = 3.91; Standard Deviation = 0.836), "Management always support and encourage the use of information and communication technologies for innovation project works" (Mean = 3.87; Standard Deviation = 0.821), "Management has provided most of the necessary help and resources to facilitate people in using information and communication technologies for innovation project" (Mean = 3.84; Standard Deviation = 0.736) and "Management provides good access to various types of software for innovation project" (Mean = 3.81; Standard Deviation = 0.866). The item "Management is really keen to see that people are satisfied with use of information and communication technologies in innovation project" has the least mean score (Mean = 3.52; Standard Deviation = 0.737).

The results suggest that management of those enterprises are aware of the benefits of ICTs, therefore they support and encourage the use of ICTs by providing innovation team members with both hardware and software resources. However, the management level has not shown their keenness in knowing if innovation team members are satisfied with the use of ICTs or not, which are consistent with the interviewees' statements from the in-depth interviews. During the in-depth interviews, interviewees mentioned that ICTs provided by the organization were not sufficient. It would be better if they could be provided with electronic gadgets for carrying out innovation project works. The author suggests such situation to be improved by the management level, through asking those team members for their satisfaction level and comments on the currently ICTs provided to them.

Table 5.26: the Descriptive Statistics on the Management Support Items

Code	Item	Mean	Standard Deviation
ms1	Management aware of the benefits that can be achieved through the use of information and communication technologies for innovation project works	3.96	.760
ms2	Management always support and encourage the use of information and communication technologies for innovation project works	3.87	.821
ms3	Management has provided most of the necessary help and resources to facilitate people in using information and communication technologies for innovation project	3.84	.736
ms4	Management is really keen to see that people are satisfied with use of information and communication technologies in innovation project	3.52	.737
ms5	Management provides good access to various types of software for innovation project	3.81	.866
ms6	Management provides good access to hardware resources for innovation project	3.91	.836

As shown in Table 5.27, the item "The organization possesses the necessary infrastructure to support remote communication" has the greatest mean score (Mean = 3.84; Standard Deviation = 0.790). Followed by the item "The organization possesses adequate collaborative software systems" (Mean = 3.36; Standard Deviation = 0.802), and "The organization possesses adequate videoconferencing systems" has the least mean score (Mean = 3.07; Standard Deviation = 0.802). The results indicate that although organizations provide the necessary infrastructure to support remote communication, they do not possess with adequate collaborative software systems and video and videoconferencing system. Most of the respondents from in-depth interview also mentioned that the commonly used videoconferencing tool was Skype. Just a few of them mentioned other videoconferencing systems provided by their organizations.

Table 5.27: the Descriptive Statistics on the IT Support Items

Code	Item	Mean	Standard Deviation
its3	The organization possesses the necessary infrastructure to support remote communication	3.84	.790
its5	The organization possesses adequate videoconferencing systems	3.07	.993
its6	The organization possesses adequate collaborative software systems	3.36	.802

As illustrated in Table 5.28, the item "It is clear in our organization what is acceptable and what is not acceptable" has the greatest mean score (Mean = 3.97; Standard Deviation = 0.862). Followed by the item "For most problems that arise on this project, there are rules and procedures for dealing with them" (Mean = 3.82; Standard Deviation = 0.937), and the mean scores for two items "It is clear in our team what is acceptable and what is not acceptable" and "Our team has a very orderly working behavior and pattern – it is clear what members are expected to do and they do it" are 3.80. The item "The innovation team has its own rules and procedures to facilitate the project progress" has the least mean score (Mean = 3.76; Standard Deviation = 0.701). The results indicate that although there are clearly stated rules and procedures for innovation works, the organizational rules and procedures are still more emphasized and obvious in respondents' mindsets. Therefore, respondents are likely to follow both sets of rules and procedures during the collaboration process of innovation projects.

Table 5.28: the Descriptive Statistics on the Rules and Procedures Items

Code	Item	Mean	Standard Deviation
rap1	For most problems that arise on this project, there are rules and procedures for dealing with them	3.82	.937
rap2	It is clear in our organization what is acceptable and what is not acceptable	3.97	.862
rap3	The innovation team has its own rules and procedures to facilitate the project progress	3.76	.701
rap4	It is clear in our team what is acceptable and what is not acceptable	3.80	.697
rap5	Our team has a very orderly working behavior and pattern – it is clear what members are expected to do and they do it	3.80	.772

In this research, innovation complexities are renamed as proximity in the questionnaires and are measured with two items (See Table 5.29). The item "Our team shares a same set of consistent and regular work paces" has a higher mean score (Mean = 3.63; Standard Deviation = 0.809). Followed by the item "We share a similar set of rhythm when processing our daily tasks" (Mean = 3.52; Standard Deviation = 0.791). Both measurement items concern the time issues during the collaboration process of innovation projects. The results indicate that respondents are aware of the importance of managing time properly between team members around the globe.

Table 5.29: the Descriptive Statistics on the Proximity Items

Code	Item	Mean	Standard Deviation
pro2	Our team shares a same set of consistent and regular work paces	3.63	.809
pro4	We share a similar set of rhythm when processing our daily tasks	3.52	.791

As illustrated in Table 5.30, the item "There are clear and fully comprehensive goals for subtasks within our team" has the greatest mean score (Mean = 4.02; Standard Deviation = 0.758). Followed by the item "The work done on subtasks within the project is harmonized" (Mean = 3.98; Standard Deviation = 0.715), the item "Our team members are happy with the usefulness of the information received from other team members" (Mean = 3.93; Standard Deviation = 0.687), and the item "Our team members are happy with the accuracy of the information received from other team members" (Mean = 3.88; Standard Deviation = 0.681). The item "Our team members are happy with the timeliness in which we received information from other team members" has the least mean score (Mean = 3.70; Standard Deviation = 0.757).

The results indicate that comprehensive goals and harmonization of subtasks are important when considering collaboration effectiveness. Moreover, the timeliness, accuracy and usefulness of the information among team members are important input for pursuing collaboration effectiveness during innovation projects as well. The result is consistent with that of the in-depth interviews, as respondents mentioned that their project tasks were tightly scheduled. It thus enables team members' outputs to be delivered in a timely manner to other team members as their input. Effective task coordination, communication between team members and works quality are therefore crucial for promoting collaboration effectiveness among innovation projects.

Table 5.30: the Descriptive Statistics on the Collaboration Effectiveness Items

Code	Item	Mean	Standard Deviation
coe4	Our team members are happy with the timeliness in which we received information from other team members	3.70	.757
coe5	Our team members are happy with the accuracy of the information received from other team members	3.88	.681
coe6	Our team members are happy with the usefulness of the information received from other team members	3.93	.687
coe7	The work done on subtasks within the project is harmonized	3.98	.715
coe8	There are clear and fully comprehensive goals for subtasks within our team	4.02	.758

As illustrated in Table 5.31, the item "Overall, our team earns a positive balance for themselves in the project" has the greatest mean score (Mean = 4.06; Standard Deviation = 0.790). Followed by the item "The project is within budget" (Mean = 3.96; Standard Deviation = 0.760), the item "The project is within schedule" (Mean = 3.84; Standard Deviation = 0.784), and the item "Overall, the project is done in a cost-effective manner" (Mean = 3.81; Standard Deviation = 0.812). The item "Overall, the project is done in a time-efficient manner" has the least mean score (Mean = 3.75; Standard Deviation = 0.794). Respondents show their concerns on getting a positive balance during innovation projects. The results also indicate that both budget control and schedules management are important when respondents evaluate their task performance among innovation projects, which is consistent with what we observed in the case study.

Table 5.31: the Descriptive Statistics on the Task Performance Items

Code	Item	Mean	Standard Deviation
itp6	Overall, the project is done in a cost-effective manner	3.81	.812
itp7	Overall, the project is done in a time-efficient manner	3.75	.794
itp8	The project is within schedule	3.84	.784
itp9	The project is within budget	3.96	.760
itp10	Overall, our team earns a positive balance for themselves in the project	4.06	.790

As illustrated in Table 5.32, all items have relatively high mean scores which indicate that respondents are very concerned about the construct of "Socio-psychological Satisfaction" during the evaluation of innovation team performance.

The item "I have learned things working in this project that I will use in other groups" has the greatest mean score (Mean = 4.34; Standard Deviation = 0.737). Followed by the item "I have developed many new skills from working with members from other functions" (Mean = 4.24; Standard Deviation = 0.812), the item "I have acquired important know-how through working in this project" (Mean = 4.14; Standard Deviation = 0.720), and the item "Our team learns important lessons from this project" (Mean = 4.13; Standard Deviation = 0.759). The item "Our team would like to perform innovation collaborative works again" has the least mean score (Mean = 4.01; Standard Deviation = 0.785).

The results indicate that respondents focus on knowledge and skills, which they may learn during the course of innovation projects. This is consistent with the results from both in-depth interviews and case study.

Team members hope to take part in more innovation projects, because these projects not only benefit them from the experiences they earn, but also learning new industrial knowledge, developing new skills and technical know-how, and expanding their networking.

Table 5.32: the Descriptive Statistics on the Socio-psychological Satisfaction Items

Code	Item	Mean	Standard Deviation
itp12	Our team would like to perform innovation collaborative works again	4.01	.785
itp13	I have acquired important know-how through working in this project	4.14	.720
itp14	Our team learns important lessons from this project	4.13	.759
itp16	I have developed many new skills from working with members from other functions	4.24	.812
itp17	I have learned things working in this project that I will use in other groups	4.34	.737

5.9.3. Measurement Model

In order to determine the relationship among contextual antecedents of innovation team, the collaboration effectiveness and innovation team performance, the author used AMOS 16.0 to carry out Structural Equation Modeling (SEM). The SEM technique is known as a two-step approach, which consists of the measurement model and the structural model (Hair et al., 1998). The author first conducted the measurement model in the SEM approach. The measurement model is indeed a multiple indicator approach which has the tendency to reduce overall effect of measurement error of variables on the output accuracy (Hair et al., 1998).

There are three measurement models, namely contextual antecedents of innovation teams, collaboration effectiveness and innovation team performance in this study, as discussed in Section 5.9.3.1. to 5.9.3.3.

5.9.3.1.Measurement Model Test - Contextual Antecedents

The measurement model analysis of contextual antecedents of innovation teams (See Figure 5.3) consists of 43 variables which named as CON (as Team consensus), con2, con4, con5, e1, e2, e3, MS (as Management support), ms1, ms2, ms3, ms4, ms5, ms6, e4, e5, e6, e7, e8, e9, ITS (as IT support), its3, its5, its6, e10, e11, e12, RAP (as Rules and Procedures), rap1, rap2, rap3, rap4, rap5, e13, e14, e15, e16, e17, PRO (as Proximity), pro2, pro4, e18 and e19. The measure model of contextual antecedents of innovation teams is examined; modification indices (MI) are also examined.

Figure 5.3 illustrates the hypothesized measurement model of contextual antecedents of innovation teams, whereas Table 5.33 describes the main goodness of fit indices of the initial measurement model. The results indicate that the model to some extent fit the data (χ^2=427.504, df =142, χ^2 /df =3.011, $p<0.001$, GFI=0.862, RMSEA=0.087). As shown in Table 5.33, χ^2 /df , GFI, NFI, CFI, TLI and RMSEA do not achieve figures with satisfactory level, therefore the model can be further improved.

Figure 5.3 the Hypothesized Measurement Model of Contextual

Antecedents of Innovation Teams

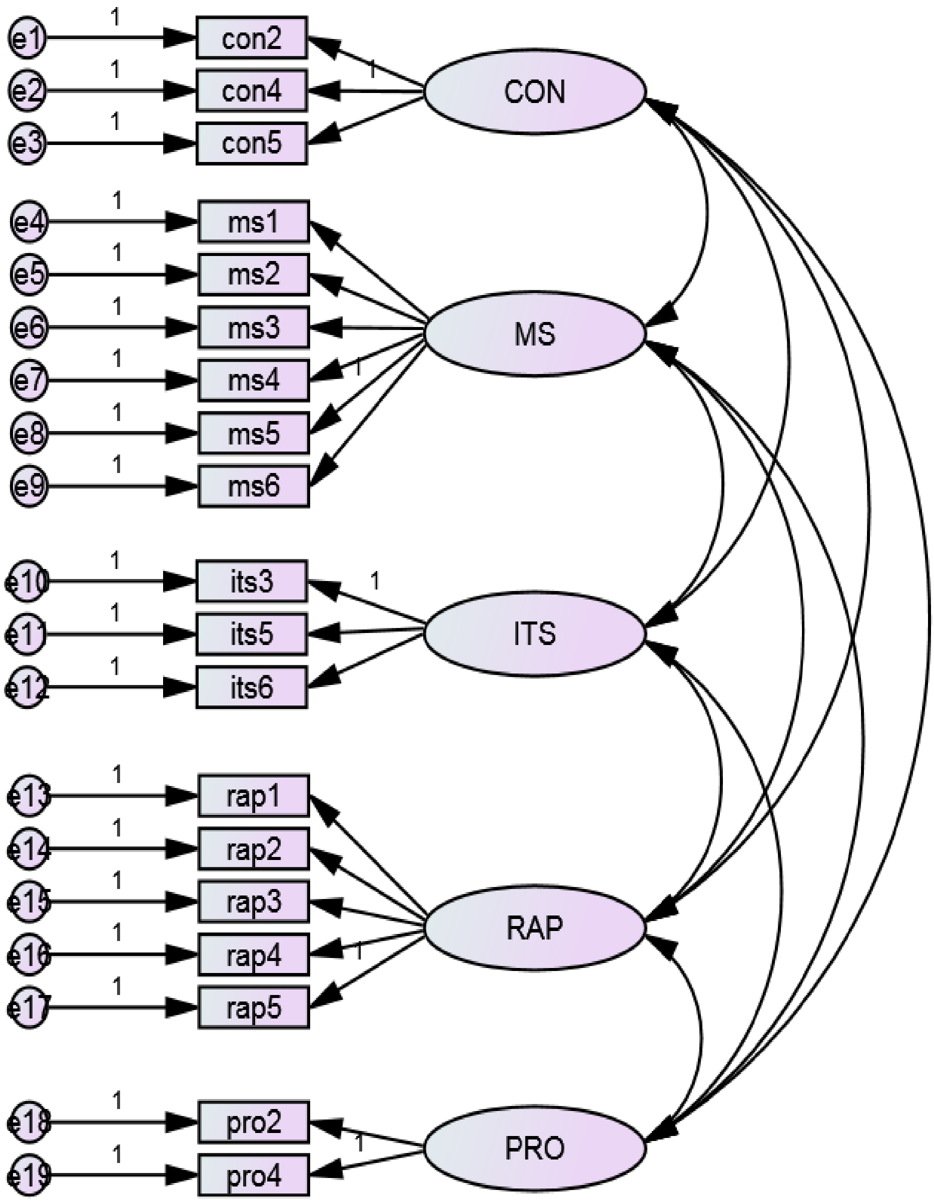


Table 5.33: the Goodness of Fit Indices of the Initial Measurement Model of Contextual Antecedents of Innovation Teams

Goodness of Fit Indices	**Value**	**Criteria**
χ^2	427.504	N/A
Degree of freedom (df)	142	N/A
χ^2 / df	***3.011***	<3
GFI	***0.862***	>0.9
AGFI	0.816	>0.8
NFI	***0.827***	>0.9
CFI	***0.876***	>0.9
TLI	***0.850***	>0.9
RMSEA	***0.087***	<0.08
RMR	0.039	<0.05

As the initial measurement model of contextual antecedents of innovation teams is not very satisfactory, the author thus makes some modifications to the model.

First of all, the item “con2” (representing “I believe it is necessary to have commitment to others’ performance in the innovation project environment”) is removed from the measure of Team consensus (shown as CON). The item “con2” is removed because the standardized factor loading is 0.51, which fails to meet the cut-off point of 0.55.

Second, the author reveals the covariance between error items based on the Modification indices (MI). There are three values of covariance of measurement errors are allowed to be correlated: (1) e16 and e15; (2) e16 and e13; and (3) e8 and e9, in which the covariance between the error items of rap3 and rap4 is particularly large. Therefore, the author adds covariance lines to link three pairs of error terms.

The modified measurement model is shown in Figure 5.4. The standard loading of each item to its construct all exceed the good level 0.63 (Comrey and Lee, 1992; Tabachnick and Fidell, 2007). Table 5.34 shows that most of the indices are good fit to the data, except NFI (0.894) is just acceptable fit to the data.

Figure 5.4 the Modified Measurement Model of Contextual Antecedents of Innovation Teams

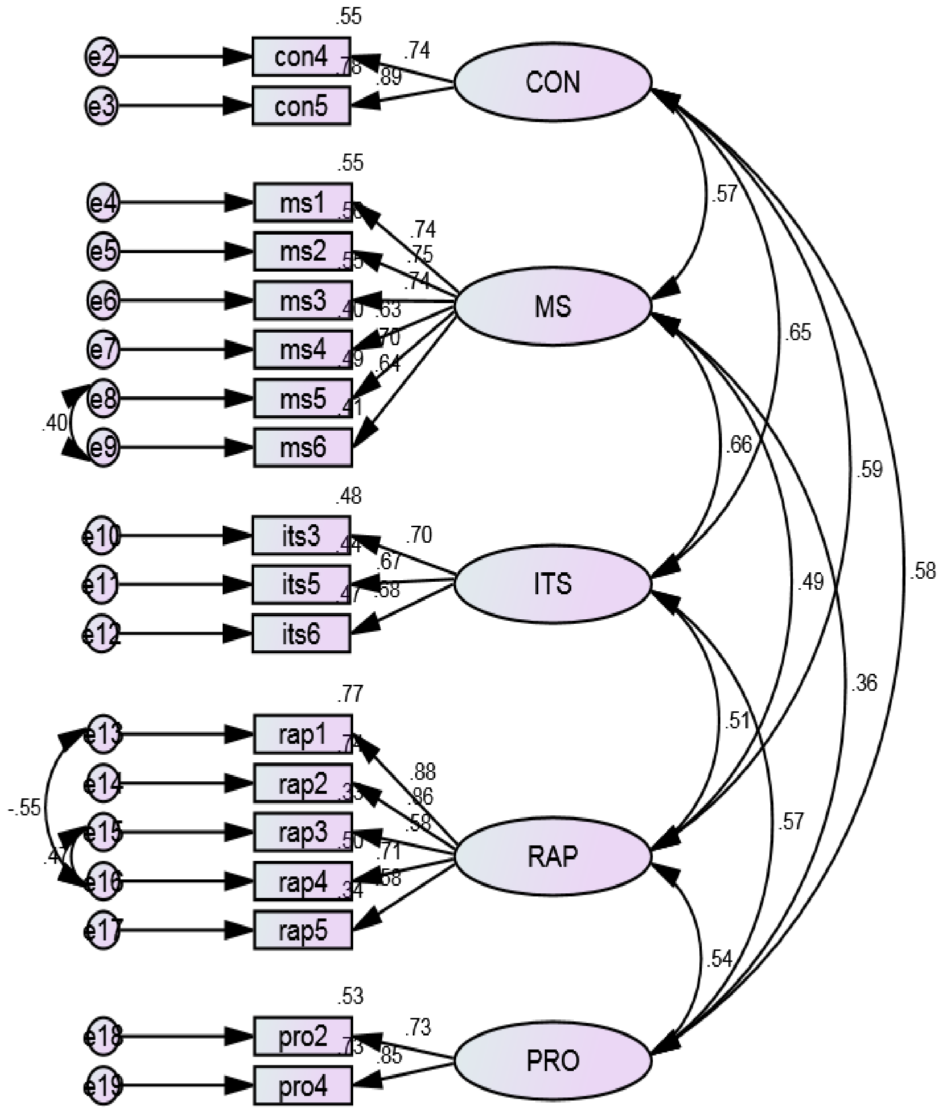


Table 5.34: the Goodness of Fit Indices of the Modified Measurement Model of Contextual Antecedents of Innovation Teams

Goodness of Fit Indices	**Value**	**Criteria**
χ^2	250.595	N/A
Degree of freedom (df)	122	N/A
χ^2 / df	2.054	<3
GFI	0.910	>0.9
AGFI	0.874	>0.8
NFI	***0.894***	>0.9
CFI	0.942	>0.9
TLI	0.927	>0.9
RMSEA	0.063	<0.08
RMR	0.037	<0.05

5.9.3.2. Measurement Model Test – Collaboration Effectiveness

The measurement model analysis of collaboration effectiveness (See Figure 5.5) consists of 11 variables which named as COE (as Collaboration Effectiveness), coe4, coe5, coe6, coe7, coe8, e1, e2, e3, e4 and e5. The measure model of collaboration effectiveness and modification indices (MI) are then examined.

Figure 5.3 illustrates the hypothesized measurement model of collaboration effectiveness, whereas Table 5.35 describes the main goodness of fit indices of the initial measurement model. The results indicate that the model to some extent fit the data (χ^2=69.696, df =5, χ^2 /df =13.931, $p<0.001$, GFI=0.905, RMSEA=0.220).

As shown in Table 5.35, χ^2 /df , AGFI, NFI, CFI, TLI and RMSEA do not achieve figures with satisfactory level, therefore the model can be further improved.

Figure 5.5 the Hypothesized Measurement Model of Collaboration Effectiveness

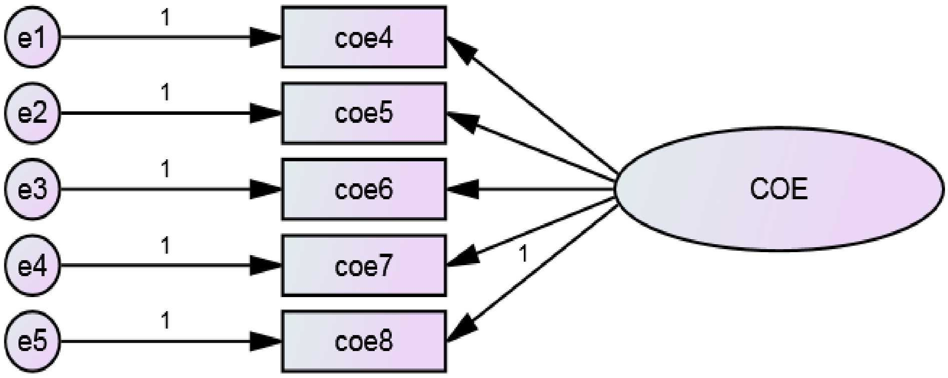


Table 5.35: the Goodness of Fit Indices of the Initial Measurement Model of Collaboration Effectiveness

Goodness of Fit Indices	**Value**	**Criteria**
χ^2	69.696	N/A
Degree of freedom (df)	5	N/A
χ^2 / df	***13.931***	<3
GFI	0.905	>0.9
AGFI	***0.716***	>0.8
NFI	***0.846***	>0.9
CFI	***0.854***	>0.9
TLI	***0.708***	>0.9
RMSEA	***0.220***	<0.08
RMR	0.043	<0.05

The initial measurement model of collaboration effectiveness is not very satisfactory, the author thus modifies the model.

First of all, the item “coe8” (representing “There are clear and fully comprehensive goals for subtasks within our team”) is removed from the measure of collaboration effectiveness (shown as COE). The item “coe8” is removed because the standardized factor loading is 0.54, which falls below the cut-off point of 0.55.

Second, the author reveals the covariance between error items based on the Modification indices (MI). There is one covariance of measurement errors to be correlated: e3 and e4, and the covariance between the error items of coe6 and coe7 is large. Therefore, the author adds a covariance line to link these two error terms.

The modified measurement model is shown in Figure 5.6. The standard loading of each item to its construct are all exceed the good level 0.63 (Comrey and Lee, 1992; Tabachnick and Fidell, 2007). Table 5.36 shows that all indices are good fit to the data.

Figure 5.6 the Modified Measurement Model of Collaboration Effectiveness

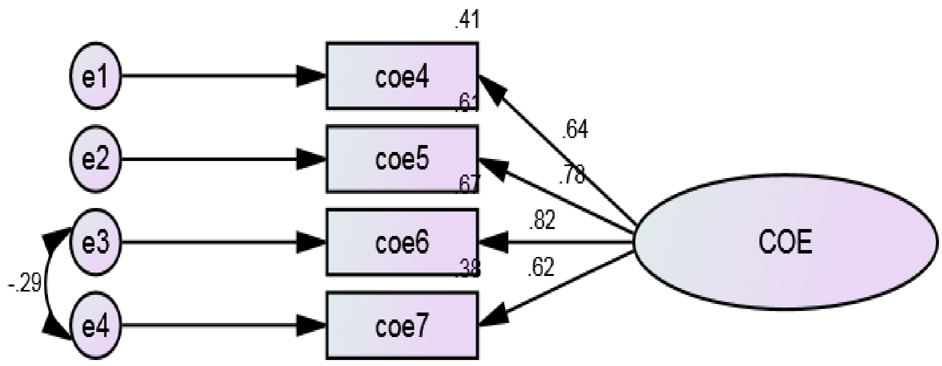


Table 5.36: the Goodness of Fit Indices of the Modified Measurement Model of Collaboration Effectiveness

Goodness of Fit Indices	**Value**	**Criteria**
χ^2	0.300	N/A
Degree of freedom (df)	1	N/A
χ^2 / df	0.300	<3
GFI	0.999	>0.9
AGFI	0.994	>0.8
NFI	0.999	>0.9
CFI	1.000	>0.9
TLI	1.013	>0.9
RMSEA	0.000	<0.08
RMR	0.003	<0.05

5.9.3.3. Measurement Model Test – Innovation Team Performance

The measurement model analysis of innovation team performance (See Figure 5.7) consists of 22 variables which named as TP (as Task Performance), itp6, itp7, itp8, itp9, itp10, e1, e2, e3, e4, e5, SAT (as Socio-psychological Satisfaction), itp12, itp13, itp14, itp16, itp17, e6, e7, e8, e9 and e10. The measure model of innovation team performance and modification indices (MI) are examined.

Figure 5.7 illustrates the hypothesized measurement model of innovation team performance, whereas Table 5.37 describes the main goodness of fit indices of the initial measurement model. The results indicate that the model to some extent fit the data (χ^2=410.900, df =35, χ^2 /df =11.740, p<0.001, GFI=0.791, RMSEA=0.201).

As shown in Table 5.37, all goodness of fit indices have not achieved figures with satisfactory level, therefore the model should be further improved.

Figure 5.7 the Hypothesized Measurement Model of Innovation Team Performance

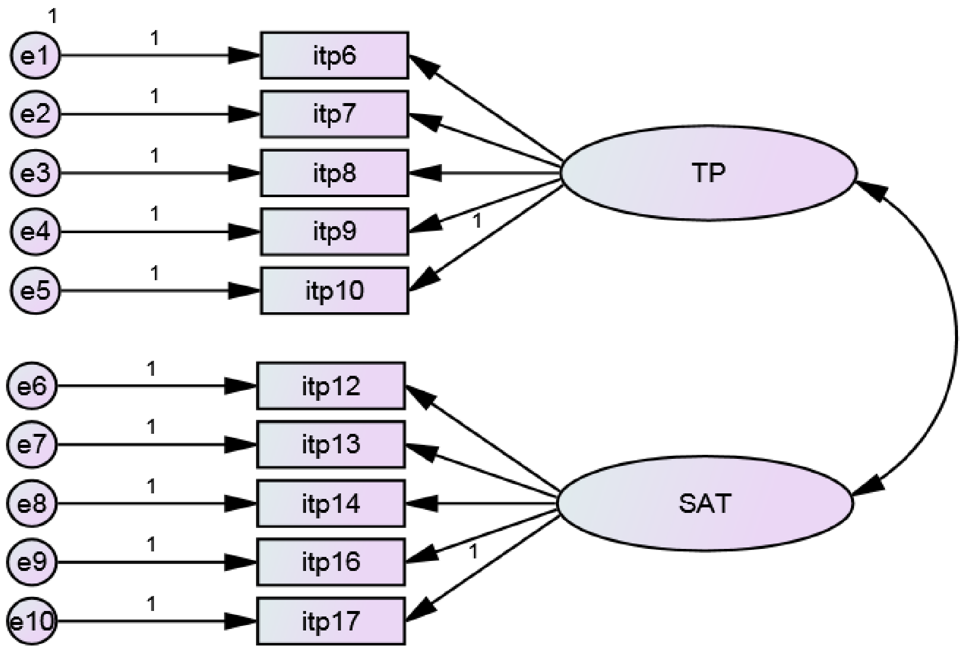


Table 5.37: the Goodness of Fit Indices of the Initial Measurement Model of Innovation Team Performance

Goodness of Fit Indices	**Value**	**Criteria**
χ^2	410.900	N/A
Degree of freedom (df)	35	N/A
χ^2 / df	***11.740***	<3
GFI	***0.791***	>0.9
AGFI	***0.672***	>0.8
NFI	***0.743***	>0.9
CFI	***0.758***	>0.9
TLI	***0.689***	>0.9
RMSEA	***0.201***	<0.08
RMR	***0.100***	<0.05

The initial measurement model of innovation team performance is not very satisfactory; the author thus makes some modifications to the model.

First, the item “itp6” (representing “Overall, the project is done in a cost-effective manner”) and the item “itp10” (representing “Overall, our team earns a positive balance for themselves in the project “) are removed from the measure of task performance (shown as TP). The item “itp6” is removed because the standardized factor loading is 0.49. The item “itp10” is removed because the standardized factor loading is 0.54, both of which fall below the cut-off point of 0.55.

Second, the author reveals the covariance between error items based on the Modification indices (MI). There are two values of covariance of measurement errors are allowed to be correlated: (1) e2 and e4; and (2) e9 and e10, in which the covariance between error items e9 and e10 are particularly large. Therefore, covariance lines are drawn to link these two pairs of error terms respectively.

The modified measurement model is shown in Figure 5.8. The standard loading of each item to its construct, except the item “itp16”, are all exceed the good level 0.63 (Comrey and Lee, 1992; Tabachnick and Fidell, 2007). Table 5.38 shows that all indices are good fit to the data.

Figure 5.8 the Modified Measurement Model of Innovation Team Performance

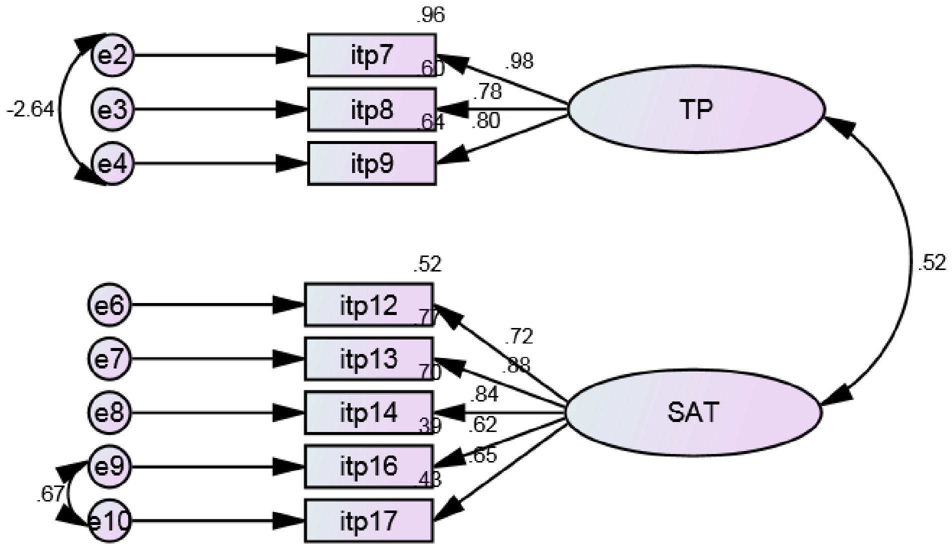


Table 5.38: the Goodness of Fit Indices of the Modified Measurement Model of Innovation Team Performance

Goodness of Fit Indices	**Value**	**Criteria**
χ^2	21.120	N/A
Degree of freedom (df)	17	N/A
χ^2 / df	1.242	<3
GFI	0.980	>0.9
AGFI	0.958	>0.8
NFI	0.983	>0.9
CFI	0.997	>0.9
TLI	0.994	>0.9
RMSEA	0.030	<0.08
RMR	0.020	<0.05

5.9.4. Reliability and Validity

After the evaluation of overall model fit, the author thus assessed the measurement of each construct for reliability and unidimensionality. Moreover, the author also assessed content validity and construct validity.

Composite reliability refers to the degree to which a set of heterogeneous but similar items is consistent with the latent construct they intended to measure. It thus measures the internal consistency of a construct. In the preliminary data analysis, Cronbach's alpha analysis is conducted to the reliability of the items. The author employs composite reliability to assess construct reliability of the construct, because it takes standardized loadings and measurement errors for each item into account. Composite reliability is calculated using the following formula:

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

In the formula, CR is Composite Reliability, λi is the ith standardized loading and θi is the *i*th error variance. Composite reliability value which greater than 0.6 is sufficient for reliability of a scale (Fornell and Larker, 1981). As shown in Table 5.39, the composite reliabilities of the constructs are all above benchmark of 0.6. The result thus indicates a good reliability of constructs of the proposed theoretical model.

Unidimensionality is the characteristics of a set of indicators that has only one underlying trait or concept in common (Hair et al., 1998). A scale is unidimensional when all items of the scale measure a single latent variable. Average variance extracted (AVE) is therefore used to assess convergent validity (Fornell and Larker, 1981). AVE is 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 standardized 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 5.39, AVEs of most of the constructs are above benchmark of 0.5, which are considered satisfactory as they indicate at least 50% of the variance in a measure is based on the hypothesized constructs (Fornell and Larker, 1981). AVEs of Management Support and IT Support are 0.493 and 0.464 respectively. It may due to the fact that these two constructs are intended to measure “Organizational Support” initially, yet it was divided based on the exploratory factor analysis (EFA) in the preliminary data analysis stage.

Table 5.39: the Measurement of Latent Constructs of the Proposed Theoretical Model

Construct	Items	Standardized factor loadings	Composite Reliability	Average Variance Extracted (AVE)
Team Consensus	con4	0.74	0.801	0.542
	con5	0.89		
Management Support	ms1	0.74	0.853	0.493
	ms2	0.75		
	ms3	0.74		
	ms4	0.63		
	ms5	0.70		
	ms6	0.64		
IT Support	its3	0.70	0.722	0.464
	its5	0.67		
	its6	0.68		
Rules & Procedures	rap1	0.88	0.851	0.541
	rap2	0.86		
	rap3	0.58		
	rap4	0.71		
	rap5	0.68		
Proximity	pro2	0.73	0.770	0.628
	pro4	0.85		
Collaboration	coe4	0.64	0.813	0.523

Effectiveness	coe5	0.78		
	coe6	0.82		
	coe7	0.62		
Task Performance	itp7	0.98	0.887	0.727
	itp8	0.78		
	itp9	0.80		
Socio-psychological Satisfaction	itp12	0.72	0.865	0.566
	itp13	0.88		
	itp14	0.84		
	itp16	0.62		
	itp17	0.65		

After assessing the reliability of constructs, the author also assessed content validity and construct validity. Content validity was assessed during the preliminary exploratory stage of this research; the questionnaire was pretested and modified.

Construct validity consists of two elements, which are convergent validity and discriminant validity. Convergent validity refers to the degree of correlation between two measures of constructs relating to the same measure. In contrast, discriminant validity refers to the degree to which measurements of two latent variables are unrelated and unique (Campbell and Fiske, 1959).

It is suggested that factor loadings greater than 0.7 are at a satisfactory level of good convergent validity by explaining more than 50% of the variance by the construct (Hair et al., 1998). In this research, the author considers and retains factors with factor loadings larger than 0.55, as researchers (Comrey and Lee, 1992; Tabachnick and Fidell, 2007) suggest that cut-off at 0.55 is considered as good when the construct explains at least 30 percent of the variance. As shown in Table 5.39, all factor loadings of the eight constructs are above 0.55 suggesting a good convergent validity.

Discriminant validity tests whether theoretically unrelated concepts or measurements are really unrelated. Researchers (Fornell and Larcker, 1981) suggest that discriminant validity can be tested by comparing the AVE value with the squared correlation between constructs.

As shown in Table 5.40, the results of average variance extracted (AVE) and squared correlations of the constructs are listed. Diagonals, which are formatted in bold, represent the square root of average variance extracted (AVE). Other matrix entries represent the correlations among constructs. All AVE values are larger than 0.5, and is greater than its squared correlation. The result thus indicate that the eight constructs in this research study are distinct and with good discriminant validity.

Table 5.40: the AVE and Squared Correlation of the Constructs

	TP	CON	MS	ITS	RAP	PRO	COE	SAT
TP	**0.852**							
CON	0.439	**0.736**						
MS	0.376	0.571	**0.702**					
ITS	0.451	0.650	0.658	**0.681**				
RAP	0.442	0.583	0.490	0.513	**0.736**			
PRO	0.490	0.582	0.356	0.572	0.542	**0.792**		
COE	0.533	0.583	0.428	0.497	0.503	0.504	**0.723**	
SAT	0.528	0.489	0.564	0.367	0.466	0.469	0.506	**0.752**

Notes:

TP = Task Performance; CON = Team Consensus; MS = Management Support;

ITS = IT Support; RAP = Rules and Procedures; PRO = Proximity;

COE = Collaboration Effectiveness; SAT = Socio-psychological Satisfaction

- Diagonals (numbers in Bold) represent the square root of average variance extracted (AVE).
- Other matrix entries represent the correlations among constructs.
- To ensure Discriminant Validity, diagonal entries should be greater than other matrix entries.

5.9.5. Structural Model Analysis

The author employed Structural Equation Modeling (SEM) in this research to test propositions and the proposed theoretical conceptual model which included a set of contextual antecedents and collaboration effectiveness among innovation projects. SEM thus allows the author to analyze the hypothesized patterns of both directional and non-directional relationships among a collection of measured (observed) and latent (unobserved) variables (MacCallum and Austin, 2000).

There are two major characteristics of SEM, which make such statistical approach so distinguishing. First, SEM helps the author to understand the patterns of multiple and interrelated dependence relationships among a set of variables. Second, SEM also explains the observed concepts in these relationships and accounts for measurement errors during the estimation process (Hair e al., 1998).

Thus, the major advantage of SEM is based on the benefits of using both measurement and structural models at the same time (Hair e al., 1998). In order to ensure both models are correctly specified with valid results, the author thus employed the seven-step approach of SEM suggest by Hair et al. (1998).

The seven-step approach of structural equation modeling (SEM) suggested by Hair et al. (1998) is as follows, (1) To develop a theoretically based model; (2) To Construct a path diagram of casual relationships; (3) To convert the path diagram into a set of structural and measurement models; (4) To choose the input matrix type and estimate the proposed model; (5) To assess the identification of the structural model; (6) To evaluate goodness of fit criteria; and, (7) To interpret and modify the model. The author carried out these steps to test the proposed theoretical model.

In this study, the author employed the Maximum likelihood Estimation (MLE) as it is the most common estimation procedure. The minimum sample size for appropriate use of MLE is from 100 to 150. When the sample size is increased above this value, the MLE method increases its sensitivity to detect differences among the data (Hair et al., 1998). The usable samples of this study are 267, which is suitable for employing MLE in the data analysis.

The assessment of goodness of fit is one of the major characteristics of SEM, in order to specify both measurement and structural models correctly. The author employed a number of goodness of fit criteria in this study, as the statistical significance from these indices can help the author to identify a correct and comprehensive model.

In this research, the author considered the following goodness of fit criteria, which included chi-square, 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). Other incremental fit indices were also used, such as: comparative fit index (CFI), normed fit index (NFI), and nonnormed fit index (NNFI).

During the process of assessing model fit, the author removed the measurement variables which did not meet the indices criteria. The measurement model was tested again after items were removed. Such process repeated until the author attained an acceptable or even a satisfactory level of model fit.

After the assessment of measurement model, the author began to test on the structural model. The structural model aims to identify the casual relationships between latent variables. As chi-square is very sensitive to sample size (Hair et al., 1998), chi-square / df is employed as it is a measure of absolute fit of model, which does not affected by the sample size. The ratio lower than 5.0 is considered as a good fit (Byrne, 2001).

GFI indicates the relative amount of variance and covariance jointly accounted for the tested model. Thus, AGFI is the GFI adjusted for the degrees of freedom of the model relative to the number of variables. The AGFI and GFI values are ranged from 0 to 1, with higher values indication better fit. GFI value which is greater than 0.9 is considered as good fit. AGFI with value greater than 0.8 is considered as good fit.

CFI measures the improvement in going from a target model to an independence model. CFI values are ranged from 0 to 1, with higher values indication better fit. CFI values close to 0.90 or above indicate satisfactory model fit (Baumgartner & Homburg, 1996). Normed fit index (NFI) is one of the most popular incremental fit measures. NFI values ranged from 0 to 1, with higher values indication better fit. NFI values close to 0.90 or above indicate satisfactory model fit (Hair et al., 1998). As NFI is subject to the effect of sample size, NNFI, (also know as Tucker-Lewis Index, TLI) was developed, which is not affected by sample size. NNFI values ranged from 0 to 1, with higher values indication better fit. NFI values close to 0.90 or above indicate satisfactory model fit (Hair et al., 1998).

RMR measures the average amount of correlation and covariance not accounted for by the model, and RMSEA is a measure of approximate fit in the population. Both RMSEA and RMR decrease as goodness of fit increases and indication perfect fit with lower values which close to zero. In this research, the marginal acceptance level for RMR is 0.08. In this research, the author also considered RMSEA values which are below 0.05 can be considered as a good model fit, while values between 0.05 and 0.08 are of acceptable fit.

5.9.5.1. Structural Model

The author used AMOS 16.0 to carry out Structural Equation Modeling (SEM). The SEM technique is known as a two-step approach, which consists of the measurement model and the structural model (Hair et al., 1998). In this section, the author conducts the structural model in the SEM approach. The structural model is indeed a set of one or more dependence relationships linking the hypothesized model's constructs, and it is particular useful in representing the interrelationships of variables between dependence relationships (Hair et al., 1998).

Figure 5.9 illustrates the hypothesized structural model, whereas Table 5.41 describes the main goodness of fit indices of the initial structural model. The results indicate that the model to some extent fit the data (χ^2=1127.899, df =387, χ^2 /df =2.914, $p<0.001$, GFI=0.788, RMSEA=0.085).

As shown in Table 5.41, most of the goodness of fit indices do not achieve figures with satisfactory level, therefore the structural model can be further improved.

Figure 5.9 the Hypothesized Structural Model

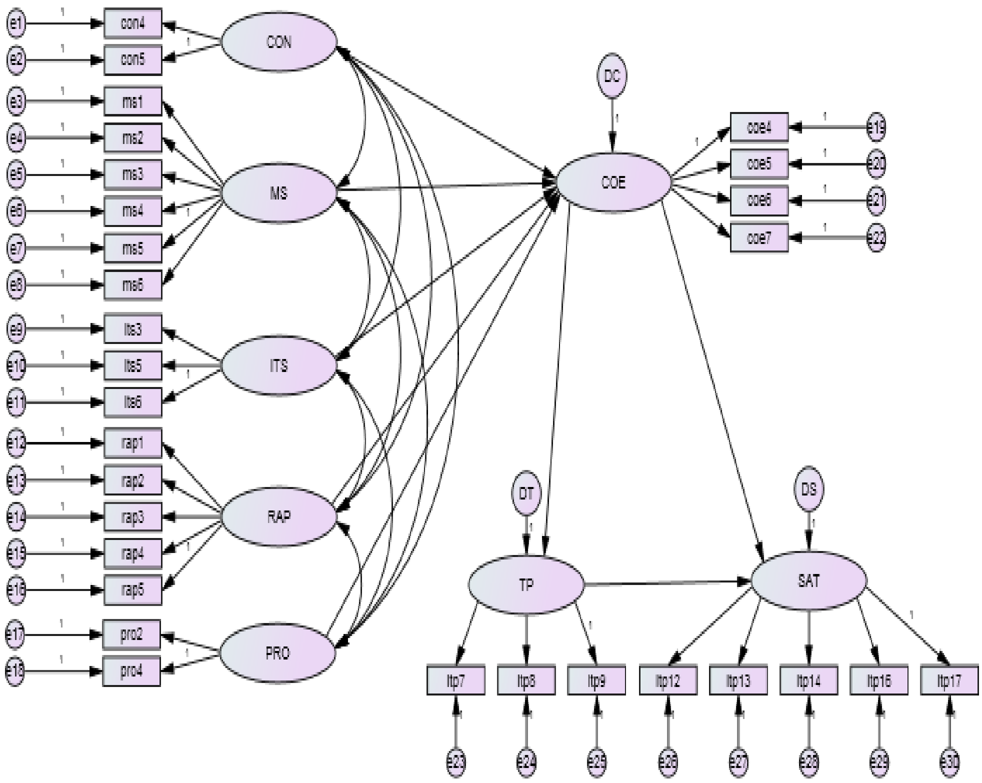


Table 5.41: the Goodness of Fit Indices of the Initial Structural Model

Goodness of Fit Indices	**Value**	**Criteria**
χ^2	1127.899	N/A
Degree of freedom (df)	387	N/A
χ^2 / df	2.914	<3
GFI	***0.788***	>0.9
AGFI	***0.655***	>0.8
NFI	***0.759***	>0.9
CFI	***0.826***	>0.9
TLI	***0.804***	>0.9
RMSEA	***0.085***	<0.08
RMR	0.047	<0.05

The initial structural is not very satisfactory; the author thus makes some modifications to it.

The author reveals the covariance between error items based on the Modification indices (MI). There are thirteen values of covariance of measurement errors are allowed to be correlated: (1) e27 and e26; (2) e28 and e27; and (3) e29 and e27; (4) e29 and e28; (5) e30 and e27; (6) e30 and e29; (7) e25 and e23; (8) e20 and e21; (9) e13 and e12; (10) e14 and e13; (11) e15 and e12; (12) e15 and e14; and, (13) e4 and e3. Among which the covariance between the error items e29 and e30 is particularly large. Therefore, the author modifies the model by adding covariance lines to link these thirteen pairs of error terms correspondingly.

The modified measurement model is shown in Figure 5.10. And, Table 5.42 shows that GFI and NFI are acceptable fit to the data, whereas other indices show a good fit to the data.

Figure 5.10 the Modified Structural Model

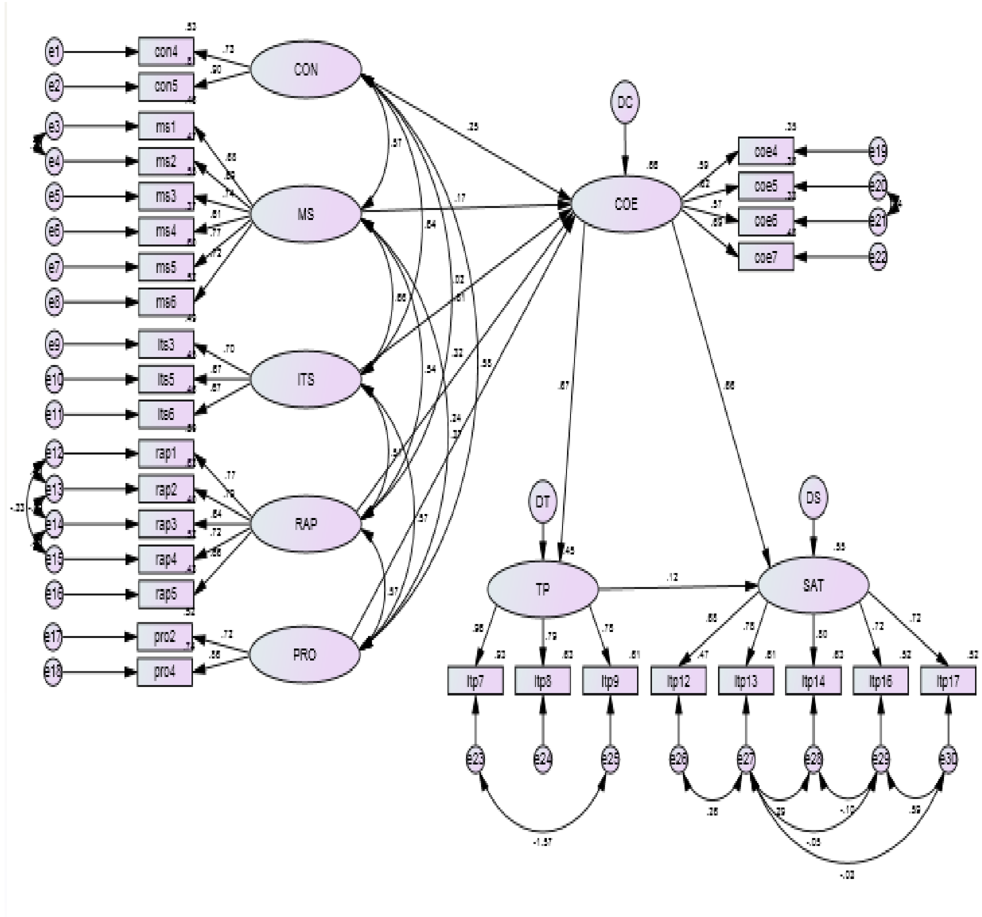
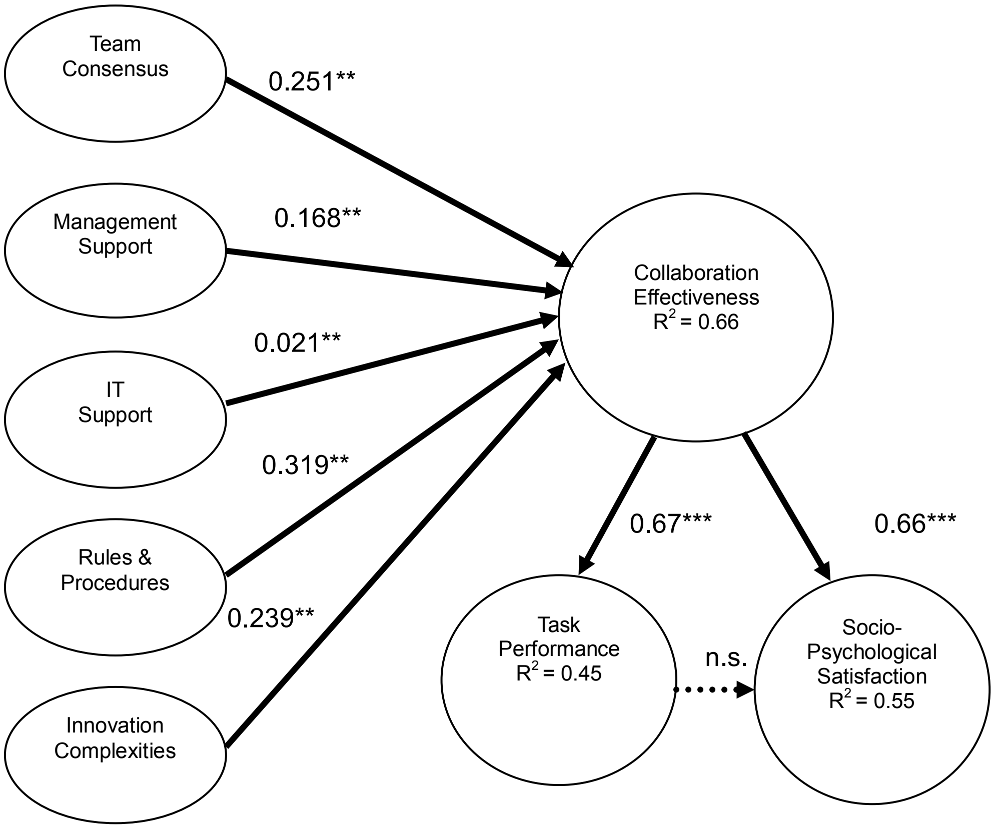


Table 5.42: the Goodness of Fit Indices of the Modified Structural Model

Goodness of Fit Indices	**Value**	**Criteria**
χ^2	768.745	N/A
Degree of freedom (df)	374	N/A
χ^2 / df	2.055	<3
GFI	***0.847***	>0.9
AGFI	0.810	>0.8
NFI	***0.836***	>0.9
CFI	0.907	>0.9
TLI	0.892	>0.9
RMSEA	0.063	<0.08
RMR	0.038	<0.05

Figure 5.11 illustrates the path diagram of the final structural model. The author also reports explanatory power of the model, which is examining by the portion of variance explained. The results suggest that the model is able to explain 66% of the variance in Collaboration Effectiveness of innovation teams, 45% of the variance in the Task Performance of innovation project and 55% of the variance in the Socio-psychological satisfaction of innovation project. Moreover, 7 out of 8 path validity coefficients are found to be significant.

Figure 5.11: the Path Diagram of the Final Structural Model



*** p<0.001, ** p<0.05, n.s. = insignificant

5.9.5.2.Hypothesis Testing

As shown in Figure 5.11, the path diagram suggests that collaboration effectiveness can be explained by five factors, which are team consensus (β = 0.251), management support (β = 0.168), IT support (β = 0.021), rules and procedures (β = 0.319) and innovation complexities (β = 0.259). These five contextual factors thus explain 62% of the variance of collaboration effectiveness among innovation teams.

The path diagram in Figure 5.11 also suggests that collaboration effectiveness of innovation teams affects both indicators of innovation team performance, which are task performance (β = 0.673) and socio-psychological satisfaction (β = 0.659). Thus, collaboration effectiveness explains 45% of the variance of task performance. It also explains 55% of the variance of socio-psychological satisfaction. However, the relationship between task performance and socio-psychological satisfaction is insignificant.

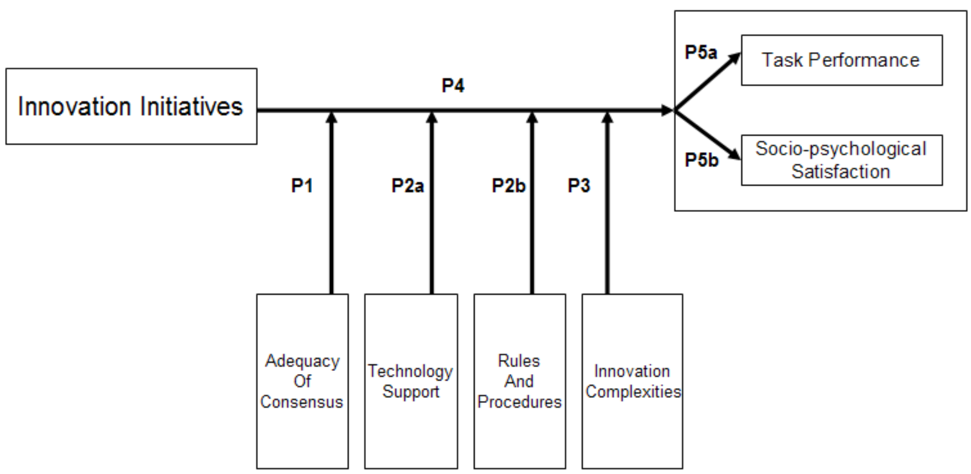
Refer to Table 5.43, seven out of eight propositions are affirmative based on the statistical results. Propositions 1, 2a, 2b and 3 are affirmative with p value smaller than 0.05. Meanwhile, Propositions 5a and 5b are strongly affirmative with p value smaller than 0.001. Proposition 4 is affirmative as the contextual antecedents explain 66% of its variance. Proposition 5c is rejected and reveals that no significant relationship between task performance and socio-psychological satisfaction.

Table 5.43: the Summary of the Hypothesis Testing Results

Propositions	Affirmative or not?	Significance level
P1 Adequate Team consensus ↓ Cross-Functional Collaboration	Affirmative	$p<0.05$
P2a Technology Support ↓ Cross-Functional Collaboration	Affirmative	$p<0.05$
P2b Organizational Rules & Procedures ↓ Cross-Functional Collaboration	Affirmative	$p<0.05$
P3 Innovation Complexities ↓ Cross-Functional Collaboration	Affirmative	$p<0.05$
P4 Effectiveness of Cross-functional Collaboration	Affirmative	It is significant as 66% of the variance is explained
P5a Cross-functional Collaboration ↓ Task performance	Affirmative	$p<0.001$
P5b Cross-functional Collaboration ↓ Socio-psychological satisfaction	Affirmative	$p<0.001$
P5c Task performance ↕ Socio-psychological satisfaction	Negative	Insignificant

Refer to Figure 5.12, the statistical results support propositions 1, 2a, 2b and 3 are affirmative. Adequacy of consensus, technology support, rules and procedures and innovation complexities constitute as vital enablers for the development of innovation initiatives among textiles innovation projects. Proposition 4 is affirmative, which reveals that the collaboration process of cross-functional team individuals is essential for the development and implementation of textiles innovation projects. Propositions 5a and 5b are affirmative as two possible outcomes of textiles innovation projects among well collaborated project team members. However, the rejection of Proposition 5c indicates that there is no significant relationship between task performance and socio-psychological satisfaction.

Figure 5.12: the Final Theoretical Model of Textiles Innovation Projects



5.10.Summary

This chapter describes the measurement development of variables, modification processes of the questionnaires, survey administration, quantitative data analysis methods, and the findings of this research. There are 142 valid responses collected for the preliminary data analysis and 267 valid responses collected for the mass industry survey. A number of validation processes are carried out to assure the measurement scales of the constructs is reliable and valid. The evaluation indices suggest a good fit between the final structural model and data. The model also achieves a satisfactory level of explanatory power in collaboration effectiveness of innovation projects, and an acceptable level of explanatory power in innovation team performance.

The results of this quantitative research reveal that seven out of eight propositions are affirmative. Contextual antecedents including team consensus, technology support (measured by management support and IT support), organizational rules and procedures, and innovation complexities (measured by proximity) have a significant and positive effect towards the collaboration effectiveness of innovation project teams. Thus, these contextual antecedents explain 66% of the variance of collaboration effectiveness. The relationship between collaboration effectiveness and Innovation team performance are also strong and significant. However, there is no significant relationship between task performance and socio-psychological satisfaction.

CHAPTER 6

DISCUSSION AND CONCLUSION

6.1. Introduction

This research study examines the contextual antecedents of team collaboration within the context of innovation projects, and investigates their relationships with collaboration effectiveness. The author puts forward the investigation to study the connection between collaboration effectiveness and innovation project performance.

Chapter 1 outlines the research background, research approach, significance and assumption of this study, and organization of this thesis. Research problems, objectives of this research are also defined in the first chapter. Chapter 2 reviews the extant literature on collaboration systems, which applied in dissimilar team structures. The investigation on an integrated management model of innovation projects collaboration thus allows the author to propose a three-step conceptual model. Research propositions are suggested based on the literature review, and the identified research gap.

Chapter 3 presents a content analysis study on the virtual collaboration issues in textiles innovation projects. It presents the background of 15 experienced team individuals from non-hierarchical textiles innovation projects. The insights provided by the industry practitioners in relation to the proposed conceptual model are then analyzed. This chapter provides empirical evidences from the viewpoint of practitioners who contribute to this research by enriching its practical implications.

Chapter 4 describes the case study on a government supported innovation project participated by textiles industry practitioners. The scope of interests between the private sector and the institutes results in a complicated collaboration contexts. This case study thus depicts the empirical observations of fieldworks during the extensive period of textiles innovation project. The interrelationship between innovation projects and the intensity of its contextual collaborative antecedents are also reported and discussed.

Chapter 5 presents the quantitative methodology adopted to further investigate and justify the proposed conceptual model on innovation projects collaboration. The results of both preliminary study and the mass industry survey are also reported. Reliability and validity tests, descriptive analysis, profiles analysis of respondents, structural equation modeling (SEM) for model and hypothesis testing are conducted. Results on the modified models and the research hypothesis are also reported.

This chapter first revisits the research questions of this research study. It thus summarizes and discusses the findings of this research in relation to the research questions and objectives. The author also discusses the issues of heterogeneity and ICTs usage. A strategic decisive model is also outlined. Implications for both academics and industry practitioners are then identified. Future research works to be done are also addressed in this chapter.

6.2. Revisiting the Research Questions

In today's business environment, innovation becomes the most imperative element for organizations' survival and success. Therefore, this study is inspired by the phenomenon of the rising significance of innovation projects in nowadays business setting. These innovation projects are often collaborated across geographical and organizational borders with dispersed and nomadic members, so as to increase the challenges of project management. For the organizations who are currently adopting such modern business structure, and for those who are interested in employing it, it is important for them to understand the underlying contextual factors which influence the effectiveness of collaboration, and how the collaboration effectiveness can help them to achieve a better innovation project performance.

The core issue of this research is therefore to be examined with reference to the growing popularity of employing innovation project teams in business operations. It will be beneficial to both academics and industry practitioners to identify the key enablers of innovation team collaboration processes, and to determine whether they have impacts on the ultimate performance of innovation projects.

In order to attain a better understanding on the area of interests, this study is designed to answer three main research questions which are as follows:

1. What are the contextual antecedents of collaboration which affects the course of collaboration processes among innovation projects?
2. How do these antecedents shape the collaboration effectiveness among innovation project teams?
3. How does collaboration effectiveness affect the performance of innovation project teams?

Aiming to address to the above questions, the author thus proposes a theoretic analytic model to conceptualize the collaboration issues of innovation projects. A mix of qualitative and quantitative approach is chosen to facilitate this research to shed a light on the research questions and to fill the gap of literatures by building up the analytic model.

6.3. Summary of Empirical Findings

This section presents a discussion of the results of propositions testing and offers explanations for the findings. Table 6.1 shows the relationships and whether they are affirmative or not. The strength of each relationship is also shown.

Each of the propositions is discussed and explanations are offered for the results of relationships between these constructs. Moreover, the strength of each relationship is based on the results of quantitative data analysis, which is indicated by the statistical significance in the path analysis and the percentage of the explained variance.

Table 6.1: the Results of Propositions testing

Propositions	Affirmative or not?	Relationship Strength
Adequate team consensus influences cross-functional collaboration	Affirmative	Moderate
Technology support influences cross-functional collaboration	Affirmative	Moderate
Organizational rules & procedures influences cross-functional collaboration	Affirmative	Moderate
Innovation Complexities influences cross-functional collaboration	Affirmative	Moderate
Effectiveness of cross-functional collaboration is determined by its contextual antecedents	Affirmative	It is significant as 66% of the variance is explained
Cross-functional collaboration influences the perceived task performance of innovation team	Affirmative	Strong
Cross-functional collaboration influences the socio-psychological satisfaction of innovation team members	Affirmative	Strong
Task performance and socio-psychological satisfaction are interrelated	Negative	Insignificant

6.3.1. The Contextual Antecedents of Innovation Team Collaboration

- Adequacy of Team Consensus

Proposition 1, that adequate level of team consensus has a positive and significant direct effect on cross-functional collaboration, is affirmative. As virtual innovation projects require an intensive collective effort in task completion and definition of goals and work processes, it is therefore identified as a high level of collaboration.

During the exploratory stage of study, it is first concluded from the in-depth interviews that an adequate team consensus enables innovation team members to secure the foundation of opinions and knowledge interchange. The results also suggest that the adequacy of team consensus is difficult to measure and adjust by innovation team members.

Besides, results from the ethnographic case study suggest that adequacy of team consensus plays an important role during the course of cross-functional collaboration of innovation projects. The author first observed that, in the idea generation and screening stage of innovation projects, an adequate level of consensus allows project teams to develop an overall framework for developing the innovation and build up a foundation for innovation project teams to follow in latter stages. Second, reaching an optimal level of consensus during the concept development and testing stage is observed to be a very challenging task for project managers and coordinators. As cross-functional team members need to handle their tasks in different ways, too much emphasis on reaching consensus may inhibit the efficiency of innovation development. Last but not least, as both operational and technical staffs are used to the existing technology, more technical assistance and training are required when introducing the new innovation system during the technical implementation stage.

During the developmental and evaluation phase of this research, the statistical results of the multivariate data analysis show that the construct fits the data well. Two out of six items remained until the later stage of analysis with a significant correlation with the construct. The results therefore suggest that innovation project members always stick to a set of clearly stated administrative procedures when tackling problems. And, it is important that their information procedures along tasks are consistent and seamless.

To conclude, it is therefore important for innovation project teams to achieve an adequate level of team consensus. Project managers and coordinators should also ensure that the intensity of team consensus is adjusted according to various stages of innovation development process. Proper levels of inter-team consensus thus form a source of knowledge interchange requirements, which enhance the collaboration effectiveness of innovation management.

- Technology Support

Proposition 2a, which proposes that intensive technology support performs as an enabler of effective collaboration, and strong ICTs support has a positive and significant direct effect on cross-functional collaboration, is affirmative. In this study, technology support is measured by the combination of IT support and management support in the availability of IT resources and the extent of such technology sophistication for the execution of innovation projects.

First of all, as innovation project teams are formed by dispersed members from diverse organizations and geographical locations, results from the exploratory stage of study thus suggest that such composition of innovation project teams leads to the great importance of technology support.

The results also suggest that technology support is necessary for the creation of virtual workplace among innovation project teams. It is consistent with the technological trend in nowadays society that virtual workplace becomes very mobile in nature. Apart from desktops and laptops, it is revealed that there is a demand for electronic gadgets (such as: Smartphone and iPad) among innovation team members. They believed that such devices will allow them to work more effectively with higher mobility.

Second, the results from ethnographic case study suggest that technology support is an important enabler for the cross-functional collaboration of innovation projects. During the idea generation and screening stage, team members are provided with a virtual platform to coordinate tasks and communicate with each other. They depend on the implementation of Information and communication technologies (ICTs) to facilitate collaboration processes of innovation projects.

However, the intensity of technology support is less emphasized in the concept development and testing stage. Functional team members focus on their individual project works, and there are less collaborative activities, which required the use of ICTs for team communication. Whereas, project managers and coordinators employ ICTs more frequently to coordinate project tasks between various functional members for an effective project flow. It is worth notice that the intensity of technology support is more emphasized in the technical implementation stage, as innovation project teams need to redefine a new mix of communication platform, which is practically fit with the concerned project environment.

The statistical results of the multivariate data analysis show that both constructs of IT support and management support fit the data well. Nine out of fourteen items remained until the later stage of analysis with a significant correlation with the construct. The results suggest that technology support acts an enabler in relation to the collaboration issues of innovation projects. Management support is more statistically relevant than IT support, which indicates that the organizations' support of IT resources is of more concerns in the point of view of innovation project members.

To conclude, technology support is important to innovation project teams during the course of collaboration. Project managers and coordinators should ensure that dispersed team members are equipped with the necessary IT resources to facilitate an effective inter-team collaboration process.

- Organizational rules and procedures

Proposition 2b, which undesirable organizational rules and procedures impose an interfering and bureaucratic effect on cross-functional collaboration, is affirmative by the results of in-depth interviews and ethnographic case study. Organizational rules and procedures are also statistically significant to the construct of collaboration.

Firstly, the results from the exploratory stage of study suggest that organizational rules and procedures inhibit the cross-functional collaboration processes, because limited empowerment lengthened the time taken for team members to complete project tasks. And, hierarchical organizational structure limits the feasibility and flexibility of innovation tasks.

Secondly, the results of ethnographic case study suggest that organizational rules and procedures are of the least importance to the collaboration processes of innovation projects. Team members tend to treat those rules and procedures, which they learnt from their organizations, as the preliminary guidelines of innovation projects in the idea generation and screening stage. And, during the concept development and testing stage, the presence of organizational rules and procedures acts as friction between cross-functional team members. Cross-functional team members have avoidance behavior towards innovation projects and become passive collaborators as they are afraid of violating rules and procedures. During the technical implementation stage, innovation project teams have to collaborate in the field by not violating rules and procedures which are out of the innovation scope.

The statistical results of the multivariate data analysis show that the construct of rules and procedures fit the data well. Five out of six items remained until the later stage of analysis. The results suggest that organization rules and procedures is a significant determinant for innovation projects collaboration. Therefore, it is important for project managers and coordinators to come up with a set of rules and procedures for innovation teams to facilitate the collaboration processes of innovation projects.

- Innovation complexities

Proposition 3, which an appropriate control of innovation complexities can result in a harmonious collaboration environment among cross-functional project teams, is affirmative. As the complexities of innovation creates the operating foundations of innovation projects, such as, the geographical arrangement, the social behavioral factors and time-related working behaviors.

First, innovation complexities describe the operating foundations and background of cross-functional project teams. Results from in-depth interviews thus suggest that an appropriate set of ICTs and management mechanism are required to create a harmonious collaborative environment among innovation project teams.

Second, the results from ethnographic case study suggest that innovation complexities are particularly important in the idea generation and screening stage. As project managers and coordinators must help project team members to build up a common set of work patterns and collaboration behaviors to implement during the collaboration processes of innovation projects. The intensity of innovation complexities is subject to change in other stages, as the work patterns of nomadic members have significant influence on cross-functional collaboration.

The statistical results of the multivariate data analysis show that the construct fits the data well. Two out of five items remained until the later stage of analysis with a significant correlation to the collaboration construct. The results suggest that it is important for innovation project members to share a same set of consistent and regular work paces. And, the results also show that innovation team members value the sharing of a similar set of rhyme when processing their daily tasks.

To conclude, innovation complexities act as an important enabler for innovation project teams to collaborate. Project managers and coordinators should put emphasis on creating a common set of time-related working behaviors among innovation project teams. Although geographical location also constitutes to innovation complexities, an appropriate arrangement of time-related working behaviors can offset the geographical distance between team members, thus enhance the overall collaboration effectiveness of innovation projects.

6.3.2. The Collaboration Effectiveness of Innovation Project Teams

Proposition 4, which cross-functional collaboration acts as a mediating process from contextual antecedents towards the perceived task performance and socio-psychological satisfaction, is affirmative. Managing collaboration issues among innovation projects is very challenging, as it involves dispersed team members and complicated project tasks.

The results from in-depth interviews suggest that both team communication and tasks coordination are important for determining collaboration effectiveness, which is consistent with that in the literatures. The cross-functional collaboration effectiveness is thus subject to the extent of how well the cross-functional teams communicate and how smoothly they coordinate their tasks (Wynn and Novick, 1995).

Second, the results from ethnographic case study suggest that the intensity of collaboration varies throughout the course of innovation projects. The process of innovation development is complex and demands the involvement of diverse expertise. Therefore, innovation project teams have to change their communication patterns at different stages in order to facilitate different project tasks. Project managers and coordinators also need to coordinate tasks flexibly in order to cope with different work patterns of cross-functional members and nomadic members.

The statistical results of the multivariate data analysis show that the construct fits the data well. Four out of ten items remained until the later stage of analysis with a significant correlation to the construct. The results suggest that timeliness, accuracy and usefulness of data are especially important for enhancing collaboration effectiveness. It is also important to maintain a harmonious atmosphere when carrying out various project tasks. Moreover, the structural equation modeling also reveals that the proposed contextual antecedents explain 66% of the variance of collaboration effectiveness.

To conclude, collaboration effectiveness is statistically significant and acts as the mediating role between contextual antecedents and innovation project performance. Thus, it is important for project managers and coordinators to adjust both communication patterns and tasks coordination throughout the course of innovation projects.

6.3.3. The Effects of Collaboration Effectiveness on Innovation Team Performance

Proposition 5a, in which states highly effective cross-functional collaboration has a positive and significant effect on the perceived tasks performance, is affirmative. Task performance (such as: the completion time and budget of projects) is tangible and measurable. Results from the exploratory interviews and ethnographic case study show that task performance is thus the most commonly used indicator for assessing the effectiveness of innovation projects among organizations.

Proposition 5b, in which states highly effective cross-functional collaboration has a positive and significant effect on the socio-psychological satisfaction, is affirmative. Socio-psychological satisfaction is intangible, and it indicates team members' sense of excitement, enjoyment and learning experiences which gained from innovation projects. Results from both qualitative data analysis show that socio-psychological satisfaction is of great importance from the views of project team members. It directly influences their willingness and motivations to engage in future innovation projects.

The statistical results of the multivariate data analysis show that the construct fits the data well. Ten out of seventeen items were remained until the later stage of analysis with a significant correlation to the construct. The results suggest that budget and schedule control are important for enhancing the perceived task performance, while learning experiences and skills which obtained from project works are important for enhancing the socio-psychological satisfaction of innovation team members. Moreover, the structural equation modeling also reveals that propositions 5a and 5b are statistically significant, as the proposed contextual antecedents explain 66% of the variance of collaboration effectiveness. Thus, collaboration effectiveness explains 45% and 55% of the variance of task performance and socio-psychological satisfaction respectively.

To conclude, the effects of collaboration effectiveness on innovation team performance are statistically affirmative. Collaboration effectiveness influences both tangible and intangible indicators of innovation project performance. Project managers and coordinators can therefore improve the innovation project performance by enhancing the collaboration effectiveness of innovation projects.

6.3.4. The Interacting Effects of Tangible and Intangible Innovation Team Performance

Proposition 5c, in which states highly satisfactory perceived task performance has a positive and significant effect on socio-psychological satisfaction of virtual innovation project team members, and vice versa., is not statistically affirmative.

In both exploratory interviews and ethnographic case study, the results show that satisfactory tangible task performance has positive and direct effect to the socio-psychological satisfaction of innovation project members, and vice versa. For example, interviewees revealed that they had gained satisfaction when the innovation projects meet certain measurable milestones. Such comments indicated that both tangible and intangible performance indicators are interrelated.

However, the statistical results of the structural equation modeling reveals that proposition 5c is statistically insignificant. Perceived task performance and socio-psychological satisfaction are not interrelated in the proposed conceptual framework.

6.4. Discussions

In addition to the variables of main interests in this study, the author would like to discuss a few interesting issues in this section, which are the effects of team heterogeneity, the popularity of ICTs and group norms in ICTs usage. The author thus suggests a strategic decisive model for project managers and coordinators. The management model is particularly useful when they are in the dilemma of selecting appropriate collaboration mechanisms for innovation projects.

6.4.1. The Construct of Team Heterogeneity

During the process of literature reviews, team heterogeneity has been studied by a few researchers (Forrester, 2000; Guzzo and Dickson. 1996; Ljungquist, 2013). However, during the data collection process of in-depth interviews, there was no solid feedback from interviewees on the significance of team heterogeneity. Therefore, the construct of team heterogeneity was not included in the proposed conceptual model. In this section, the author would like to discuss on the role of team heterogeneity by first reviewing literatures on this construct.

In general, collaborative teams are responsible for conducting complex and varied project tasks, which are often highly autonomous and functionally diverse. Therefore, collaborative incident might mean accommodating a wider span of heterogeneity among the virtual innovation project team memberships.

From the perspectives of absorptive capacity, such diversity of team memberships allows individuals to create novel associations and linkages of their personal knowledge. A firm has to recognize and acquire external knowledge, which could be important and beneficial to the organizational operation. Guzzo and Dickson (1996) claims that team heterogeneity can be either an asset or a liability to team effectiveness.

Team heterogeneity indicates the differences of dispersed team memberships in the course of collaboration processes, such as geographical dispersion, culture diversity and the specialization of their functional expertise and interests (Forrester, 2000; Ljungquist, 2013; Mesly et al., 2014). The differences stem inherently from the team members' individual psychological engagements, cultural values, belief and attitude sets. If a project manager could not manage the heterogeneous characteristics of a project team advisably, conflicts and organizational rivalry for types of interests may then arise.

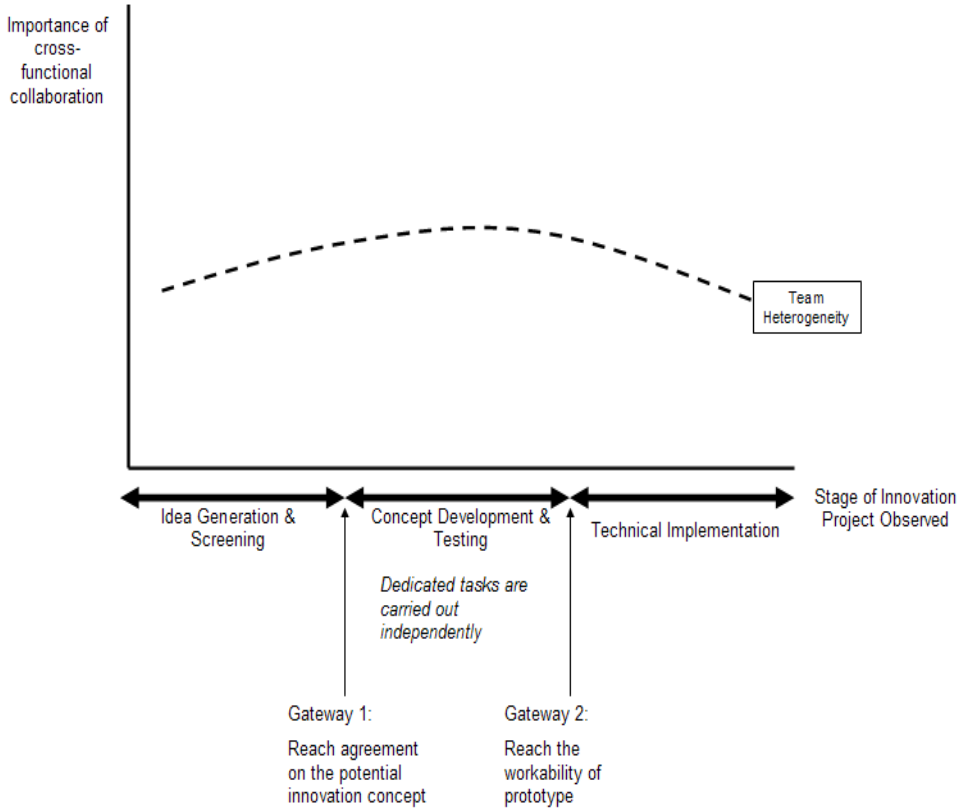
Therefore, team heterogeneity provides an important source of collaboration input and influences the degree of versatility among the members of collaborative teams. With an appropriated management model, an effective coordination of heterogeneous teams may give rise to positive knowledge interchange and building.

In nowadays business environment, organizations realized the complexity of developing an innovation. They often collaborate with experts from other fields in order to bring in new insights and skills, which are essential for textiles innovation projects. As there are normally two or more companies involved in a textiles innovation project, team members have to work with project team members who come from other industries.

Although team heterogeneity is requisite for innovations development, it could also be a threat to the collaboration processes of textiles innovation projects. As team heterogeneity leads to diversified cultural backgrounds and working behaviors, which may give rise to conflicts between project team members. The higher the team heterogeneity, the more intensive the knowledge and expertise it will be, the more difficult for project managers and coordinators to manage. Therefore, project managers and coordinators should design a proper set of managerial mechanisms for each textiles innovation project, so as to cope with the dissimilar composition of team members among innovation projects.

The author also tries to propose the curve of team heterogeneity in relation to the course of textiles innovation projects and Cross-functional collaboration (See Figure 6.1).

Figure 6.1 the Illustration of the moderating effects on team heterogeneity under the relationship between Textiles innovation projects and Cross-functional collaboration



The curve of team heterogeneity should be at its lowest position during the idea generation and screening stage, as only those who are at higher hierarchical status in their corresponding organizations took part actively in this stage. They aim to make commitments on the set up of project objectives and the overall project framework. In latter stages, they would empower other cross-functional team members to carry out their corresponding project tasks for the attainment of project goals.

Contrarily, the curve of team heterogeneity ascends and reaches its highest position during the concept development and testing stage. In this stage, experiences and knowledge from various functional team members should be greatly indispensable. The dynamic exchange of information and expertise during the collaboration thus enables the innovation team to come up with ideas, which are out of the box of one particular specialism. All functional team members thus collaborate actively aiming to make contributions to develop the potential innovation concept for achieving project objectives in regarding to the project framework.

The curve of team heterogeneity starts descending during the technical implementation stage. The intensity of team heterogeneity should be decreased as some functional team members have completed their corresponding project tasks in the previous project stage. Nomadic team members also collaborate less actively because they might consider the technical implementation stage as a steady project stage that requires technical fine-tune with little variations. However, this belief is not necessarily true at all times, especially in the ill-structured and challenging manufacturing environment.

The above discussion on team heterogeneity is closely related to this research study. The author would like to devote more research efforts on this construct in the future, by studying its importance and uncovering the reason why it was not regarded by team members as an essential antecedent for cross-function collaboration among innovation projects.

6.4.2. The Popularity of ICTs and Group Norms of ICTs Usage

In addition to the conceptual framework of collaboration among innovation projects, the author would also like to get some insights about the information and communication technologies (ICTs) from the mass industry survey.

- The Popularity of ICTs implementation

According to the mass industry survey, email is the most popular ICTs employed by innovation team members. Respondents from the in-depth interviews also mentioned that email is the most readily prepared tool by organizations, and it was relatively easy to create a new email account for project use. Face-to-face interaction is of great importance as well, which indicates that innovation project teams still gather at the same location and discuss on some vital issues. Respondents from the interview also reported and gave example to such face-to-face interaction, such as kick off meetings.

Although telephone is a traditional communication tool, it is still commonly used among innovation team members. When textual information is not sufficient and difficult to understand, team members sometimes prefer contacting other members by telephone to communicate verbally. However, respondents mentioned that it was difficult to record these conversations, and they would still send a confirmation email to other members to repeat the content that they had discussed.

Data from the mass industry survey shows a neutral application rate on collaboration software and computer conferencing, with relatively high standard deviations. It therefore indicates that the data were more dispersed around the mean scores. There are indeed some innovation teams which adopt collaboration software and computer conferencing in conducting their project tasks. Collaboration software is not as popular as email because organizations tend to employ different collaboration software for their internal use. It is difficult to unify the usage of collaboration software among innovation team members who came from different organizations. Such difficulties also applied to the employment of group support systems (GSS).

Computer conferencing was frequently mentioned by interviewees as an informal communication tool among intra-team members; however, most of the organizations block the usage of computer conferencing to prevent casual chats between subordinates with their friends during office hours. Therefore, they are not regarded as popular ICTs employed from the viewpoint of innovation projects and organizations.

Telephone conferencing and voice mail are not commonly used among innovation project teams. Respondents from in-depth interviews mentioned that they preferred to send email rather than leaving a voice mail to team members, because it was more likely for team members to neglect a voice mail rather than an email. Moreover, innovation project teams seldom employed telephone conferencing nowadays, as they stated that it was not easy to trace back who the speakers are and therefore difficult to prepare for minutes.

It is not surprising that electronic bulletin board is not commonly used, as there was no respondent from the interviews mentioned about it. From their viewpoints, respondents believed that electronic bulletin board is completely replaceable by discussing issues through email and shared their schedules on electronic calendars with their intra-team members. However, it is quite surprising that videoconferencing was not as popular as the results of in-depth interviews. All interviewees have the experience of employing videoconferencing during the course of innovation projects. Perhaps, the frequency of implementation is much lower than that of other ICTs, the respondents thus regarded it as a less popular communication tools.

- The Group Norms of ICTs Usage

According to the mass industry survey, most of the respondents think that ICTs usage is largely determined through explicit requirements by team leader. However, it is not the whole picture as it seems according to the respondents from in-depth interviews. Respondents shared their experiences that the ICTs usage pattern is subject to change during the course of innovation projects.

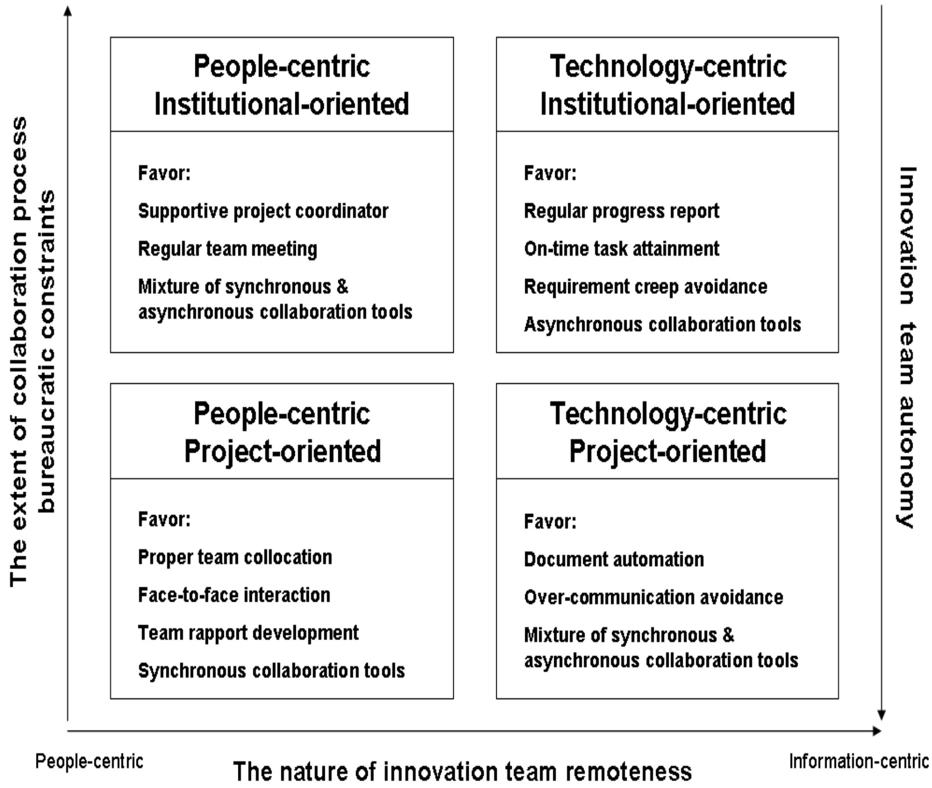
At the preliminary stage of innovation projects, team leader will first determine the explicit requirements of ICTs usage. However, innovation teams will adjust the ICTs usage patterns according to their needs and the nature of project tasks (Aldea et al., 2013). They will further develop acceptable standards and norms for enhancing the collaboration effectiveness of innovation projects. Therefore, there is no standard reason for using specific ICTs, group norms of ICTs usage are indeed based on the emerging needs of project teams and characteristics of project tasks.

6.4.3. Strategic Model for the Adoption of Collaboration Mechanisms

The findings of this research suggest that an appropriated selection of collaboration mechanism is particularly important for enhancing the collaboration processes of innovation projects and its performance. Thus, the author hereby outlines a strategic decisive model for project managers and coordinators, which they can employ as a guideline for choosing appropriated collaboration mechanisms for specific innovation projects.

Figure 6.2 shows the analysis of the contextual relationship between degree of perceived innovation team autonomy (in the reverse sense, as the extent of imposed collaboration process standardization) and the nature of task-remoteness among virtual innovation project teams. Figure 6.2 also demonstrates the strategic decisive framework of collaboration mechanisms for effective innovation project management. Aiming to fulfill the need for various types of innovation activity collaboration, the framework therefore categorizes contextual conditions favoring different combinations of collaboration mechanisms. In the course of research, groups of experienced innovation project team members discussed and verified the model on a collective basis.

Figure 6.2 Management model for adoption of collaboration mechanisms in virtual innovation project



For innovation activities under a relatively proximate organizational setting, effective communication and coordination at most emphasizes on the traditional people-centric mechanisms. The innovation processes are often structured by team members from a range of functionally partitioned experts, who have their own distinctive knowledge, analytic knowledge, work pattern, and experiences. A high level of consensus is reachable only by intensive sharing and discussions of abstract concepts, ideas, and opinion. Despite of the mutual understanding among team members, close interaction are also indispensable through rigorous communication processes and massive sharing of tacit knowledge. When the innovation task involves numerous highly mobile activities in a dispersed manner, the affiliated entities tend to assure interactivity collaboration by the use of remote technology-centric interface systems. These systems generally involve standardized scheduling functionality, consistent operational and engineering workflow, and commonly accessible production database. Besides, collaborative package would also attach with supplementary functionalities to tie in different team requirements if necessary.

In the meantime, for innovation tasks with strong organizational bureaucracy, innovation task commitments become more certain. Interaction amongst virtual innovation teams can be regulated by institutional rules and procedures, and even types of conforming mentality in organizations. However, very often, teams must handle tasks in several roles and projects assignments. Such problem of roles replication might reduce the likelihood of individual task creativity and cause task handling in mechanical manner. Collaboration mechanisms should maintain a prompt progress reporting system for securing on-schedule task attainment. As the nature of asynchronous virtual tools for dispersed activities allows multi-directivity in communication, innovation details and projects requirements tend to creep unawares throughout the communication systems in unordered way.

For virtual innovation project team members handling ad-hoc project-centered activities, which carry a great extent of innovation complexities, the collaborative mechanism should ensure a refined documentation sharing platform to facilitate timely information exchange processes. Based on the results of in-depth interviews and ethnographic case study, individuals are inclined to devote in exhaustive communication for keeping others informed and keeping documented evidences as the proof of decisions. Under such circumstances, individuals are at high risk of overlooking important messages among the countless volume of emails, which might greatly reduce the communication effectiveness as a result. The collaborative mechanism should therefore promote the use of subject-based thread with the utilization of virtual communication platform (e.g., electronic discussion whiteboard) to avoid over-communication among the corresponding entities.

6.5. Implications

The findings of this research study are both theoretically significant to the academics and practically beneficial to the industry practitioners. This study not only has implications on the conceptual model development of collaborations among innovation projects, but also suggests a decisive strategic model for industry practitioners on the adoption of collaboration mechanisms.

6.5.1. Implications for Theory

This research study makes several contributions to the academic field by extending previous research done by other researchers on the topic of innovation management and collaboration systems. The author aims to fill the gap of scant literatures on the concept of innovation management by focusing on the implementation of virtual innovation projects. The author thus reviews extant literatures and collecting industry practitioners' viewpoints on innovation projects. A three-step analytic model was then developed for exploring the antecedents, which led to an effective collaboration processes of innovation project teams, the collaboration processes itself and the perceived project performance. As limited literatures study the theoretic foundation in the field of innovation management under the project team context, the development of such conceptual framework therefore provides a means to study innovation development in the context of project teams.

This research study also provides an insight into the dynamics of collaboration processes among innovation projects, including the investigation of contextual antecedents among innovation project collaboration. New scales were developed to measure constructs of the proposed model which could be used in the future research on collaboration studies. Scales of team consensus and popularity of ICTs were developed particularly for this research study since there were no existing items measuring these constructs in previous literatures. These measurement items were revised by conducting multivariate data analysis and achieved a satisfactory reliability and validity.

This study has introduced a conceptual model for the measurement of collaboration effectiveness in the domain of innovation projects, in which both previously developed constructs and newly developed constructs were employed. Researchers can make use of the measurement items, which are developed in this study for those newly developed constructs as a foundation for future research. The proposed and modified model also contributes to the academic field by developing a connection between the contextual antecedents, collaboration effectiveness and project performance of innovation projects.

Nonetheless, this study also makes contributions to the research methodology by combining both qualitative and quantitative methodologies. This research study was divided into three different phrases, and data were collected from qualified respondents in each phrase in order to gather valuable opinions and work experiences of innovation projects. The author also observed the underlying phenomenon in the field and carried out statistical analysis by conducting industry surveys among experienced innovation team members. The final model thus is reliable, valid and can be generalized to provide a more comprehensive understanding on the collaboration contexts in innovation management.

6.5.2. Implications for Practice

This research study highlights the importance of collaboration as a means to promote project performance in innovation projects. The findings show that project managers and coordinators must pay attention to the elements of team consensus, organizational contexts, as well as innovation complexities if they would like to achieve desirable collaboration effectiveness in innovation projects. The findings of this study provide evidence for the significance of these contextual antecedents on innovation project performance. Project managers and coordinators must ensure that an adequate level of team consensus can be reached throughout the course of collaboration processes of various project stages. They should also maintain a balance within the organizational contexts of innovation projects, as organizational constraints are not entirely unpleasant for the collaboration processes of innovation project teams.

The conceptual model developed in this research study is significant in the textile technology development projects. It provides guidelines for project managers and coordinators who aim to carry out an effective and desirable innovation management. Apart from the contextual antecedents, the author suggests project managers to put their focus not only on the communication processes of innovation project teams, but also on the control of budget and schedule among innovation projects. Project managers and coordinators should also enhance team members' learning experiences throughout innovation projects, as the findings show that team members value their learning processes and skills developed the most when they evaluated their satisfaction gained from innovation projects.

This research also contributes to the industrial practitioners by outlining a strategic decisive model of collaboration mechanisms to be employed in various innovation project environments. The strategic model was proposed based on the results of in-depth interviews and ethnographic case study. It was modified after further discussions with experienced team individuals and project managers were carried out. The suggestions made in the model therefore provide a solid foundation for project managers and coordinators to enhance the collaboration effectiveness of project teams and the overall performance of innovation projects under a dynamic project environment.

Last but not least, this study provides a review on the information and communication technologies (ICTs), which are commonly used nowadays. It thus provides a foundation for project managers and coordinators on the selection and evaluation of ICTs, they can therefore choose an appropriate mix of ICTs according to the characteristics of innovation project teams. It also provides valuable ideas to those software developers who would like to engage in the development of collaboration tools and platforms. They can use the opinions provided by the respondents in the in-depth interviews as reference, and they can also put the group norms of ICTs usage into account when they start their marketing campaign in promoting the developed platform, in which suggested that team leaders and project stages are two major criteria when it comes to the decision of ICTs usage.

6.6. Future Research Works

There are a number of issues which have risen in this research study, that the author is interested to do more further investigation. Although the role of heterogeneity is discussed in this chapter, the author would like to further study the construct of heterogeneity in relation to the collaboration effectiveness of innovation projects. In the future, additional in-depth interviews will be carried out to collect more valuable insights from the practitioners. It is believed that they may provide more interesting views and experiences on the importance of team heterogeneity in the collaboration contexts of innovation projects.

Apart from the construct of team heterogeneity, the author would like to extend this research study to investigate the innovation projects concerning on other industries. By studying the collaboration contexts on innovation projects among other industries, the author can thus compare the results with that of this research study. The comparison of results would provide the audiences with a more comprehensive picture on collaboration issues and innovation management. Whether the contextual antecedents of this study will have stronger or weaker effects on the collaboration effectiveness of other industries' innovation projects is worth to find out.

Last but not least, the author would like to develop an electronic collaboration tool for innovation project teams. The findings of this study provide a lot of users' comments on the existing information and communication technologies (ICTs), the author thus would like to take these valuable feedbacks into account for the development of a new and effective collaboration tool. More research efforts are therefore required to review innovation team members' preferences for collaboration technologies development.

6.7. Summary

This final chapter revisits the research questions of this research study. It also summarizes and discusses the findings of this research in relation to the research questions and objectives. Three interesting aspects in relation to the collaboration contexts of innovation management are also discussed. The implications for both theory and practice are identified and discussed. And, future research works are also addressed.

This research study examines the collaboration contexts in innovation management by conducting in-depth interviews, an ethnographic case study and a mass industry survey. All data were collected from qualified innovation project teams. The results show that three contextual antecedents (adequacy of team consensus, organization contexts and innovation complexities) are significant in determining the collaboration effectiveness of innovation projects. Thus, the collaboration effectiveness is significant to the formation of both tangible and intangible project performance. However, tangible and intangible project performance indicators are not significantly correlated.

The proposed and modified conceptual framework in this research study allows both academics and industry practitioners to obtain a comprehensive understanding on collaboration contexts in innovation projects. Project managers and coordinators can therefore manage the collaboration processes of innovation projects more effectively by paying extra attention to the contextual antecedents of the framework and employing the strategies provided by this study.

Appendix 1: the Cover letter for In-depth Interview Participation

THE HONG KONG
POLYTECHNIC UNIVERSITY
香港理工大學

INFORMATION SHEET

<u>The Impact of Collaboration Contexts on Innovation Team Performance</u>

This study aims at examining the dimensions underlying the collaboration process effectiveness among innovation project teams, and the respective importance of each attribute on academic grounds. Based on the information sought, we attempt to propose for a new information and communication technologies (ICTs) design, and evaluation of management models for facilitating collaboration effectiveness and project outcomes.

You are hence invited for an interview to explore your experiences as team leader or member of innovation projects, your views and feelings towards information and communication technologies (ICTs), and your perception about collaboration effectiveness and team performance.

All information related to you will remain undisclosed, and will be identifiable by codes only known to the researcher. All data collected will be used solely for this study. If you would like more information about this study, please contact Dr. Chester To at telephone number 2766-6533 or Ms Krista Ko at telephone number 2766-6538

It is hoped that the research deliverables not only help to bring more understandings in the collaboration issue of innovation team, but also have a large impact to alert organizations about the concerns in managing team collaboration for achieving better project outcomes.

Thank you for your interest in participating in this study.

Krista Ko
Chester To
Institute of Textiles and Clothing,

The Hong Kong Polytechnic University

Appendix 2: the In-depth Interview Guide

Interview guide

I. Problems related to the virtual innovative projects

1. Tell me about your role working as a team member or a project manager on one or more virtual innovation projects.
2. As a (team member or a project manager), tell me about a critical incident that put a project at serious risk of failing.
3. Who would you first notify after the critical incident happened?
4. Describe someone else on the project that had a different understanding of a project status.
5. What was the first action being taken after the critical incident happened?
6. What other actions did you take based on your beliefs that the project was not "on track"?
7. How did those actions affect the outcome of the project?
8. What were the differences between the "actual" and "perceived" project goals?
9. In what ways were you encouraged to voice your concerns about the problems?
10. What would have happened if you voiced your concerns?
11. In what ways were you encouraged to keep your project concerns private?
12. Tell me more about the conflict that existed on the project team?
13. What caused the critical incident?
14. What were the formal stages or phrases of the project?
15. Tell me about the formal criteria for success at each stage?
16. Give me an example of something that was required for the project to actually be successful even though it was not listed on the formal requirements?
17. Give me an example of a formal requirement that was not very important.
18. Is there any other information that you think might be helpful to understand more about how team members might have different stories about project than the official story?

II. Problems related to the antecedents of collaboration effectiveness

1. What is the one thing that you worry the most during the collaboration process of a project?
2. Do you often require reaching certain levels of consensus with your project members?
3. What were the steps of reaching consensus between project members?
4. Tell me about your experience of acting dual roles as an institutional employee and a project member at the same time.
5. What were the innovation complexities exists in the virtual innovation projects?
6. What are contextual factors that you have just mentioned would affect the cross-functional collaboration during a virtual innovation project?
7. What do you perceive as causes of implementing an effective cross-functional collaboration?

8. Can you think of any factors that aggravate or reduce the effectiveness of a cross-functional collaboration?

III. Comments on the Available Collaboration Tools

1. Have you used any collaboration tools during any virtual innovative projects?
2. Why did you (not) use it?
3. What type of collaboration tools have you used?
4. When do you usually use collaboration tools?
5. Do you find those tools help in facilitating the collaboration effectiveness during the virtual innovative projects?
6. How do you think the collaboration tools work to facilitate the collaboration effectiveness during projects?
7. What are the merits and drawbacks of the collaboration tools that you are used to?
8. Take a good look at these collaboration tools samples (A-F) one by one and tell me what you like/dislike about each tool and give your reasons
9. From these samples, choose one tool that your think is the best/ worst and give reasons for your choice.

IV. Suggestions for New Collaboration Tools

1. What interfaces/designs do you prefer and why?
2. Which platforms do you prefer and why?
3. What kind of functions do you prefer and why?
4. What type of accessories do you prefer and why?
5. Here is a diagram (below) showing some of the important factors for the design of a new collaboration tool, which do you think are the top five important ones and rank them from the order of the most important to the least important. You can add factors that are not on this diagram.
6.

Email
instant messaging
Voice mail
interface
mobility
Ease to use
"Do not disturb" option
Choice of language
Videoconferencing
platform
Recording function
Instant editing
Telephone conferencing
multi-actors
capability

Appendix 3: the Questionnaire for the Preliminary Study

Innovation Teams Collaboration Survey

PURPOSE

The purpose of this survey is to gather information regarding to the innovation team of which you are a member or leader. It is important for us to understand how innovation team members think and feel during the course of collaboration in dispersed project works. Only with this awareness will address any areas of concern which are significant or demand improvements.

For your information, we have certain objectives with this survey. First, we wish to understand the dimensions underlying the collaboration process effectiveness among your innovation project team. Second, we would like to review what information and communication technologies (ICTs) your organization developed to support your team interaction. Third, we would like to determine how these factors affect your team performance in achieving its project goals.

YOUR PARTICIPATION

In order to accomplish these goals, we need your complete and honest participation. For this reason, we ensure complete confidentiality for everyone who completes this survey. Responses from all of the completed surveys will be pooled together so no individual can be identified.

SURVEY RESULTS

Lastly, in order to keep everybody informed and promote an effective team collaborative environment, 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 this process. Thank you for your honest responses.

DIRECTIONS

The innovation team collaboration survey will take approximately 20 – 30 minutes to complete. Please follow the instructions on the survey and indicate your responses accordingly.

If you have any questions about this survey, , please contact Dr. Chester To at telephone number 2766-6533 or Ms Krista Ko at telephone number 2766-6538

SECTION 1. ICTs Availability

This section asks about the types of information and communication technology that your company makes available to you and your frequency of use. Please place a "X" in the box that represents the most appropriate response for the statement.

	Types of Communication Technology Available to You	0 Nil	1 Seldom	2	3	4	5 Frequently
1	Collaborative Software; facilitate the multiple authorship of documents, joint development of databases, spreadsheets, and other information resources						
2	Computer conferencing; Real-time on-line discussion, such as: MSN						
3	Electronic bulletin board						
4	Email						
5	Fax						
6	Group Support Systems (GSS); designed to create and environment for brainstorming, focus group work, and group decision making.						
7	Telephone						
8	Telephone conferencing						
9	Videoconferencing (Dedicated room)						
10	Videoconferencing (Desktop)						
11	Voice mail						
12	Face-to-face interaction						
13	Other. Please Specify: ______________________________						

SECTION 2. ICTs Usage

This section asks questions to determine how you came to use specific information and communication technologies (ICTs) for specific purposes in the way that you do, as a member of your innovation team. Please place a "X" in the box that represents the most appropriate response for the statement.

		1 Strongly Disagree	2	3	4	5 Strongly Agree
1	Through explicit statements or requirements by the team leader					
2	Through precedents created within the team during critical events					
3	Through repetitive usage patterns that simply emerged from the team					
4	Through collaborative team efforts to develop acceptable standards or norms for communication					
5	Based on my prior experience before becoming a member of this team					
6	Other. Please specify: ____	N/A	N/A	N/A	N/A	N/A

SECTION 3. Consensus

This section asks questions to determine the process of meeting a common agreement in your innovation project team. Please place a "X" in the box that represents the most appropriate response for the statement.

		1 Strongly Disagree	2	3	4	5 Strongly Agree
1	We can always obtain a shared agreement in a short time interval.					
2	I believe it is necessary to have commitment to others performance in the innovation project environment.					
3	We spend a lot of effort to overcome different barriers in order to attain a shared decision.					
4	We conform to a set of clearly-stated administrative procedures to reach our common agreement.					
5	I think our information processing procedures along tasks are consistent and seamless.					
6	We set our goal among our innovation team members on collective basis.					

SECTION 4. Management Support

This section asks questions to evaluate the general support that top management of your company offers to you in the innovation project team. Please place a "X" in the box that represents the most appropriate response for the statement.

		1 Strongly Disagree	2	3	4	5 Strongly Agree
1	Management aware of the benefits that can be achieved through the use of information and communication technologies for innovation project works					
2	Management always support and encourage the use of information and communication technologies for innovation project works					
3	Management has provided most of the necessary help and resources to facilitate people in using information and communication technologies for innovation project					
4	Management is really keen to see that people are satisfied with use of information and communication technologies in innovation project					
5	Management provides good access to various types of software for innovation project					
6	Management provides good access to hardware resources for innovation project works					
7	Management regards the use of information and communication technologies as a high priority for innovation project works					
8	Management identify the use of information and communication technologies for innovation project as part of the company's mission					

SECTION 5. IT Support

This section asks questions to determine the extent of technological support that your company provides to you in the innovation project team. Please place a "X" in the box that represents the most appropriate response for the statement.

		1 Strongly Disagree	2	3	4	5 Strongly Agree
1	The organization possesses a good telecommunications infrastructure					
2	The organization possesses a categorized electronic data exchange system					
3	The organization possesses the necessary infrastructure to support remote communication					
4	The organization possesses a rapid internet/ intranet access					
5	The organization possesses adequate videoconferencing systems					
6	The organization possesses adequate collaborative software systems					

SECTION 6. Rules and Procedures

This section asks questions to determine the imposed rules and procedures that developed by the company and the innovation project team itself during the project period. Please place a "X" in the box that represents the most appropriate response for the statement.

		1 Strongly Disagree	2	3	4	5 Strongly Agree
1	For most problems that arise on this project, there are rules and procedures for dealing with them.					
2	It is clear in our organization what is acceptable and what is not acceptable.					
3	The innovation team has its own rules and procedures to facilitate the project progress.					
4	It is clear in our team what is acceptable and what is not acceptable.					
5	Our team has a very orderly working behavior and pattern – it is clear what members are expected to do and they do it.					
6	Our team has clear standards for the behavior of team members.					

SECTION 7. Collaboration Effectiveness

This section asks questions to determine how you evaluate the communication and coordination effectiveness of the innovation project respectively, as a member of your innovation team. Please place a "X" in the box that represents the most appropriate response for the statement.

		1 Strongly Disagree	**2**	**3**	**4**	**5 Strongly Agree**
1	There are frequent communications within the innovation project team					
2	I often communicate with other team members in spontaneous meetings or through implementing information and communication tools (such as: Phone, Email, etc.)					
3	Project-relevant information is shared openly by all team members.					
4	Our team members are happy with the timeliness in which we received information from other team members.					
5	Our team members are happy with the accuracy of the information received from other team members.					
6	Our team members are happy with the usefulness of the information received from other team members.					
7	The work done on subtasks within the project is harmonized.					
8	There are clear and fully comprehensive goals for subtasks within our team					
9	The goals for subtasks are accepted by all team members.					
10	There are conflicting interests in our team regarding subtasks/ subgoals.					

SECTION 8. Proximity

This section asks questions to determine how you would rate the physical and time proximities as a member of your innovation team. Please place a "X" in the box that represents the most appropriate response for the statement.

		1 Strongly Disagree	**2**	**3**	**4**	**5 Strongly Agree**
1	All of our team members are conveniently located in our working location.					
2	Our team shares a same set of consistent and regular work paces.					
3	Some of our team members are dispersed across different countries.					
4	We share a similar set of rhythm when processing our daily tasks.					
5	From our team's perspective, the time scale of project development is of great importance.					

SECTION 9. Innovation Team Performance

This section asks questions to determine how you would rate the quality of task outcome and your personal success as a member of your innovation team. Please place a "X" in the box that represents the most appropriate response for the statement.

		1 Strongly Disagree	**2**	**3**	**4**	**5 Strongly Agree**
1	According to the results, this project can be regarded as successful.					
2	From the company's perspective, all project goals are achieved.					
3	The project result is highly satisfactory.					
4	The team is satisfied with the project result.					
5	From the company's perspective, the project progress satisfactorily.					
6	Overall, the project is done in a cost-effective manner.					
7	Overall, the project is done in a time-efficient manner.					
8	The project is within schedule.					
9	The project is within budget.					
10	Overall, our team earns a positive balance for themselves in the project.					
11	Our team has gained from the innovation project.					
12	Our team would like to perform innovation collaborative works again.					
13	I have acquired important know-how through working in this project.					
14	Our team learns important lessons from this project.					
15	Our team sees this project as a technical success.					
16	I have developed many new skills from working with members from other functions.					
17	I have learned things working in this project that I will use in other groups.					

SECTION 10. This section asks you for general information about you, your team, and your organization. Please respond to each question as indicated.

1. What is your position in the virtual team? (please mark with an "X")

	(1) Team Leader		(3) Advisor/Supporter
	(2) Team Member		(4) Other (Specify) ______________________

2. The percentage of your work time that you work to accomplish this teams goals.

	%

3. Total number of team members on your team?

4. How long has this team been in existence?

	Year		Month

5. How long have you been a member of this team?

	Year		Month

6. What is your functional area?

	(1) Accounting		(4) General Management		(7) Sales		(10) R & D
	(2) Finance		(5) Personnel		(8) Manufacturing / Production		(11) Other. (Specify) ___________ ___
	(3) Marketing		(6) Information Systems		(9)Engineering		

7. Which area of focus is your team?

	(1) Product Development		(3) System Development		(7) Process Advancement

8. What is your primary organization's business? (Please check one)

	(1) Manufacturing		(4) Public Sector		(7) Hardware
	(2) Health Care		(5) Finance Services		(8) Sales & Marketing
	(3) Educational		(6) Software		(9) Others (Specify) ________________ ___

9. Age:

	18-25		26-35		36-45		46-55		Over 55

10. Gender

	Male		Female

- The End -

Thank you for your kindly participation.

If you have any enquiries about this survey, please contact Ms Krista Ko by email: krista.ko@__________ , or at telephone number 2766-6538.

Appendix 4: the Questionnaire for the Industry Study

Innovation Teams Collaboration Survey

PURPOSE

The purpose of this survey is to gather information regarding to the innovation team of which you are a member or leader. It is important for us to understand how innovation team members think and feel during the course of collaboration in dispersed project works. Only with this awareness will address any areas of concern which are significant or demand improvements.

For your information, We have certain objectives with this survey. First, We wish to understand the dimensions underlying the collaboration process effectiveness among your innovation project team. Second, We would like to review what information and communication technologies (ICTs) your organization developed to support your team interaction. Third, We would like to determine how these factors affect your team performance in achieving its project goals.

YOUR PARTICIPATION

In order to accomplish these goals, We need your complete and honest participation. For this reason, We ensure complete confidentiality for everyone who completes this survey. Responses from all of the completed surveys will be pooled together so no individual can be identified.

SURVEY RESULTS

Lastly, in order to keep everybody informed and promote an effective team collaborative environment, 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 this process. Thank you for your honest responses.

DIRECTIONS

The innovation team collaboration survey will take approximately 20 – 30 minutes to complete. Please follow the instructions on the survey and indicate your responses accordingly.

If you have any questions about this survey, , please contact Dr. Chester To at telephone number 2766-6533 or Ms Krista Ko at telephone number 2766-6538

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7	Telephone						
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SECTION 2. ICTs Usage

This section asks questions to determine how you came to use specific information and communication technologies (ICTs) for specific purposes in the way that you do, as a member of your innovation team. Please place a “X” in the box that represents the most appropriate response for the statement.

		1 Strongly Disagree	2	3	4	5 Strongly Agree
1	Through explicit statements or requirements by the team leader					
2	Through precedents created within the team during critical events					
3	Through repetitive usage patterns that simply emerged from the team					
4	Through collaborative team efforts to develop acceptable standards or norms for communication					
5	Based on my prior experience before becoming a member of this team					
6	Other. Please specify: ______________________________	N/A	N/A	N/A	N/A	N/A

SECTION 3. Consensus

This section asks questions to determine the process of meeting a common agreement in your innovation project team. Please place a "X" in the box that represents the most appropriate response for the statement.

		1 Strongly Disagree	2	3	4	5 Strongly Agree
1	I believe it is necessary to have commitment to others performance in the innovation project environment.					
2	We conform to a set of clearly-stated administrative procedures to reach our common agreement.					
3	I think our information processing procedures along tasks are consistent and seamless.					

SECTION 4. Management Support

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		1 Strongly Disagree	2	3	4	5 Strongly Agree
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2	The organization possesses adequate videoconferencing systems					
3	The organization possesses adequate collaborative software systems					

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6	Our team would like to perform innovation collaborative works again.					
7	I have acquired important know-how through working in this project.					
8	Our team learns important lessons from this project.					
9	I have developed many new skills from working with members from other functions.					
10	I have learned things working in this project that I will use in other groups.					

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2. The percentage of your work time that you work to accomplish this teams goals.

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3. Total number of team members on your team?

4. How long has this team been in existence?

	Year		Month

5. How long have you been a member of this team?

	Year		Month

6. What is your functional area?

	(1) Accounting		(4) General Management		(7) Sales		(10) R & D
	(2) Finance		(5) Personnel		(8) Manufacturing / Production		(11) Other. (Specify) ____________
	(3) Marketing		(6) Information Systems		(9)Engineering		

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	18-25		26-35		36-45		46-55		Over 55

10. Gender

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Thank you for your kindly participation.

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