DETERMINANTS OF GROUP EFFECTIVENESS: THE EFFECT OF GROUP LEARNING AND KNOWLEDGE CONVERSION ON THE RELATIONSHIP BETWEEN GROUP STEWARDSHIP AND GROUP EFFECTIVENESS

BY

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We hereby certify that this Dissertation submitted by Daniel T. Chang conforms to acceptable standards, and as such is fully adequate in scope and quality. It is therefore approved as the fulfillment of the Dissertation requirements for the degree of Doctor of Business Administration.

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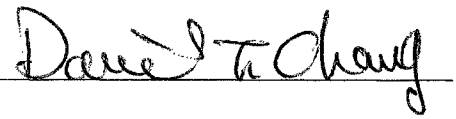
Signed 

Daniel T. Chang

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ABSTRACT

This dissertation examines how group stewardship influences group learning, knowledge conversion processes and on group effectiveness in a large engineering and manufacturing firm. Knowledge, skills, and expertise reside in peoples' head. Business managers that frequently rely on knowledge management systems often fail to manage these domains. This dissertation investigates an integrative research framework based on Chang and Groesbeck's (2004) group learning and knowledge conversion model and empirically tests the processes in relation to group stewardship (antecedent) and group effectiveness (outcome). Three research questions are examined: (1) How does group stewardship affect group learning and knowledge conversion? (2) How does knowledge conversion affect group learning? (3) How do group learning and knowledge conversion affect group outcomes?

787 individual members and supervisors from 75 workgroups in the participating organization were surveyed. A total of 635 usable questionnaires from 73 workgroups were received. Factor analysis, discriminant validity analysis and structural equation model analysis were used to analyze the research model. The findings confirmed certain hypotheses that were tested in prior research. Group stewardship is positively correlated to group learning and knowledge conversion, while group learning and knowledge conversion are positively correlated to group effectiveness. Knowledge conversion does affect group learning; they are strongly correlated. Undoubtedly, more investigations are needed to pursue further understanding of the implications of the four group learning processes and four knowledge conversion practices.

ACKNOWLEDGEMENTS

This work is dedicated to my father, Chang, Seng Ron (1921 - 1973).

I owe this dissertation to many people. First, I owe thanks to those who are close to me. I want to express my gratitude to my wife who has sacrificed countless things while accompanying me through this journey. I also owe much to my chairperson, Dr. William C. Wall, who started me on the path with encouragement. Dr. Wall always provided his full support, guidance, encouragement, friendship and time during this long journey.

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Finally, I owe thanks to my mother and the rest of my family in Taiwan. Instead of giving my time and support to them, I have been utilizing it to work on this study. I am indebted to them for their selfless support.

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CHAPTER I
INTRODUCTION

The study aims to contribute to the understanding of the impact of group stewardship in knowledge work teams by identifying relevant constructs, the elements that define these constructs and the relationships among these constructs and their elements, and their empirical validation in organizational field study.

BACKGROUND AND MOTIVATION

The new digital era is re-modeling markets. Survival of business organizations no longer rests solely on control of capital resources and labor, but also on knowledge resources. Many commentators suggest that the individual firm's knowledge and learning capabilities are the main source of distinctive capability and competitive advantage (e.g., Kogut & Zander, 1992; Prahalad & Hamel, 1990; Starbuck, 1992). Thus, to compete effectively, firms must leverage their existing knowledge and create new knowledge that favorably positions them in their chosen markets (Gold, Malhorta, & Segars, 2001).

According to Kogut and Zander (1993) firms are social communities that specialize in creation and internal transfer of knowledge. Thus, leveraging these two knowledge processes is vital for effective knowledge resources management. Bender and Fish (2000) assert that knowledge management (KM) is not a program, but a way of working. KM needs to be embedded, through the organizational process, technology and human resource management. Because people are at the heart of KM, the success of KM depends on an organization's ability to manage its employees.

The workgroup concept has been credited with improving productivity and quality in many organizations. Much has been written about how to form teams, types of teams, what

makes teams effective, leadership within teams and their importance in supporting organizational learning (Argote, Gruenfeld, & Naquin, 2001; Crossan, Lane, & White, 1999; Groesbeck, 2001). The importance of learning in teams has been recognized in both organizational learning and emerging group learning literature. Yet these two streams of work have developed in parallel with little exchange of ideas (Argote et al., 2001).

Given the need for organizations to become more flexible and adaptive to change, it seems appropriate to determine to what extent learning and knowledge management research can add to our understanding of how work groups can be more effective. First, further work is needed to operationalize the concept of group learning and knowledge creation (Chang & Groesbeck, 2004) in a way that explicitly tests the cognition and action processes coupled with the four knowledge conversion modes (Nanoka, 1994; Nonaka & Takeuchi, 1995) practiced in group learning (Watkins & Marsick, 1993, 1996).

Second, while Edmondson (1999b) tested a model relating group learning to group effectiveness, she calls for additional work to establish construct validity for psychological safety, control for the effect of both task and team types on learning outcomes, and study of a wider range of contextual and managerial factors influencing group learning.

This research addressed several of these research needs and attempts to shed light on the explanatory and predictive capability of group processes when group members must rely not only on one another, but also on the knowledge sharing and collaborative learning.

PURPOSE OF THE STUDY

The first purpose of this research is to investigate the relationships between the group learning and knowledge creation (GLKC) model (Chang & Groesbeck, 2004) and group effectiveness. To this end, the constructs for group learning and knowledge conversion practices

were developed, operationalized, and the research conducted to test hypotheses about the antecedents and consequences of these two constructs is presented in following chapters.

A second purpose of this research is to contribute to the investigation of the relationship between group stewardship (Groesbeck, 2001) and the integrated GLKC model (Chang & Groesbeck, 2004), and the effects on group outcomes. Intrinsic motivation is crucial when tacit knowledge in and between teams must be transferred (Osterloh & Frey, 2000). Group stewardship behavior is intrinsically motivated and important in enabling group learning and group proactive behaviors (Groesbeck, 2001).

To achieve the purposes, three underlying objectives have been met:

1. Operationalized the group learning and knowledge creation model (Chang & Groesbeck, 2004) through a field survey instrument as described in Chapter III. Synthesized findings from research studying in group learning, knowledge management and work group effectiveness have been analyzed and described in Chapter II. Moreover, the relationship between group learning and knowledge creation was revealed to be critical link between individual and organizational learning.
2. Analyzed the proposed set of antecedents (task, group and organizational) and outcomes associated with group learning and knowledge conversion within the framework of a model of work group effectiveness as depicted in Figure 1.1. In the selected antecedents, primary emphasis was given to those suggested by the intrinsic motivation and tacit knowledge sharing literature.
3. Sample data collected from 641 individuals that included 568 members and 73 supervisors from 73 workgroups in an engineering manufacturing firm has adequately

met the research requirement. The testing result of the proposed hypotheses that relate to the proposed antecedent and outcomes associated with group learning and knowledge conversion have been completed and described in Chapter IV.

CONTRIBUTION OF THIS RESEARCH

The study aims to contribute to the understanding of the impact of group stewardship in knowledge work teams by identifying relevant constructs, the elements that define these constructs and the relationships among these constructs and their elements, and their empirical validation in organizational field study. Given the large body of relevant theoretical work concerning the constituent concepts of motivation in knowledge workgroups, it involves a substantial theoretical exploration effort combined with an investigation of knowledge workgroups in practice. Next, the purpose of the research is to examine how the application and elaboration of this model in knowledge work situations calls for amendments, enhancements or perhaps even partial refutation of the model.

In terms of the significance of the study to practitioners, the primary contribution sought is to provide managers with an understanding of the relative influences of group stewardship and group knowledge work on group effectiveness. Secondarily, the study also seeks to define the patterns of group learning and knowledge creation. Identification of meaningful patterns may provide managers with a better understanding of what groups have learned and how to maximize the knowledge creation.

Research model constructs were developed and operationalized, and the research framework has been conducted to test the proposed hypotheses in related to the antecedents and consequences of these two constructs. The result of hypotheses test was provided for practitioners and researchers.

TERMS AND DEFINITIONS OF THE THEME

The following describes the terms, definitions and the themes used in this study.

Information and Knowledge

Davenport and Prusak (1997) believe there are three levels of information in Information Science, with each successive level becoming more complex. These levels are data, information and knowledge. Davenport and Prusak's (1997) summary of the definitions of data, information and knowledge is most succinct. Data: simple observations of states of the world; Information: data endowed with relevance and purpose; Knowledge: valuable information from the human mind that includes reflection, synthesis and context. Davenport and Prusak (1998) further defined knowledge as fluid mix of framed experience, values, contextual information and expert insight that provide a framework for evaluation and incorporating new experiences and information.

Knowledge and information have an interactive relationship; knowledge creation depends on information and also the development of the appropriate information requires use of knowledge (Nonaka, 1994, 1996). The same information can be transferred into different types of knowledge dependent upon the type and the purpose of the interpretation and the person himself (Roberts, 2000). The value of any given information only resides in the relationship between the receiver and the information (Stenmark, 2002), but value is subjective. Thus, information may be interpreted in tacit and explicit dimensions.

Knowledge can be either tacit or explicit (Choo, 1998; Nonaka, 1994; Polanyi, 1958, 1966), is also expressed as the distinction between knowing and knowledge (Brown & Duguid, 1998; Cook & Brown, 1999). Tacit knowledge is more implicit and much harder to articulate (Polanyi, 1958, 1966). Nonaka and Takeuchi (1995, p. 8) state, "Tacit knowledge is highly

personal and hard to formalize, making it difficult to communicate or to share with others. Subjective insights, intuitions, and hunches fall into this category of knowledge".

In contrast, explicit knowledge is more easily transmitted as it is characteristically codified. Explicit knowledge is formal knowledge that is easy to share or disseminate throughout an organization. Examples can be seen in rules, specifications, and mathematical formulations. Further, knowledge can be conceived as existing at multiple levels – not only at the individual level but also at the group and organizational levels (Nonaka, 1994). Both tacit knowledge and explicit knowledge are used in this study.

Group and Knowledge Worker

The term "knowledge worker" is described as someone who adds value by processing existing information to create new knowledge which could be used to define and solve problems. The author uses these three definitions for knowledge workgroup through out the study: (1) A group is a work group or work team with a supervisor and clear group purpose; (2) A knowledge worker is an employee who uses his/her brain more than hands to perform the task, adding value to information; (3) The terms, group and team are interchangeable.

Group Learning and Knowledge Conversion

Group Learning. Recently work group learning has been defined as "A process through which a group creates knowledge for its members, itself as a system, and for others. . . .[It is] an interrelated set of processes in which collective thinking and action play a central role" (Kasl, Marsick, & Dechant, 1997, p. 229). Similarly, Watkins and Marsick (1996, p. 6) define team learning as "The mutual construction of new knowledge and the capacity for concerted, collaborative action". These definitions of group learning suggest the idea that learning includes both cognitive and action-oriented behaviors.

Knowledge Conversion. According to the knowledge creation spiral model (Nonaka, 1994), the process of knowledge conversion proceeds through four different modes: **S**ocialization (the sharing of tacit knowledge from one person to others); **E**xternalization (the conversion of tacit to explicit knowledge); **C**ombination (the creation of new explicit knowledge from existing knowledge); and **I**nternalization (the conversion of explicit to tacit knowledge through learning by doing). These four modes of knowledge conversion form the "SECI" knowledge creation spiral model.

Nonaka (1994) argues that knowledge creation initiates at the individual level as a "justified true belief" and is expanded through social interactions to include a diversity of perspectives that ultimately represent shared knowledge at the organizational level. Importantly, "He identified four different patterns of interaction between tacit and explicit knowledge can be converted into new knowledge" (Nonaka, et al., 1994, p. 339). Although the tacit knowledge held by individuals lies at the heart of the knowledge creating process, gaining access to the benefits of that knowledge requires "A dynamic interaction between the different modes of knowledge conversion" (Nonaka, 1994, p. 20).

While the SECI practices may support group learning, the proposed integrated group learning and knowledge creation (GLKC) model (Chang & Groesbeck, 2004) integrates the SECI knowledge creation spiral model (Nonaka, 1994; Nonaka & Takeuchi, 1995) with group learning (Groesbeck, 2001; Watkins & Marsick, 1993, 1996). Together the models suggest that each of the group learning processes is most strongly supported by two of the SECI practices. For example, collaboration can occur, as group members are involved in socialization and externalization practices.

Similarly, each SECI practice is most strongly associated with two group learning processes. For example, while conducting a training session (a practice to externalize knowledge) can enable collaborative processes, it also can support the interpretation of explicit concepts by both students as well as teachers who later recognize they have learned more than the students they were teaching as they engaged in the training experience.

Motivation Within Knowledge Workgroups

Employees are motivated intrinsically as well as extrinsically. Intrinsic motivation is crucial when tacit knowledge in and between teams must be transferred (Osterloh & Frey, 2000). Often the issue of motivation generates strong debate about incentives for knowledge workers (Davenport & Prusak, 1998). Regardless, it is recognized that rewards depend to a great extent on the cultural norms in an organization or group. Knowledge work requires voluntary behaviors.

Wenger, McDermott, and Snyder (2002, p. 182) observed that rewarding "voluntary" behavior poses a dilemma: "How do we encourage behavior through extrinsic means when the intrinsic motivation for such behavior is considered a matter of pride and identity?" They observe people often value the satisfaction derived from giving as reasons of professional affiliation or commitment to a large cause, not because they are rewarded with a "carrot".

A truly voluntary internalized behavior is based upon internal value systems of the knowledge workers in contrast to pride and identity that characterize social influences based upon identification (Malhotra & Galletta, 2003). According to Deci (1980) perceptions of personal control satisfy these needs, and constitute the fundamental feature distinguishing intrinsically motivated behavior from extrinsically motivated behavior. Stewardship behavior is intrinsically motivated and can occur when present in the congruence of a personal value system.

Davis, Schoorman and Donaldson (1997) proposed that stewards are motivated to act in the best interests of their principals, internally motivated, and willing to act in concert with others. Group stewardship is a collectively held sense of responsibility to oversee and improve performance in the group area of responsibility in accordance with the best interests of the organization (Groesbeck, 2001). The author proposes group stewardship as an intrinsic motivation factor in this study.

Group Effectiveness

In this work, group effectiveness is assessed through group performance, team satisfaction, and viability as depicted in Table 1.

Table 1 - Team Effectiveness Components

Team effectiveness' components	Description
Team performance	Performance outcomes (e.g., quality of decisions and deliverables, client satisfaction).
Satisfaction with team	The satisfaction of individuals - with respect to their membership in the group.
Team viability	The capability of the individuals to continue to perform effectively in the future.

The author refers to these three components of group effectiveness as performance, satisfaction, and viability, respectively, in this study.

RESEARCH QUESTIONS

This study draws on group effectiveness theories and several conceptual models related to organizational learning and knowledge management and group stewardship. Based on the above arguments, this study proposes an integrative framework as depicted in Figure 1, by asking three research questions:

1. Does group stewardship affect group learning and knowledge conversion? If so, then how does group stewardship influence group learning and knowledge conversion respectively?
2. Does knowledge conversion affect group learning? If so, then how does knowledge conversion influence group learning?
3. Do knowledge conversion and group learning affect group outcomes? If so, then which aspects of knowledge conversion and group learning are most significantly related to each of the group outcomes?

THE CONCEPTUAL RESEARCH MODEL

This research empirically tested how group learning and knowledge creation processes function as mechanisms to impact workgroup effectiveness. A conceptual research model of hypothesized relationships between variables is presented in Figure 1. The variables of interest are:

- Input variables: task design factors, group factors (including group stewardship), and organizational context factors.
- Process variables: group learning and knowledge conversion.
- Outcome variables: team performance, team member satisfaction, and team viability.
- Control variables: team size, team tenure, education, gender, and profession tenure.

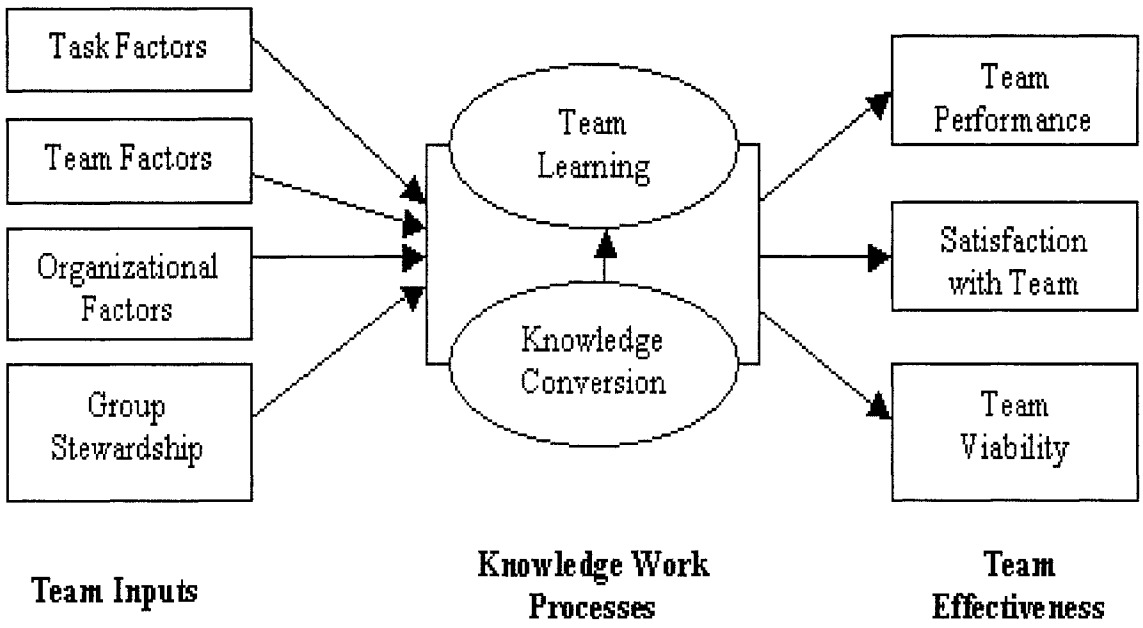


FIGURE 1 - RESEARCH MODEL

RESEARCH HYPOTHESES

The research questions from the above section lead to several hypotheses which were tested in this research, and are described below.

In addressing the first question the study argues that today's knowledge workers are educated, motivated, responsible, and more capable than yesterday's knowledge workers and not closely supervised. They have a desire to control their own destiny, and have a low absenteeism threshold, a greater desire for self-expression, personal growth, and self-fulfillment. In other words, these workers are not satisfied to report to work merely for the paycheck. They want something more. Teams of knowledge workers are self-managed workgroups, they are motivated intrinsically to learn and share their knowledge. Group stewardship is associated with intrinsic motivation and can be present in certain task, group and organizational contexts. Based on this argument the author hypothesizes that:

H1: Group stewardship is positively related to group learning and knowledge conversion.

H1a: Group stewardship is positively related to knowledge conversion.

H1b: Group stewardship is positively related to group learning.

Next, in answering the second research question, the study argues that if a knowledge work group is motivated then its members should be proactive (Groesbeck, 2001), which translates into more interaction and socialization between members. Interaction and socialization are the key elements of group learning that impact group effectiveness. Therefore, the practices of knowledge conversion should influence group learning. Based on the argument the author hypothesizes that:

H2: Knowledge conversion is positively related to group learning.

Lastly, work groups have been credited with improving productivity and quality in many organizations. To answer the third research question "What are the implications between knowledge conversion practices on group effectiveness?" the author hypothesizes them as the below:

H3: Group learning and knowledge conversion are positively related to team effectiveness.

H3a: Knowledge conversion is positively correlated with team performance rating.

H3b: Knowledge conversion is positively correlated with team member satisfaction.

H3c: Knowledge conversion is positively correlated with team viability.

H3d: Group learning is positively correlated with team performance rating.

H3e: Group learning is positively correlated with team member satisfaction.

H3f: Group learning is positively correlated with team viability.

LIMITATIONS OF THIS RESEARCH

This study, like other research, has limitations particularly in analyzing the interactive process between antecedents of individual employees' characteristics and the work environment and its effects on group knowledge creation. In an organizational setting, knowledge creation is a dynamic, complex interaction process of individuals and work environment. In this study, interaction between individual employees' characteristics and work environment was excluded since it would make the model for this study too complex and building an unnecessary complex model would distract from the focus of the study with the expense of losing the advantage of brevity.

Second, this study does not take into account the probable moderating effects of other group motivations (e.g., group psychological safety, group efficacy). Third, this study has some generalization limitations as the research findings mainly are related to high-tech engineering workgroups in the computer related hardware and software industry.

JUSTIFICATION FOR THIS RESEARCH

Justification of this research for an Information Technology Management dissertation requires demonstrating that the research will contribute to the body of knowledge being studied and that the problem being studied is an information technology management problem. Prior research focused only on one single aspect, i.e. organizational learning process or technology applications. There is a need also to look at from the people's (employees) perspective, so that the implication of organizational knowledge creation may be more fully understood.

This research incorporates three aspects including knowledge worker motivation, processes, and information technology and that expects to shed light on the implication of organizational knowledge creation.

SUMMARY OF THIS CHAPTER

In this chapter, the rationale and need for this study of the relationship between group stewardship, group learning and knowledge conversion on group effectiveness were discussed. Research questions and hypotheses, limitations of the study, and definitions of terms used in this dissertation were presented.

This dissertation is organized into four additional chapters. First, Chapter II focuses on the literature review of group learning, knowledge conversion and the antecedents including group stewardship, and group effectiveness research and expected findings related to the study. Next, Chapter III presents the research methodology including the sample, research variables, operation techniques and instrument reliability and validity. Chapter IV presents the results of hypotheses analysis. The last chapter, Chapter V, concludes what has been learned, the implication of this study, and suggestions for future research.

CHAPTER II
LITERATURE REVIEW

INTRODUCTION

This chapter discusses the literature on information and knowledge, organization learning, learning organization, group learning and knowledge conversion (GLKC), and consequences of GLKC, with a specific emphasis on the importance of GLKC to competitive advantage. The first section reviews the relevant literature on definitions of information and knowledge and the distinction between them. The following section reviews and summarizes the conceptual differences between organization learning and the learning organization, and emphasizes the need for an integrated model that can be empirically tested (e. g., GLKC model), as well as motivation in knowledge workgroups. The last section lists potential consequences of GLKC and its antecedents.

INFORMATION AND KNOWLEDGE

It is ironic that the term "information" is itself ambiguous and used in different ways (Buckland, 1991). However, in our daily life, the word 'information' is closely associated with the concept of communication, more specifically with the aspect of communication of ideas, thoughts, and knowledge, bringing forth an understanding that information has properties to convey ideas, thoughts, concepts and knowledge.

Webster (1995) defined information as "something told", and knowledge acquired in "any manner". American Heritage Dictionaries (2000) calls it a "condition of being informed" and "communication of knowledge". The web encyclopedia Wikipedia (2005) defines that "information is a term with many meanings depending on context, but is as a rule closely related

to such concepts as meaning, knowledge, instruction, communication, representation, and mental stimulus" and "knowledge is the psychological result of perception, learning and reasoning".

Moreover, there are two main streams of literature related to information and knowledge research that are reviewed in the following sections.

Literature from Information Science

As Machlup (1983, p. 642) has noted, the original meaning of the word "information" derives from the Latin "informare" which means "to put into form". Informing therefore carries the sense of "imparting learning or instruction" or more generally conveys the sense "to tell (one) of something". Thus, information refers to the action of informing or to that which is told. As Webster (1995, p. 26) points out, the semantic definition of information conveys that "information is meaningful, it has a subject and is intelligence or instruction about something or someone."

Communication theorists suggest that we code our knowledge as the information we communicate. It is the receiver of our communication who decodes and processes that information into knowledge of his or her own. For example, Brookes' (1980) elaboration of Popper's Three-world model: World I, II, and III from the information and knowledge conceptual realms, presents a more refreshing thoughtfulness about the concepts of information and knowledge.

Brookes (1980) argues that Popper's 'Three-world model' provides a framework for understanding the nature of information in information science. In this model, World I consist of nature and human, and physical artifacts, such as buildings, books or computers. In the other words that which is called "physical universe". World II is "subjective knowledge" within the mind of individuals, "the world of subjective mental states, [which] is occupied by our thoughts

and mental images..." (p. 129). World III consists of "objective knowledge" (i.e., recorded knowledge), mainly generated by humans (Popper, 1979).

Brookes (1980) defined information as a "small bit of knowledge" (p. 131), and as "an entity which pervades all human activity," (p. 126). He explained his view of knowledge as "a structure of concepts linked by their relationship and information as a small part of such structure" (p. 131). He further identifies information as the "interaction between the mental and physical processes or between subjective and objective modes of thought" (p. 126), practically, going from World I to World III via World II.

The objective knowledge in Brookes' (1980) world in fact is contrary to Polanyi's (1966) and Nonaka's (1994) explicit knowledge. "In order to objectivise our individual thoughts we have to express them and deposit the records in World III where they are accessible to, and can therefore be critically considered by, others" (Brookes, 1980, p. 130). 'Objective knowledge' is the main concept around which Brookes' fundamental equation operates and is situated in Popper's World III:

> He [Popper] recognizes a third world, that of objective knowledge which is the totality of all human thought embodied in human artifacts, as in documents of course, but also in music, the arts, the technologies. These artifacts enshrine what Popper declares to be his autonomous – or near autonomous – world of objective knowledge (Brookes, 1980, p. 127).

Machlup and Mansfield (1983) have concisely suggested that information is not a simple thing to describe and explain. It is a phenomenon with multifaceted understanding, perhaps requiring a multitude of methodologies and means of investigation and research. Buckland (1991) maintains that there are three meanings of "information" to be distinguished: "Information-as-process"; "information-as-knowledge"; and "information-as-thing". He further identifies three principal uses of the word "information":

Information-as-process (the ability to inform): When someone is informed, what they know is changed. In this sense 'information' is 'The act of informing...; communication of the knowledge or 'news' of some fact or occurrence; the action of telling or fact of being told of something" (Oxford English Dictionary, 1989, 7, p. 944).

Information-as-knowledge (the knowledge imparted in the process of being informed): 'Information' is also used to denote that which is perceived in 'information-as-process': the "knowledge communicated concerning some particular fact, subject, or event; that of which one is apprised or told; intelligence, news" (Oxford English Dictionary, 1989, 7, p. 944).

Information-as-thing (it is objective): The term information is also attributed to objects, such as data and documents, that are referred to as "information" because they are regarded as being informative, as "having the quality of imparting knowledge or communicating information; instructive" (Oxford English Dictionary, 1989, 7, p. 946).

Buckland's (1991) three distinguished meanings of "information" combined with his three principal uses of the word "information" are the most pervasive understanding of information in use by various disciplines, with "information-as-thing" perhaps having the most evident effect on the understanding of information management research and practice so far. For instance, Ingwersen (1996) expressed that by interacting with information, a person may become aware of an anomalous state of knowledge (Dervan & Nilan, 1986), and thus be forced into searching for new information to overcome this deficiency. Information is something that affects and transforms the receiver's state of knowledge when perceived (Ingwersen, 1996).

Information can then be summarized as the ability to inform (communication of knowledge, ideas, and thoughts), the knowledge imparted in the process of being informed (subjective and perceived by the receiver), and it is objective (Brookes, 1980). More precisely,

> In order to extract, integrate and use information, the cognitive system must develop ways of representing the available information. ...a representation is an encoding of selective information about an external event; it does not encode all possible information available. What gets selected for encoding is a function of the organism's present interests and abilities (McShane, 1991, p. 17).

Literature From Knowledge Management

The question, "what is knowledge," is a debatable topic. In the realm of philosophy, the study of knowledge has its own name, "epistemology". In epistemology, the traditionally accepted definition, attributed to Socrates and Plato, is that knowledge is a "justified true belief" (Sober, 1991). In much of the current literature, knowledge has been defined differently. Sanchez, Heene and Thomas (1996) defined knowledge as the ability to maintain the synchronized exploitation of assets and capabilities in a mode that assures the achievement of the goals, and knowledge is the state of knowing and understanding (Alavi & Leidner, 2001).

In their book *Working Knowledge*, Davenport and Prusak (1998) draw distinctions among data, information and knowledge. They see information as data that makes a difference, and depends on the context for its use or application. Their view of knowledge is that it is "broader, deeper, and richer than data or information" and further,

> Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms (Davenport & Prusak, 1998, p. 5).

Davenport and Prusak (1998) suggest that some of the components that might contribute to 'knowledge' include:

Experience: Knowledge develops over time. This means experience provides a historical perspective from which to view and understand new situations and events.

Practical Utility: Knowledge means being able to distinguish what should work from what really does. It is where "the rubber meets the road". It is the difference between what is taught in business schools and what really happens in the business world.

Speed: The knowledgeable are able to recognize patterns and provide short cuts to solutions rather than build one from scratch every time. As a result, knowledge offers supercharged problem solving.

Complexity: Knowledge is about dealing with complexity. This means it is comfortable with the ambiguity of real-world situations. By denying complexity, those without knowledge offer simple solutions that invariably fail.

Evolving: Because the key to knowledge is knowing what you don't know, the knowledgeable are also able to refine their knowledge through further experience, study, and learning.

However, one of the most cited definitions of knowledge is offered by Polanyi (1966) and advanced by Nonaka (1994). Polanyi (1966) describes all knowledge as inherently personal. All knowledge has a tacit component when it resides in the mind of a person. Therefore, he argued, when transferring this knowledge from one person to another, the knowledge changes in the sense that the other individual must interpret the knowledge in the context of his or her own person.

Nonaka (1994) views knowledge as being more than information, since it engages awareness or understanding obtained with the help of experience, familiarity or learning. Nonaka and Takeuchi (1995, p. 58) argue "knowledge is a dynamic human process of justifying personal belief toward the truth". More broadly, "Knowledge has to do with goodness, beauty, and truth" (Machlup, 1980; Nonaka, 1996, p. 3). Knowledge is described as the application and productive use of information.

Nonaka (1994; 1996) distinguishes between information and knowledge. To him, information is the flow of a message, while knowledge is created by accumulated information; information is something passive, but knowledge comes from belief and commitment. He further expressed, "This understanding emphasizes an essential aspect of knowledge that relates to human action" (Nonaka, 1994, p. 15).

An organization processes information to make sense of its environment, to create new knowledge, and to make decisions (Choo, 1998). Information affects knowledge and vice versa. Knowledge is structured and integrated information, and information is fragmented knowledge. (Brookes, 1981; Todd, 1999). On its own information has no value (Sveiby, 1994). When information is applied to a specific subject, the same objective information may result in different subjective meanings and values.

A researcher with receiver centered interest would thus not only examine the information itself but also the receiver's cognitive and psychological needs and preferences (Choo, 1998). It is in the combination of information content and interpretation that the receiver finds values. The value of any given piece of information does thus reside in the relationship between the receiver and the information (Stenmark, 2001).

Choo (1998, p. 62) suggests that the outcome of information usage is "A change in the individual's state of knowledge and a capacity to act". When the information is used, i.e. interpreted in the light of the user's previous knowledge and experiences, or when new facts inform us, it does not become knowledge but it alters the existing knowledge by increasing the individual's knowledge state (Kidd, 1994), thereby opening new possibilities to act.

Conclusively, knowledge involves both a dimension of resolution (knowing) and of action (doing). It involves resolution in the sense that, while you may have conflicting information, it is unusual for some one to say they have conflicting knowledge. Equally, someone might say "I have the information but I don't understand it" but you would think it bizarre if they said "I have that knowledge but I don't understand it" (Brown & Duguid, 2000, p. 120). It involves action because the role of purpose is important in the creation of knowledge. In other words "Knowledge can and should be evaluated by the decisions and actions to which it leads" (Davenport & Prusak, 1998, p. 6).

DEFINITIONS OF INFORMATION AND KNOWLEDGE

Drawing from prior discussions, the author distinguishes knowledge from information, and acknowledges that the value of any given information only resides in the relationship between the receiver and the information. Value is subjective. Thus, information might be characterized in tacit and explicit dimensions with interpretation accordingly. Knowledge is a fluid mix of framed experience, values, contextual information and expert insight that provide a framework for evaluation and incorporating new experiences and information (Davenport & Prusak, 1998).

Knowledge can be either tacit or explicit; this attribute is also expressed as the distinction between knowing and knowledge (Brown & Duguid, 1998; Cook & Brown, 1999). Tacit

knowledge refers to knowledge that has a personal quality that makes it hard to communicate, the knowing or the deeply rooted know-how that emerges from action and experience in a particular context.

In contrast, explicit knowledge refers to the codifiable component that can be disembodied, transmitted, and extracted (e.g., arts, products, patents) from the knowledge holder and shared with others. Further knowledge can be conceived as existing at multiple levels – not only at the individual level but also at the group and organizational levels (Nonaka, 1994).

Yet, knowledge and information have an interactive relationship; knowledge creation depends on information, and the development of the appropriate information requires use of knowledge (Nonaka, 1994; 1996). The same information can be transferred into different types of knowledge depending upon the type and the purpose of the interpretation and the person himself (Roberts, 2000).

ORGANIZATIONAL LEARNING

Introduction

Despite its popularity and countless academic works, there are still no commonly agreed upon definitions of organizational learning (OL). The concepts of organizational learning and learning organization (LO) are being used inconsistently. Researchers once used the terminologies OL and LO interchangeably (e.g., Boje, 1994; Crossan & Guatto, 1996; Nevis, DiBella & Gould, 1995; Ortenblad, 2001). OL involves learning at individual, team and organizational levels, as well as learning how to learn at these different levels.

Several conceptual models will be presented on how to become a LO and these are often very different from approaches and definitions of OL and therefore, so are their ideas. Thus, it may be the gap between the concepts of academic theories and those of practitioners that limits a clear understanding of what triggers "collective learning".

This section discusses several definitions of OL and LO in an attempt to clarify the differences between OL and LO. The various views and conceptual models of OL and LO will be presented. Finally, it is concluded that distinguishing OL as the descriptive domain of academic and LO as the prescriptive domain of practitioners provides a much needed and clearer platform for further research, i.e., the integrated group learning and knowledge creation model (GLKC) by Chang and Groesbeck (2004).

Organizational Learning

Argyris and Schön (1978) first elaborated the concept of organizational learning. In their early work with individuals, Argyris and Schön concluded that individuals develop a "theory of action" that they apply to create and carry out their behavior in almost any situation in which they find themselves. They further explored the impact of formal organizational structures, control systems, and management on individuals, and their interest lies in the extent to which human reasoning, not just behavior, can become the basis for diagnosis and action.

The ability to engage with others, to make links with the general and the particular, and to explore basic orientations and values is just what Argyris talks about when exploring the sorts of behaviors and beliefs that are necessary if organizations are to learn and develop.

Argyris and Schön (1978) defined organizational learning as "the detection and correction of error" (p. 2), and further state "Error is detected and corrected in ways that involve the modification of an organization's underlying norms, policies, and objectives" (p. 3). Argyris and Schön developed the concept of single-loop learning which involves the gradual improvement of organizational practice and routines (Cyert & March, 1963; Levinthal & March, 1981; Nelson & Winter, 1982), and double-loop learning described below.

Single-loop learning occurs within a given firm context of structure and rules, focuses on repetitive behavior and routines (Epple, Argote, & Devadas, 1991; Fiol & Lyles, 1985), and does not lead to changes in norms or values of the firm (Argyris & Schön, 1978).

Double-loop learning involves learning how to learn. Double-loop learning is the process through which "error is detected and corrected in ways that involve the modification of an organization's underlying norms, policies, and objectives" (Argyris & Schön, 1978, p. 3). It changes the organization's norms, values, and worldviews (Hedberg, 1981; Huber, 1991), and implies an alteration of the organization's mental models (Argyris & Schön, 1978; Barr, Stimpert, & Huff, 1992; Prahalad & Bettis, 1986; Porac & Thomas, 1990).

Argyris and Schon's (1978) notion of organizational learning is shared by many contemporary researches. However, as Huber (1991) and Dixon (1994) identified in their reviews of the literature, organizational learning is characterized in many ways, including among them as flexibility and responsiveness, as adaptation to a changing environment, and as change within the organization. Fiol and Lyles (1985, p. 803) see organizational learning as "the process through which better knowledge and understanding" leads to improved actions.

Shaw and Perkins (1991, p. 1) hold the view that is the "capacity of an organization to gain insight from its own experience, the experience of others, and to modify the way it functions according to such insight." Hodgkinson (2000) looks inside an organization, focuses more on the importance of teams and social interaction, and defines OL as the coming together of individuals to enable them to support and encourage each other's learning, which, in the long term benefits the organization.

Huber (1991, p. 89) states that learning occurs in an organization "If through its processing of information, the range of its organization's potential behaviors is changed".

Dodgson (1993, p. 377) describes organizational learning as "The way firms build, supplement, and organize knowledge and routines around their activities and within their cultures and adapt and develop organizational efficiency by improving the use of the broad skills of their workforces". While Dodgson (1993) addresses fixing errors, Huber (1991) insists that by understanding the problem, the future of the organization is changed.

Organizational knowledge has been defined as valued information that is socially constructed, collectively held, and linked to the goals of the firm. Distinct from individual knowledge, organizational knowledge is the product of a highly dynamic, recursive process of the collective. New organizational knowledge is viewed as the result of social interactions and involves combining existing knowledge structures with interpretation of external information (Weick, 1979).

A deeper understanding of organizational knowledge also can be gained through a description of socially constructed knowledge structures (e.g., schemas and scripts) of the firm. Schemas are the mental representations of knowledge, implicit theories, or domains of interest and provide a link to the past. Schemas are created, modified, and used to assign meaning to organizational actions through a process of sense making (Weick, 1995).

People are continually constructing or interpreting new experiences and by so doing are transforming their prior knowledge into new knowledge (Crebbin, 1999). This processing of information to construct new knowledge is learning (Gagne & Glaser, 1987).

According to Dixon (1994) organizational learning is the intentional use of learning processes at the individual, group and organizational level to continuously transform the organization in a direction that is increasingly satisfying to its stakeholders. Senge (1990, p. 3) states organizational learning occurs in "Organizations where people continually expand their

capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to see the whole together".

Learning Organization

What is a learning organization? Some definitions of the learning organization in current literature are very consistent. For instance, Tsang's (1997, p. 75) report, "A learning organization is an organization that expresses normative commitment to organizational learning, and is good at it", and Dodgson (1993) elaborated that a learning organization is a firm that purposefully constructs structures and strategies so as to enhance and maximize organizational learning.

Senge (1990) defined the learning organization as one that continually expands its capacity to create its future. Wick and Leon (1993, p. 4) identified a learning organization as one that "Continually improves by readily creating and refining the capabilities needed for success." Senge (1990, p. 22), Pedler, Burgoyne and Boydell (1991), and Marsick and Watkins (1999b) regard learning organization as a guiding vision for reaching out to, rather than as an attainable end state.

The concept of the learning organization (Senge, 1990) has become popular since organizations want to be more adaptable to change, and more agile and competitive. Learning is a dynamic concept and it emphasizes the continually changing nature of organizations. The focus is gradually shifting from individual learning to organizational learning. Just as learning is essential for the growth of individuals, it is equally important for the growth of organizations. Since individuals are building block of the organization, they must establish the necessary forms and processes to enable organizational learning in order to facilitate change.

Although theorists of learning organizations have often drawn on ideas from organizational learning, there has been little traffic in the reverse direction. Moreover, since the central concerns have been somewhat different, the two literatures have developed along divergent tracks. The literature on organizational learning has concentrated on the detached collection and analysis of the processes involved in individual and collective learning inside organizations; whereas the learning organizations literature has an action orientation and is geared toward using specific diagnostic and evaluative methodological tools which can help to identify, promote and evaluate the quality of learning processes inside organizations (Easterby-Smith & Araujo 1999, p. 2; see also Tsang, 1997).

In contrast to these western researchers, scholars, and commentators' definitions of learning as processing of explicit information, Nonaka (1994) used the concept of a spiral of knowledge creation to explain organizational learning process. He takes the view that an information processing perspective cannot adequately explain innovation, in specific, and knowledge creation, in general. The information-processing paradigm sees the organization as a system that 'processes' information inputs and solves problems in an uncertain environment as efficiently as possible.

As Nonaka (1994) suggested, this paradigm does not give due consideration to what is created by the organization within this "input-processing-output" sequence. Nonaka and Takeuchi (1995) presented a comprehensive model of how Japanese organizations dynamically create knowledge. Knowledge creation is reached by the interplay of tacit and explicit knowledge in the organization. Tacit knowledge is personal knowledge that is hard to formalize or communicate to others. Explicit knowledge is formal knowledge that is easy to articulate and to transmit between individuals and groups (Nonaka, 1994; Nonaka & Takeuchi, 1995).

In Nonaka's (1994) spiral of knowledge creation, knowledge moves upward in an organization, starting at the individual level, moving up to group level, and then up to the firm level. As the knowledge spirals upward in the organization, it may be enriched and amplified as individuals interact with each other and with their organizations (Inkpen & Dinur, 1998; Nonaka, 1994).

Thus, organizational learning is more than the sum of the parts of individual learning (Dodgson, 1993; Fiol & Lyles, 1985). Organizational knowledge creation occurs when all four modes are managed to form a continual cycle, as depicted in Figure 2.

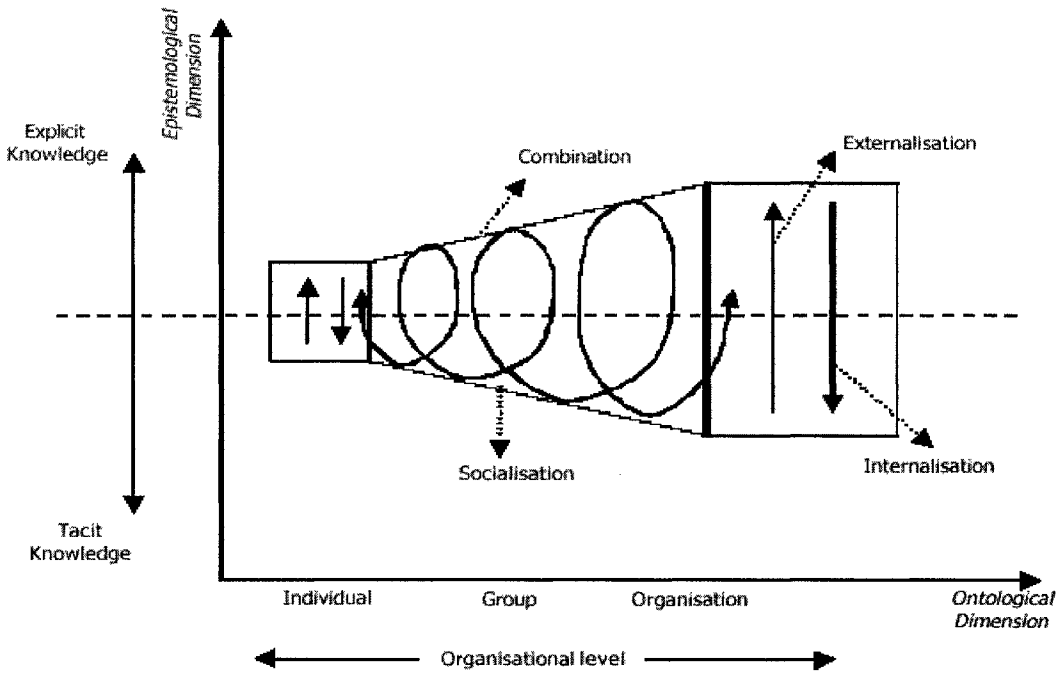


Figure 2 - Nonaka's Spiral of Organizational Knowledge Creation (Source: Nonaka, 1994, p. 20)

Nonaka and Takeuchi (1995, p. 59) suggest that the production of new knowledge involves "A process that 'organizationally' amplifies the knowledge created by individuals and crystallizes it as a part of the knowledge network of the organization". Two sets of activities drive the process of knowledge amplification: (1) converting tacit knowledge into explicit knowledge; and (2) moving knowledge from the individual level to the group, organizational,

and inter-organizational levels. The process grows like a spiral as the dance between tacit and explicit knowledge takes place at higher and higher levels of the organization.

Organizational knowledge creation occurs when all four of these modes are managed to form a spiral and a continual cycle, as depicted in Figure 3. The SECI model proposes that a "knowledge-creating company" consciously facilitates the interplay of tacit and explicit forms of knowledge. This is accomplished through systems and structures, and a corporate culture which facilitate the interaction of four knowledge-creating processes, per the following:

Socialization. A process of converting tacit knowledge in tacit (sympathetic) knowledge by sharing and acquiring of experiences between individuals through joint activities, physical proximity: such as apprentices learn the craft of their masters through observation, imitation, and practice, such as on-the-job training.

Externalization. A process of converting tacit knowledge into publicly comprehensible forms, explicit concepts (conceptual knowledge) through use of abstractions, metaphors, analogies, or models. The externalization of tacit knowledge is the quintessential knowledge-creation activity and is most often seen during the concept creation phase of new product development. While Nonaka emphasizes the role of metaphors and analogies, we consider conceptual modeling as an excellent technique to externalize knowledge with the aim to collect organized and codified knowledge in an organizational memory (Mason, 1993).

Combination. A process of converting explicit knowledge into more complex sets of explicit knowledge: meetings, communication, dissemination, systematization of explicit knowledge, by techniques like reasoning, programming, data mining, and information exchange through formal information systems.

Internalization. An internalized process of converting newly gained knowledge into tacit knowledge on an individual or organizational scale. The embodiment of explicit knowledge into actions, practices, processes and strategic initiatives. Internalization is facilitated if the knowledge is captured in documents or conveyed in the form of stories, so that individuals may gain the insight of experience indirectly the experience of others.

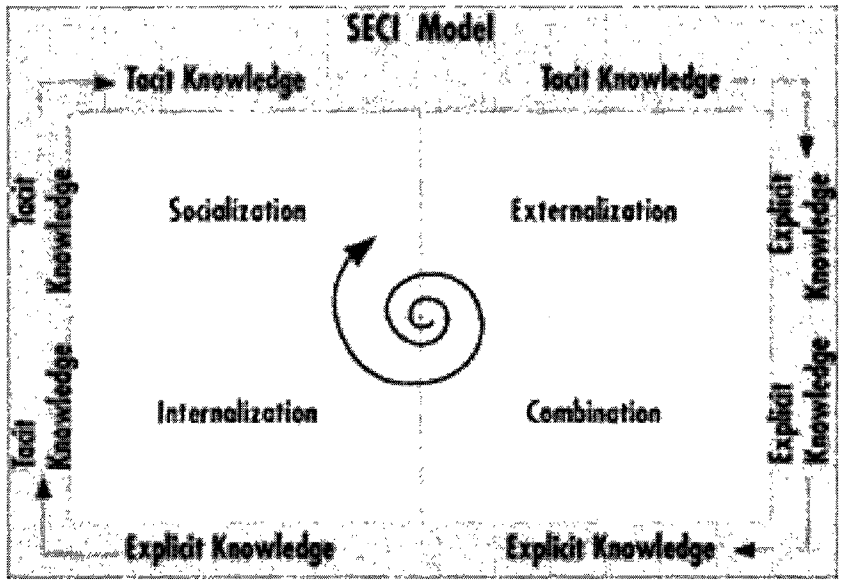


Figure 3 - Nonaka and Takeuchi's (1995) Organizational Knowledge Creation Model (Source: Nonaka & Takeuchi, 1995, p. 62)

The reconfiguration of existing information and recontextualizing explicit knowledge can lead to new knowledge (Nonaka, 1994). That new knowledge is then embodied in actions, practices, processes and strategic initiatives. "Productivity and competitiveness are, by and large, a function of knowledge generation and information processing: firms and territories are organized in networks of production, management and distribution; the core economic activities are global – that is they have the capacity to work as a unit in real time, or chosen time, on a planetary scale" (Castells, 2001, p. 52).

In addition to the flow of knowledge between organization levels (Nanoka, 1994), another key concept from the learning organizational literature involves the extension of private

meaning structures into accessible space, so that new meaning may be constructed (Dixon, 1994). For example, Polanyi (1966, p. 61) described how the transfer of tacit knowledge requires the transferor to have a deep awareness of the meaning of communicable details and the transferee to undertake the "same kind of indwelling" with this tacit knowledge to allow the deeper meaning to emerge.

Organizational learning is achieved through a synergistic relationship between tacit and explicit knowledge in the organization, and through the design of social practices that create new knowledge by converting tacit knowledge into explicit knowledge (Choo, 1996). Although the tacit knowledge held by individuals lies at the heart of the knowledge creation process, gaining access to the benefits of that knowledge requires dynamic interactions between four modes of knowledge conversion (Nonaka, 1994).

In Nonaka's (1994) spiral model of knowledge creation, knowledge moves upward in an organization, starting from the individual level, moving up to the group level, then up to the firm level, and finally to the inter-firm level. As the "Knowledge spirals upward in the organization, it may be enriched and amplified as individuals interact with each other and with their organization" (Inkpen & Dinur, 1998, p. 457).

Thus, organizational learning is more than the sum of the parts of individual learning (Dodgson, 1993; Fiol & Lyles, 1985). Hedberg (1981, p. 6) elaborates that "Although organizational learning occurs through individuals, it would be a mistake to conclude that organizational learning is nothing but the cumulative result of their members' learning. Organizations do not have brains, but they have cognitive systems and memories".

GROUP LEARNING

Another stream of the organizational learning literature finds four themes that can be drawn particularly from the writing of Dechant, Marsick and Watkins (Dechant & Marsick, 1991; Watkins & Marsick, 1993), and the more recent one (Groesbeck, 2001).

First, learning is a process through which people invent ways to cope with obstacles, surprises and discontinuities in the course of doing their work collectively.

Second, organizational learning must go beyond the individual. It must involve collective actions such as making sense of ideas, experimenting, integrating perspectives, and taking action together.

Third, organizational learning occurs when there is some "set of mechanisms" through which individual and work group knowledge, group norms, work procedures, and behaviors are captured and diffused across the organization so that they are retained in the organization's culture and knowledge base. Fourth, the organization must be connected to the external environment in order to obtain accessibility to relevant and vital external knowledge (Leonard-Barton, 1995).

Dialogue

A unique relationship develops among team members who enter into the "set of mechanisms" regularly. They develop a deep trust that cannot help but carry over to discussions. They develop a richer understanding of the uniqueness of each person's point of view. They experience how larger understandings emerge by holding one's own point of view "gently". Senge (1990) examined dialogue from a team learning perspective, and argues the vision of "dialogue" is the assumption of a "larger pool of meaning" accessible only to a group. Thus,

"while it may appear radical at first, has deep intuitive appeal to managers who have long cultivated the subtle aspects of collective inquiry" (p. 248).

Senge (1990) often says that "reflection and inquiry skills provide a foundation for dialogue" and that "Dialogue that is grounded in reflection and inquiry skills is likely to be more reliable and less dependent on particulars of circumstance, such as the chemistry among team members" (p. 249). Dialogue in learning organizations ranges from deeply contemplative self-questioning (Bohm, 1990; Cayer, 1997) to the hallways, where people share insights, experiences and observations, and consider ideas on merit rather than on the basis of seniority or affiliation (Dixon, 1997).

Collective Learning

The writings co-authored by Dechant, Kasl, Marsick and Watkins explicitly consider the role of the group in learning organizations (Dechant & Marsick, 1991; Kasl, et al., 1997; Watkins & Marsick, 1993, 1996). Group learning has been defined as "A process through which a group creates knowledge for its members, itself as a system, and for others. . . .[It is] an interrelated set of processes in which collective thinking and action play a central role" (Kasl, et al., 1997, p. 229).

Similarly, Watkins and Marsick (1996, p. 6) define team learning as "The mutual construction of new knowledge and the capacity for concerted, collaborative action." Moreover, "Teams are crucibles through which opposing ideas can be brought together and confronted – ideas that otherwise would remain within the heads of individuals and not be linked together in new combinations" (Watkins & Marsick, 1993, p. 97). These definitions of group learning suggest the idea that learning includes both cognitive and action-oriented behaviors.

Until recently, few researchers wrote specifically about group learning. The socio-cognitive constructs associated with group learning need to be operationalized and tested at the group or team level (Akgun, Lynn, & Byrne, 2003). Edmondson (1999b) utilized a single team learning behavior scale including items related primarily to information gathering, reflection and group processes.

Dechant and Marsick (1993) developed a theoretical learning model explicitly considering both cognitive and action-oriented behaviors: framing, reframing, integrating perspectives, experimenting, and crossing boundaries. Their analysis found the items associated with the five constructs were highly interrelated; factor analysis did not support distinct constructs. Three of the proposed constructs were cognitive (framing, reframing, integrating perspectives) while two are actions (crossing boundaries, experimenting).

Groesbeck (2001) utilized concepts from these researchers to test the distinctiveness of five group learning concepts: interpreting (similar to framing and reframing), crossing internal and external boundaries to obtain and share information (2 concepts), collaborate, and experiment. Three constructs emerged: collaborate, interpret and experiment. Items relating to integration did not form a distinct factor, but loaded to the factors relating to interpret and experiment. The three constructs are described in Table 2.

Table 2 - Group Learning Constructs

Construct	Definition
Experiment	Team action is taken to test hypotheses or to discover and assess impact of actions. May involve systematic, planned testing or trial and error to observe the results of actions.
Collaborate	Individuals seek or give information, views, and ideas through interaction with other.
Interpret	Team members develop or modify their frameworks or mental models of their work and its place in organizational processes. Involves reflective thinking or making sense of the results of experimentation and collaboration.

Knowledge is not easily exchanged or shared between groups. It is often accomplished through interaction and the exchange of ideas between cross-boundary group members formally and informally. Time pressure, hidden agendas, politics and power competitions can hinder knowledge sharing. Most people will focus on their own group tasks, instead of sharing information or knowledge with other groups. On the other hand, communities that are not dependent on certain tasks may be useful for diffusing knowledge throughout the organization (Wenger, et al., 2002).

Consistent with the definition of learning organization (Senge, 1990; Yang, Watkins & Marsick, 2004), much of the organizational learning literature focuses on the practices that enable organizations to create knowledge and the practices that will enable them to share this knowledge within the organization.

For example, Crossan et al. (1999, p. 524) proposed "The 4I framework of organizational learning containing four related (sub) processes – intuiting, interpreting, integrating, and institutionalizing – that occur over three levels: individual, group and organization". A key proposition of the 4I model is that information must flow from individuals and groups up to the organization and then back out from the organization to groups and individuals to enable organizational learning.

Learning organizations are organizations where people "Continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to see the whole together" (Senge, 1990, p. 3). A learning organization requires an understanding of the strategic internal drivers that map necessary processes for building learning capacity (Yang et al., 2004). Goh (1998) argues that learning organizations have five core strategic building blocks:

clarity and support for mission and vision, shared leadership, knowledge across organizational boundaries, and teamwork and cooperation.

The Learning Company is a vision of what might be possible. It is not brought about simply by training individuals; it can only happen as a result of learning at the whole organization level (Argyris & Schön, 1978, 1996; Brown & Duguid, 1991; Fiol & Lyles, 1985; Hedberg, 1981; Huber, 1991; Tsang, 1997). Learning organizations are characterized by total employee involvement in a process of collaboratively conducted, collectively accountable change directed towards shared values or principles (Watkins & Marsick, 1992). More specifically, the learning organization is viewed as one that has the capacity to integrate people, technology tools, and process internally and externally in order to move toward continuous learning and change.

The Need for An Integrated Organizational Learning Model

Despite the popularity of the concept and countless academic works, there are no commonly agreed upon definitions of organizational learning. Marsick and Watkins (1999a) stress the importance of extending the capacity to use learning as a strategic tool to generate new knowledge in the form of products, patents, processes and services, and to use technology to capture knowledge. Unless individual knowledge is somehow shared with other organizational members or groups, the knowledge will not be captured by the organization (Kim, 1993).

Thus, for organizational knowledge to create, one must understand how to manage organizational learning involving a focus on three levels: individual, group and organization. Moreover, it particularly involves understanding how to support the learning and sharing of knowledge throughout the organization as well as within the work group. Figure 2.3 portrays the vital role of group learning as a key link between individual and organizational learning.

Watkins and Marsick (1996) describe group processes required for the mutual construction of new ideas and collaborative action, but focus less on the practices through which these group processes take place and the interplay between tacit and explicit knowledge. Conversely, the spiral of knowledge creation posits four conversion modes required for knowledge to be shared and become embedded within the organization.

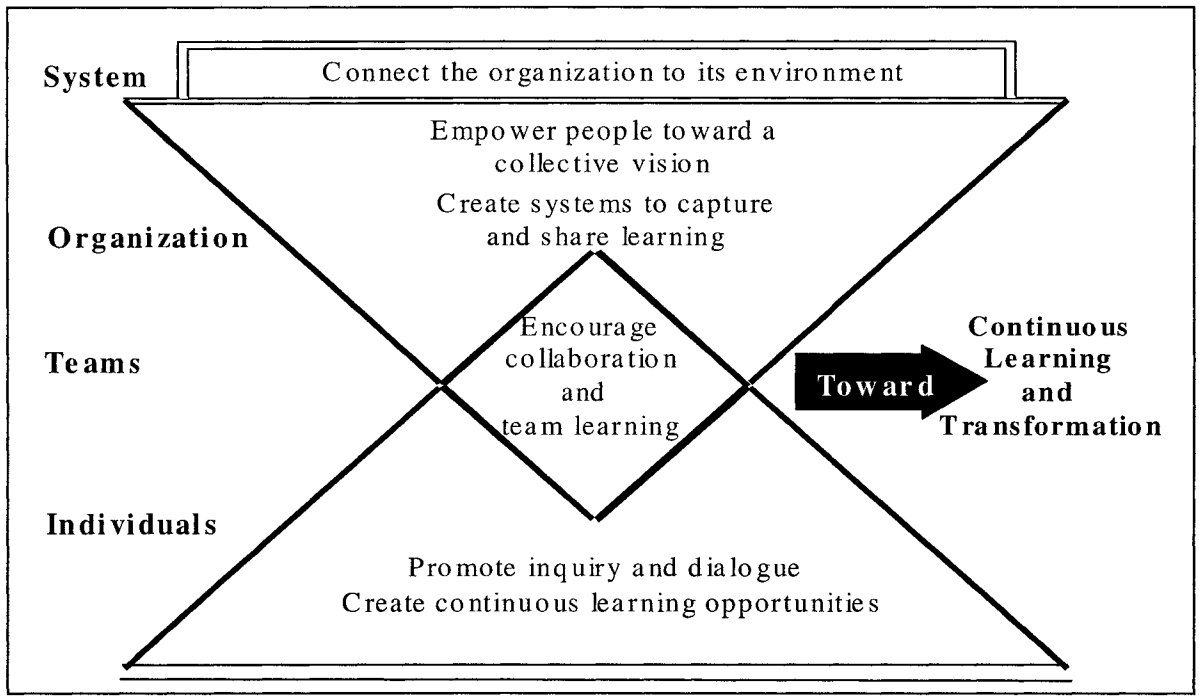


Figure 4 - Learning Organization Action Imperatives Support Learning at the Team Level (Source: Watkins and Marsick, 1993, p. 10)

That is, for organizational learning to occur, tacitly held knowledge must become explicit to be transferred from individuals and groups to groups and the organization through the four knowledge conversion modes (Nonaka, 1994).

However, the knowledge conversion model does not describe the processes which must actually be occurring in order for individuals working in groups to learn collectively. Dixon (1994) argued that it is not sufficient simply to have the meaning structures exchanged by members. Rather, organizations need to facilitate a learning cycle that involves the generation of

ideas, the dissemination of information into the organizational context, interpretation of knowledge, and the sense of authority to act on what is known.

The best practice in knowledge management is to enable knowledge flow rather than focusing on managing knowledge (von Krogh et al., 2000). Knowledge flows from internal and external, tacit and explicit sources. It should be processed in light of the firm's strategy to create new knowledge and acted upon to create tangible results (Choo, 1996).

The Integrated GLKC Model

The integrated group learning and knowledge creation model (Chang & Groesbeck, 2004) as depicted in Figure 5, describes the four practices of the SECI model work to support the processes of group learning. First, tacit knowledge is accessed from private meaning structures to enable collaboration through dialogue and other forms of sharing information.

Second, the accessible knowledge is translated, categorized and contextualized as group members interpret explicit information to make sense of it and see where it fits within their focused area and overall within the organization. Third, new knowledge is put into action through experimentation to allow its conversion from explicit to tacit as individuals "learn by doing". Lastly, the tacit knowledge gained from experimenting is interpreted within individuals' private meaning structures.

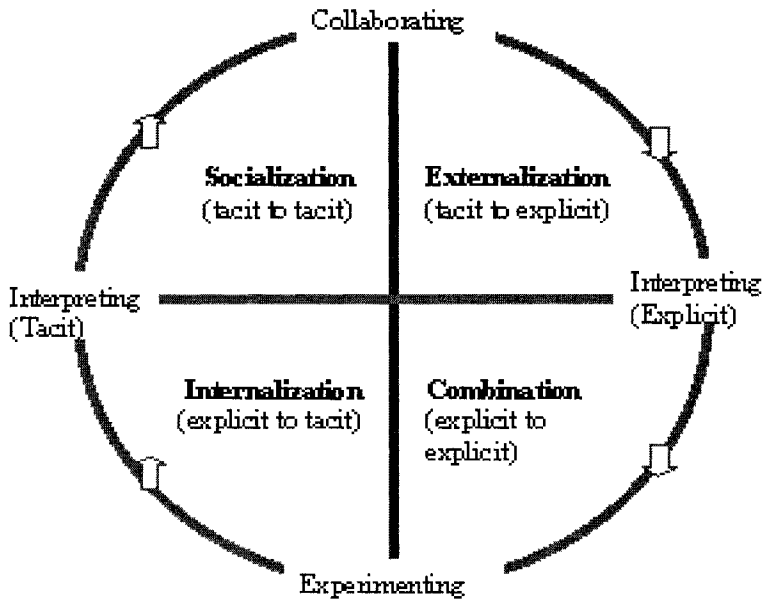


FIGURE 5 - GROUP LEARNING AND KNOWLEDGE CREATION MODEL (SOURCE: CHANG & GROESBECK, 2004, P. 493)

The portrayal in Figure 5 suggests that each of the group learning processes is most strongly supported by two of the SECI practices. For example, collaboration can occur as group members are involved in socialization and externalization practices. Similarly, each SECI practice is most strongly associated with two group learning processes. For example, conducting a training session (a practice to externalize knowledge) can enable collaborative processes; it also can support the interpretation of explicit concepts by both students as well as teachers who later recognize they have learned more than the students they were teaching as they engaged in the training experience.

Interpretation processes may involve tacit (privately held) or explicit (publicly held or accessible) information. Conceptually there is an important distinction. Interpretation of explicit information can occur as group members share their divergent views but focus on a deep

awareness of the meaning of communicable details so that others can undertake the "same kind of indwelling" to allow deeper meaning to emerge.

Thus interpretation can have an outward (tacit to explicit) focus from one's personal mind toward group-oriented concerns, as well an in inward (explicit to tacit) focus as individuals integrate and make sense of information from collective mental models and personal experience.

With this background, the supportive interaction of SECI practices and group learning processes can be described. A sequential perspective of how the practices and processes relate is described in the following paragraphs.

Socialization includes practices that enable individuals transfer their tacit knowledge to others by sharing their experiences and expertise through interactions in and outside their organization. Socialization requires interaction over time. It occurs through opportunities to share insights stemming from experiences and expertise. Transmission of tacit knowledge requires proximity and interpersonal interaction (Davenport & Prusak, 1998; Hensen, 1999; Nonaka & Konno, 1998; Sole & Edmondson, 2002; Szulanski, 1996).

An individual can acquire tacit knowledge directly from others by observation, imitation, and practice without using language. Mechanisms for tacit knowledge sharing include mentorship, apprenticeship, and repeated practice over a period of time (Nonaka & Takeuchi, 1995; Spender, 1996).

Collaboration processes occur as individuals seek or give information, views, and ideas through interaction with other individuals or units without boundary. Boundaries can be physical, mental, or organizational. Boundary crossing involves bringing in ideas, insights, information or data from outside the group or from other individuals within the group. Collaboration is supported by socialization and externalization practices.

Externalization involves practices that support articulating tacit knowledge into explicit concepts through language. Tacit knowledge becomes explicit through metaphors, diagrams, analogies, concepts, hypotheses, or models (Nonaka & Takeuchi, 1995). Externalization requires practices that support communication of new insights and guidance of new thoughts (von Krogh, Ichijo, & Nonaka, 2000).

Expressions used to externalize information are often inadequate, inconsistent, and insufficient. However, such discrepancies and gaps between images and expressions help promote reflection and interaction between individuals.

Interpretation of explicit information is a process through which group members develop or modify the frameworks or mental models of their work as well as their place in organizational processes. It involves reflective thinking or making sense of the results of shared information. Once tacit knowledge has been made explicit, it can be turned into information to share others (Gladstone, 2000).

Unless the information is understood and interpreted by others in meaningful ways, someone's tacit knowledge made explicit is nothing more than data. Hence, without interpretation, group members may be data rich but information poor.

Combination includes practices where two or more pieces of explicit knowledge are combined into more complex sets of explicit knowledge through acquiring, integrating, synthesizing, processing, and disseminating existing internal and external information (Nonaka, Byosiere, Borucki, & Konno, 1994).

Practices supporting combination could include visits to other operations performing similar work, customer supplier interactions, use of information and communication technology (ICT) networks and large-scale databases, financial reports, and market intelligence information.

Experimentation includes processes where action is taken to test hypotheses or to discover and assess the impact of actions or new mental models. It may involve systematic, planned testing or trial and error to observe the results of actions.

Internalization practices facilitate the embodiment of explicit knowledge into action and standard practices. Documents help individuals internalize what others have experienced by experiencing them indirectly. These practices enable people to benefit from others' experiments without actually having to re-experience other's trial and error. Internalization practices include opportunities for reading or listening to others success stories, interaction with people who have different expertise and specialization, and increasing familiarity with concepts through continued practice using simulations or experiments to support "learning by doing."

Interpretation of tacit information is a process where group members develop or modify individual frameworks or mental models of their work and its place in organizational processes. It involves reflective thinking or making sense of the results of experimentation toward commonly understandable perspectives. As Dixon (1994) noted,

> Information that is collected externally and/or generated internally can only be understood within the context of the total organization. The silo phenomenon in organizations is when one part of the organization does not have access to what other parts know, in effect, it cannot learn from them. But an equally detrimental effect of the silo phenomenon is the inability of each part to understand its own information because it lacks the context of the whole picture. It would be like closely examining a single piece of a jigsaw puzzle without access to other pieces. (p. 73)

Thus, interpretation tacit information is the process through which new knowledge is translated into something that organization members can understand from both big picture and focus perspectives. The GLKC model (Chang & Groesbeck, 2004) that integrates the SECI knowledge creation spiral model (Nonaka, 1994; Nonaka & Takeuchi, 1995) with group learning models (Groesbeck, 2001; Watkins & Marsick, 1993, 1996) is depicted in Figure 5.

Why GLKC Model Is Important?

As Chang and Groesbeck (2004, p. 491) argue, that "Integrating our understanding of the processes through which groups learn and the practices associated with organizational learning in Nonaka's (1994) knowledge conversion model can shed light on practices that will support the presence of group learning in organizations". The model provides a clearer view of the roles of tacit and explicit information within group learning. It emphasizes the need for an individual's tacit knowledge to be made explicit to group members, utilized and then incorporated back into the tacit knowledge that is used in tasks.

For instance, effective interpretation processes require more than just the opportunity to share, they also require the use of tools to draw out or enable the transfer of tacitly held information, e.g., using a formal modeling language is not to map a putative reality. This modeling process captures or externalizes the meanings and knowledge shared by the users. The GLKC model also highlights the need for both externalization of knowledge and combination practices as groups seek to interpret the data and information available to them.

KNOWLEDGE WORKGROUPS AND MOTIVATION

Knowledge Workgroups

The term "knowledge worker" is described as someone who adds value by processing existing information to create new knowledge which could be used to define and solve problems. Examples of knowledge workers include lawyers, doctors, diplomats, marketers, scientists, engineers, software developers, managers and bankers... However, some may argue that a plumber, a bricklayer, or a carpenter, who also uses his/her knowledge to do their work should be considered as knowledge workers.

The author draws a line to define knowledge worker: A knowledge worker is an employee who uses his/her brain more than hands to perform the task, adding value to information. A knowledge workgroup is collection of knowledge workers working together and sharing common goals and consequences.

Motivation in Knowledge Workgroups

In work places and other contexts, motivation is often described as being "intrinsic" or "extrinsic" in nature (Sansone & Harackiewicz, 2000). Employees are extrinsically motivated if they are able to satisfy their needs indirectly, especially through monetary compensation. Money is a goal that provides satisfaction independent to the actual activity itself, and intrinsic motivation is valued for its own and appears to be self-sustained (Calder & Staw, 1975; Deci, 1975).

Moreover, intrinsic motivation can be directed to the activity's flow, to a self-defined goal such as climbing a mountain (Loewenstein, 1999), or to the obligations of personal and social identities (March, 1999). In other words, motivation is intrinsic if an activity is undertaken for one's immediate need satisfaction. Intrinsic motivation is crucial when tacit knowledge in and between teams must be transferred (Osterloh & Frey, 2000). Often the issue of motivation generates strong debate about incentives for knowledge workers (Davenport & Prusak, 1998). Regardless, it is recognized that rewards depend to a great extent on the culture norms in an organization or group.

Wenger et al. (2002, p. 182) observe that rewarding "voluntary" behavior poses a dilemma: "How do we encourage behavior through extrinsic means when the intrinsic motivation for such behavior is considered a matter of pride and identity?" They observed that people often value the satisfaction derived from giving for reasons of professional affiliation or

commitment to a large cause, not because they are rewarded with a "carrot". A truly voluntary internalized behavior is based upon internal value systems of the knowledge workers in contrast to pride and identity that characterize social influences based upon identification (Malhotra & Galletta, 2003).

The knowledge workers' intrinsic motivation comes from need satisfaction (Leonard-Barton, 1995) while engaging in activities, and they continue to focus on innate needs for competence and autonomy (Deci & Ryan, 2000). Deci and Ryan further proposed that socialization can transfer external regulations into inner values, and that individuals can be self-determined while enacting external regulations.

Intrinsic rewards and values appear to operate in ways different from extrinsic rewards and values, and also differentially effect attributions of intrinsic motivation, perceived control and satisfaction (Bateman & Crant, 2001). Intrinsic motivation, derived from within the person or from the activity itself, positively affects behavior, performance, and well being (Ryan & Deci, 2000).

The Need for Group Stewardship

A sense of trustworthiness and commitment to the organization are the two employee traits most valued by managers (Cappelli, 2000). When knowledge work requires development of relationships and working across organizational boundaries, employers need people who they can trust, who will stay in their jobs long enough to learn the responsibilities of their jobs and those with whom they work (Groesbeck, 2001).

The concept of stewardship is several thousand years old. A steward is one who manages another's property, finances, or other affairs. Davis et al. (1997) proposed that stewards are motivated to act in the best interests of their principals, internally motivated, and willing to act in

concert with others. Some of the basic tenets of stewardship that are important to knowledge workgroups, as defined by Peter Block (1993), are:

1. Everyone is responsible for outcomes.
2. Total honesty is critical. End secrecy. Give knowledge away because it is a form of power (p. 67).
3. Mutual trust is the basic building block.
4. The willingness to risk, to be vulnerable, is a given. Vulnerability indicates that we accept the "rhythm of events" and trust that good will come without our controlling efforts (p. 76).
5. Stewardship is personal. If we are not transformed, institutional change will have no impact (p. 77).
6. Trust comes out of the experience of pursuing what is true" (p. 43).

Stewardship is anchored in action on behalf of organizational stakeholders and supported by the belief that the steward's interests are best served when the organization succeeds (Davis et al., 1997). Group stewardship is a collectively held sense of responsibility to oversee and improve performance in the group area of responsibility in accordance with the best interests of the organization (Groesbeck, 2001).

The author acknowledges that psychological ownership may perform similar function to stewardship, but the difference is that psychological ownership is about possession –"what's mine" or something people take upon themselves as their own. Stewardship is accepting a charge to act in behalf of or as an overseer for the true owner. Psychological ownership is anchored in the self (Pierce et al., 1992), a trait demonstrated by groups that become too inwardly-focused or

collude in their own best interest (Quinn et al., 2000). Thus, group stewardship is "Conceptually distinct from psychological ownership" (Groesbeck, 2001, p. 146).

Drawing on the discussion of motivation in knowledge workgroups and group stewardship the author proposes group stewardship as an intrinsic motivation factor that may have key influences on group learning and knowledge conversion processes.

ANTECEDENTS OF GKLC MODEL

This section outlines the constructs believed to influence the extent of group learning and knowledge conversion within workgroup domains. There is a limited amount of literature upon which to draw for this section due to the emerging nature of group learning and organizational knowledge creation.

Conditions enabling group learning and knowledge conversion have received little attention in previous research. It is necessary for organizations to identify the factors involved in group learning and knowledge conversion. The contemporary interest in enabling conditions for group learning and knowledge conversion derived from an assumed positive relationship between work environment factors and group learning and knowledge conversion. It is assumed that the extent of the enabling conditions affects rate and quality of group learning and knowledge conversion, which in turn influences group effectiveness.

Nonaka and Takeuchi (1995) outlined the organizational conditions that appear to be necessary for fostering knowledge creation. They emphasized five such conditions as:

1. Organizational aspiration/intention,
2. A sufficient degree of autonomy of individuals to examine as yet unexplored opportunities,

3. The deliberate managerial deployment of fluctuation and creative chaos to break down rigid routines and cognitive frameworks,
4. Redundancy as intentional overlapping of information about business activities, management responsibilities, and the company as a whole in order to promote the sharing and socialization of tacit knowledge, and
5. Requisite variety; the necessary access to information, spread throughout the organization, to cope with environmental complexity and change.

Indubitably, knowledge creation and creativity are closely linked and stem from an individual's cognition, but whether or not individual creativity is activated, exercised, and realized into a final product or service is a function of the work environment. Moreover, encouraging creativity in an organizational setting may not always lead to more or better organizational knowledge creation.

For instance, although organizations attempt to enhance employees' autonomy and independence to improve their creative output, this greater autonomy and independence may not necessarily facilitate coordination or cooperation, which are assumed to be influential in the knowledge creation process (Barker, 1993; von Korgh, 2000).

With a similar logic, the need or opportunity for the creation of ideas may be strongly influenced by work variables such as non-routine jobs, the breadth of the task, the opportunity for communication within and external to the group, and implementation of ideas is likely to inspire group or organizational support (Groesbeck, 2001).

As group learning or knowledge creation in the literature is just emerging, the literature related to creativity and innovation is being reviewed for potential insights into the antecedents and consequences of group learning and knowledge conversion. Creativity has been defined as

the production of novel and useful products, ideas, or procedures by employees "that provide an organization with important raw material for subsequent development and possible implementation" (Oldham & Cummings, 1996, p. 607).

This construct appears to be closely related to the cognitive aspect of group learning (Groesbeck, 2001) which includes the mutual construction of new knowledge (Watkins & Marsick, 1996) through an ongoing process of reflection, asking questions, and seeking feedback (Edmondson, 1996b). Drawing the conclusion from prior literature discussions, antecedents of group learning and knowledge conversion may be considered within the framework of task factors, group factors and organizational factors.

Task Factors

The need or opportunity for the creation of ideas collectively may be strongly influenced by task variables such as task interdependence, clear purpose, non-routineness of work, the breadth of the task and the opportunity for communication within and external to the group (Groesbeck, 2001).

Clear purpose, is the degree to which the work group has a well-defined mission or purpose that is understood by group members. A clear purpose can facilitate work group performance (Cohen, Mohrman & Mohrman, 1999). A clear purpose can also help group members stay focused on the task and with some assurance that the risks they are taking with failure are likely to be worthwhile because the results of the interpersonal risks can be assessed against a desired end-state (Cannon & Edmondson, 2001).

Task interdependence, is the degree to which completing tasks requires the interaction of group members (Shea & Guzzo, 1987) and has been identified as a variable that can be key to group effectiveness (Wageman, 1995). In groups with high task interdependence, the completion

of group tasks requires interaction and coordination among group members (Guzzo & Shea, 1992; Shanley & Langfred, 1998).

The interaction and coordination among group members are key enabling factors for group learning and knowledge sharing. Moreover, "Groups that have high coordination requirements will be much more likely to be able to operate smoothly as a unit than groups with group members working relatively independently of one another" (Langfred, 2000).

It is the shared commitment to a specific purpose that helps define a team. Clear purpose in teams may in fact guide toward collective direction by encouraging individuals to "focus simultaneously on multiple dimensions of their work" (Oldham & Cummings, 1996) in reflections and acts interdependently within workgroup. Therefore clear purpose and task interdependence are considered to be key enablers in task factors for group learning and knowledge conversion in this study.

Group Factors

Affective-trust, is a willingness to take interpersonal risk due to emotional-based relationship (McAllister, 1995). Prior research has demonstrated that trust in one's supervisor and trust in one's coworkers can have a significant positive impact on organizational outcomes including greater productivity (Davis & Landa, 1999), citizenship behavior (Korsgaard, Brodt, & Whitener, 2002; McAllister, 1995), commitment (Whitener, 2001), team member cooperation, perceived team performance, and team satisfaction (Costa, Roe, & Tallieu, 2001; Costa, 2003).

Research has also shown that team members who have greater trust in their supervisor report less stress and burnout (Davis & Landa, 1999; Harvey, Kelloway, & Duncan-Leiper, 2003). When trust is high, team members believe their supervisor and coworkers are open, honest, truthful, consistent, fair, and have good intentions (Gabarro & Athos, 1978). Also, Erdem

and Ozen (2003) suggested that trust provides an atmosphere of psychological safety for team members, and only in such an atmosphere can members accept criticisms easily, discuss mistakes and express their thoughts freely. Moreover, trust involves a willingness to be vulnerable (Mayer et al., 1995).

Heedful interrelating among group members and in member interactions with individuals outside of the team boundary is a necessity. Heed, defined by Weick and Roberts (1993), is not a behavior; rather it refers to the way in which behaviors are enacted. Interpersonal interactions assembled with heed are attentive, purposeful, conscientious and considerate. They increase group effectiveness by improving members' ability to work together efficiently (Cohen, 1994). Without the enactment of heed, interpersonal interactions and relationships are paid little regard (Druskat & Pescosolido, 2002).

A shared mental model about the need for heedful interrelating would be rooted in recognition of team member interdependence and the inter-dependence between the team and its environment. It would describe the team as a system in which members act with an understanding that the system relies on connected action (Weick & Roberts, 1993).

Weick and Roberts (1993) propose that the more heedfulness reflected in member interactions, the greater a team's capability to reduce process errors and adapt effectively to evolving needs and unexpected events. If organizational priorities allowed few formal opportunities for building and maintaining heedful relationships, a well-developed shared mental model of heedful interrelating would drive team members to find informal ways to develop and maintain such relationships, for example, through within-group communication, or communication with external constituents.

Group stewardship, its effect on learning and knowledge conversion practices has not been studied other than in Groesbeck (2001). However, as its presence requires shared mental models leading to common expectations that support engagement it is in the best interest of the organization. The level of group stewardship was found to be positively correlated with both learning (cognitive) and action-oriented learning behaviors (Groesbeck, 2001). In the other words, the presence of group stewardship may lead to group learning and proactive behaviors.

Furthermore, a proactive behavior within a group may lead to sharing and querying of information and knowledge among members. Parker and Sprigg (1999) found a sense of production ownership was positively correlated with proactiveness, the tendency to enact environmental change, which could be associated with action-oriented learning behaviors such as experimenting or practical application of new ideas.

Group composition, although learning is a function of the individuals comprising the group, group learning is not likely to be the simple aggregate of individual learning. Group composition factors including diversity are likely to influence learning. Creativity is likely to be highest when groups are composed of individuals from diverse fields or having different backgrounds (Woodman, Sawyer, & Griffin, 1993).

All groups face the inevitable challenges created by interpersonal conflict and individual differences. Group diversity may indirectly influence cognitive group processes through intragroup task conflict and intragroup emotional conflict (Pelled et al., 1999). Thus, work groups may develop the resolution of a deep interpersonal difference catalyzed the group toward new levels of learning (Kasl, Marsick & Dechant, 1997; Marsick, 1990) or inhibited the group from further learning (Gavan, 1996).

These findings suggest that, to the extent that diversity stimulates task-oriented conflict or cognitive processes that expose alternatives and promote the development of a comprehensive shared mental model of the work domain, diversity may enable learning.

Organizational Factors

Information and resources, knowledge of expectations, feedback about performance, the resources and infrastructures needed to perform work, and knowledge of organizational rules, procedure, standards, and policies embodying organizational knowledge are inputs to the intuiting and interpretation processes that should enable group learning.

In a culture where experimentation is encouraged, and which thrives on implementing new ideas, mistakes are an inevitability. Garvin (2000) explains that the first step for learning from a mistake involves removing the personal component from an error to focus on the system, processes and organizational failures.

If the focus falls on the person who made the mistake, people will feel threatened and will distance themselves from the occurrence. If it is instead accepted that an error is a result of the way the organization structure or management systems are designed, it is more likely that root of the problem will be identified and double or event triple loop learning can take place (Garvin, 2000)

Edmondson (1999b) developed a scale to assess the supportiveness of the organizational context including the extent to which group members received appropriate information, assistance, training, and recognition for excellent work. She found that group psychological safety fully mediated the influence of a supportive context on group learning behaviors. In other words, supportive conditions may work together to support development of a condition where individuals feel safe in working together which in turn enables group learning.

An interaction approach to creativity suggests group creative performance is increased by the availability of slack resources and decreased by restrictions on information flows within the system (Woodman et al., 1993). Several studies have verified the importance of a supportive context to enable creativity. For example, Shalley and Gilson (2000) found that giving recognition, value, and adequate time and resources for creativity was positively correlated with which creative and original outputs were developed.

Supportive supervision, Edmondson (1999b, 2000) found team leader coaching behaviors (e.g., availability for consultation and initiation of meetings to discuss progress) supported increased learning behaviors. Edmondson found supportive team leader coaching acted indirectly to increase learning behaviors through the creation of psychological safety.

Somewhat similarly, Axtell et al. (2000) found that management and team leader support through collaboration, facilitation and feedback was significantly related to group member perceptions of participative safety but not with the level of shopfloor suggestions made by individuals. However, others have found that creativity is increased by supervision that supports group work and values contributions (Amabile, 1989).

Researchers have also hypothesized that supportive supervision increases group learning and individual creativity indirectly through the creation of group or individual efficacy. However, these hypotheses have not been confirmed (Edmondson, 1999b; Tierney & Farmer, 2000).

CONSEQUENCES OF GLKC

There is growing evidence that the existence of shared mental models among the members of a work team has a positive effect on team processes and effectiveness (Klimoski & Mohammed, 1994; Levine & Moreland, 1991; Mathieu et al., 2000; Weick & Roberts, 1993).

Shared mental models are socially constructed cognitive structures that represent shared knowledge or beliefs about an environment and its expected behavior. They influence team member behavior and improve coordination by enabling members to anticipate one another's actions and needs (Cannon-Bowers et al., 1993; Weick & Roberts, 1993). The higher the convergence in member mental models (i.e. the more 'shared' the model), the better the team will perform (Blickensderfer et al., 1998; Cannon-Bowers et al., 1993; Mathieu et al., 2000; Rouse et al., 1992).

Shared mental models emerge as team members interact to make sense of their situation and cultivate shared beliefs about how they should work together to complete their task (Klimoski & Mohammed, 1994). Bettenhausen and Murnighan (1985) propose that cognitive representations from past group experiences provide a frame for interpreting new experiences. They state, "When new information is presented people search through their memory to find similar situations to help them organize and make sense of the new stimuli" (p. 353).

Two significant changes in shared mental model and collective action occur in group members as a result of group learning and knowledge conversion. First, group learning and knowledge conversion result in collectively held new knowledge that is diffused among group members (Tompkins, 1995; Watkins & Marsick, 1996).

As learning begins with the intuitions of individuals (Crossan et al., 1999), then clearly diffusion must take place for knowledge to be collectively held. Diffusion of knowledge takes place as the group interprets ideas, thoughts, or information and integrates new knowledge into its shared mental models. Therefore, as group learning occurs, group members will increasingly hold a collectively shared vision, conform to group decisions, and be able to respond rapidly to questions about processes or their vision without referral to others (Tompkins, 1995).

The second change resulting from group learning and knowledge conversion is an expansion of capacity to take concerted, effective action (Dixon, 1994; Kim, 1993; Watkins & Marsick, 1996; Tompkins, 1993). Group capacity to act should be increased by the extent group members have developed common knowledge (Dixon, 2000) collectively held knowledge of group member abilities, commonly held principles or values, and technical knowledge about processes for which they are responsible.

Groups demonstrating collective learning should be able to reach decisions more rapidly as group member's shared mental models reduce the time for the group to reach decisions. Groups should also be able to predict consequences of actions more accurately, utilize more of the group's members effectively, and increase the coordination among members (Tompkins, 1995).

Group learning and knowledge conversion may be self-reinforcing. As learning-oriented outcomes may include perceived mastery (a knowing doing gap that drives individual to learn and share), role breadth efficacy, production ownership, and skill utilization (Groesbeck, 2001; Parker & Sprigg, 1999) are also believed to create conditions which enable the formation of group stewardship and promote group learning. Several outcomes of group learning and knowledge conversion at the work group-level are similar to those studied in team effectiveness models. Edmondson (1999b) found group learning led to increased levels of supervisor and self-assessed group performance (Groesbeck, 2001), and team creativity (Huang & Wang, 2002).

Creativity is positively correlated with productivity (Amabile, 1989) and the quantity and quality of work performed (Oldham & Cummings, 1996). The extent of learning may be positively correlated with group attitudinal outcomes. Conditions associated with increased

creativity have also been found to be associated with group member satisfaction, commitment, and reduced intentions to quit (Oldham & Cummings, 1996; Shalley & Gilson, 2000).

Group learning appears to be associated with increased levels of group satisfaction, commitment and effectiveness (Groesbeck, 2001). Edmondson (2000) found increased levels of group learning were associated with more successful adoption of new technology. Knowledge work teams requires learning how to behave including the new roles and skills required, and the unlearning of old habits and behaviors and requires growth in the team's capacity to manage itself as a unit, and to acquire, share and use knowledge to make effective decisions (Slavin, 1991).

Learning is necessary in knowledge work teams because of the need for such teams to engage in complex group decision-making, self-evaluation and self-correction (Druskat & Kayes, 2000; Hackman, 1986). In order for this to occur, all members must have the appropriate knowledge and training to meaningfully evaluate member inputs, team processes and the quality of team outputs.

As proposed in their future research, Chang and Groesbeck (2004) suggest that there is a need to test the hypothesized relationship among the constructs, as well as possible opportunity to refine to the constructs used to access each of the eight constructs in the GLKC model. Thus, to be consistent with prior research, the author proposes the empirical research model as depicted in Figure 1.

SUMMARY OF THIS CHAPTER

Chapter I provided a general introduction of this study, three research questions, a research model, and eleven hypotheses. Chapter II presents a review of the literature that is pertinent and timely to the research topic. It presents the core theory on which this research is

based, as well as empirical findings of previous studies. The literature review is used as the basis for the development of the research model and questions. Antecedents and consequences of group learning and knowledge conversion relevant to the topic have been reviewed and discussed as well in this chapter.

Chapter III presents the research design and methodology. It covers a description of the sampling, construct of variables and the survey instrument, as well as data collection and data analysis.

CHAPTER III
RESEARCH METHODOLOGY

INTRODUCTION

This dissertation examined how group stewardship influences group learning, knowledge conversion processes and group effectiveness in an engineering and manufacturing firm. In contrast with previous studies that focus on only one aspect such as organizational learning, knowledge management, knowledge transfer, or group learning, this study is distinct from prior research in that it argues that both group learning and knowledge conversion processes acting together are the core of organizational knowledge creation and sharing. Together these processes sustain competitive advantage over competitors.

Based on this argument, the author proposed an integrative research framework based on Chang and Groesbeck's (2004) group learning and knowledge conversion model as the process in relation to group stewardship (antecedent) and group effectiveness (outcome). Three research questions are examined: (1) How does group stewardship affect group learning and knowledge conversion? (2) How does knowledge conversion affect group learning? (3) How do group learning and knowledge conversion affect group outcomes? The results of the examination are described in Chapter IV.

The prior two chapters described the research model and eleven hypotheses to be tested in this study and the relevant literature review respectively. This chapter describes the methodology to implement the conceptual model and to test the hypotheses as depicted in Figure 1. This chapter is divided into four main sections in addition to the chapter summary. The first two sections begin with a detailed discussion of the sampling and survey instrument, with particular emphasis on reliability and validity. The next section provides a detailed description of

the measures to be used for each of the independent, control and dependent variables. Following the third section, the description of data processing and analysis is outlined. Lastly, the summary section is presented.

SAMPLE

This dissertation examined how interactions among workgroup members influenced the performance of the groups. The unit of analysis is the workgroup. Data were collected from workgroup members, their supervisors and their senior managers. Further, the data received from those members and supervisors who responded was checked and analyzed (see the section of administration of survey in this chapter) before being aggregated to the group level for analysis (see the section of team-level data aggregation in this chapter).

Sample Frame

Four criteria were proposed for selecting companies to participate in this study: (1) knowledge intensive work organizations, such as in electronics and computer software related engineering and manufacturing to ensure that group members perform non-routine tasks, (2) ISO 9001 accredited companies in order to access explicit knowledge (e.g., work procedure and task report) of respondents, (3) companies with true workgroup structures (e. g., an intact social entity, demonstrated task interdependent, and have a clear purpose), (4) the group must have been established for at least six months. These definitional criteria are intended to ensure that respondents are members of real work groups who experience group socialization and who develop group norms and share common knowledge.

It is important that the number of workgroups not be too small; otherwise, the study would not sustain the assumption of a unity of singular corporate culture assumption in this research. The author selected the study's subjects based on the four criteria listed. To qualify for

survey administration the author accessed ISO9000 accredited information technology associations in North Alabama (e.g., Alabama Information and Technology Association), and their membership directories to verify that companies with the desired characteristics could be sampled for the research. In the membership directories the author was able to identify the potential participants with the quantity of workgroups necessary to conduct meaningful work for this research.

Sample Size

Adequate sample size is necessary to permit stability of results and provide for adequate statistical power to find existing relationships. Individual-level data are used for factor analysis to validate constructs. Aggregated group-level data are used for the analysis of relationships among the group-level constructs, and further used for testing research hypotheses. Companies were invited to participate in the survey in exchange for feedback that would help them assess the status of their work groups, support the development of group effectiveness, and through group learning and knowledge creation sustain firm competitive advantages. An additional benefit offered is the opportunity to compare their feedback with that of other companies participating in the survey. The identities of companies invited to participate in this research were promised to be confidential and their survey to be anonymous.

The author initially telephoned each Human Resource manager/director from companies that met the selection criteria mentioned above. The potential participants were advised that the purpose of the survey was to conduct research, and there would be no charge to participate in the research. Two organizations showed interest in participating initially, but only one completed the survey administration and data collection. Both the number of survey respondents and the

number of work groups that participated were considered adequate for this research (for details, see the Survey Administration section).

MEASUREMENT VARIABLES

Selection of Variable Constructs

This study examines group learning and knowledge conversion and their antecedents and outcomes as discussed in Chapter II. Figure 1 illustrates the proposed relationship among the constructs. The constructs and their operationalizations are described in the following sections.

Antecedent Variable Constructs – Team Inputs

Table 3 lists the factors expected to have the strongest influence on the development of group learning and knowledge conversion processes, and on group effectiveness. They include task factors, group factors, organizational factors, and group stewardship.

Task factors

Clear purpose is the degree to which the work group has a well-defined mission or purpose that is understood by group members. A clear purpose can facilitate work group performance (Cohen, Mohrman, & Mohrman, 1999). A clear purpose can also help group members stay focused on the task and provide some assurance that the failure risks they are taking are likely to be worthwhile because the results of the interpersonal risks can be assessed against a desired end-state (Cannon & Edmondson, 2001).

Task interdependent is the degree to which completing tasks requires the interaction of group members (Shea & Guzzo, 1987) and has been identified as key to group effectiveness (Saavedra, Earley, & van Dyne, 1993; Wageman, 1995), group learning (Groesbeck, 2001) and knowledge conversion (Nonaka, 1994, Nonaka & Takeuchi, 1995). Interdependent task design can facilitate group processes such as cooperation and learning (Cohen & Bailey, 1997).

Group factors

Affect-based trust is a willingness to take interpersonal risks due to an emotionally-based relationship. The literature review suggested that affect-based trust should be used to assess group relationship in the proposed field study.

Evaluative feedback given to group is the feedback the group receives concerning their group performance. The previous research on feedback concludes that workers given information about how they perform generally outperform workers who are not given such feedback (Enzle & Ross, 1978; Harackiewicz, 1979).

Group stewardship is a collectively held sense of responsibility to act as co-owners or partners in the best interest of the organization. The literature review suggested that stewardship is intrinsically motivated behavior that is especially needed in group learning and knowledge sharing. Groesbeck (2001, p. 151) pointed out "The practical significance of group stewardship in promoting group learning and proactive behaviors". Group stewardship is selected for the rationale in this study.

Group psychological safety, a belief that the group is a safe place for risk taking, has been shown to be an antecedent of group learning (Edmondson, 1999b). Stewardship relationship is based more upon commitment to a relationship, affective trust, than commitment to values or fairness in interpersonal relationship (Graham & Organ, 1993; Groesbeck, 2001), which supports development of psychological safety. Moreover, due to a need to limit the number of constructs in this study, affect-based trust was selected and the psychological safety construct was not used.

Organizational factors

Investment in employees is when an organization takes a long-term view in developing employee skills and providing them opportunities to learn. Companies providing employee

training and development initiatives are able to reach a higher level of employee performance that leads to increased profitability, especially in a rapidly changing technical environment.

Quality of information technology is the quality of information technology infrastructure and usage that an organization provides to its employee for doing their tasks effectively. The knowledge management literature has focused on IT tools and their potential to support collaboration among people with different knowledge backgrounds (e.g., Boland & Tenkasi, 1995), to enable knowledge access and sharing including connections to company experts (Anand, Manz, & Glick, 1998); and to disseminate generic and codified knowledge, including algorithms and systematic work processes that embody the knowledge of the firm (Cross & Baird, 2000; Fulk & DeSanctis, 1999; Leonard-Barton, 1995).

Table 3 summarizes the antecedents, independent variables believed to promote shared mental model (SMM), and the development of group learning (GL) and knowledge conversion (KC), and the operational constructs proposed for each concept in this study.

Table 3 - Antecedents of GLKC and operational constructs

Model Grouping Concept	**(SMM)**	**(GL)**	**(KC)**	**Operational Construct**
Task Factor				
Outcome Interdependence	X	X	X	Clear Purpose
Task interdependence		X	X	Task interdependence
Group Factors				
Heedful interactions	X		X	Affect-based trust
Trusting relationship			X	
Psychological safety		X		
Feedback of consequences	X	X		Group-level feedback
Holistic expectations?				
Proactive		X	X	Group stewardship
Information and knowledge sharing	X	X	X	
Organizational Factors				
Training for procedural and conceptual knowledge	X		X	Investment in employees

Investment in employees		X	X	
Information and resources	X	X	X	Quality of information technology

Process Variable Constructs – Knowledge Work Processes

There are two variables in this construct: group learning and knowledge conversion as described below.

Group learning

Group learning (GL) is generally recognized to be a multidimensional concept with cognitive and action-oriented learning behaviors (Crossan et al., 1999; Fiol & Lyles, 1985; Gephart, Marsick, & van Buren, 1997; Watkins & Marsick, 1993). Chang and Groesbeck (2004) identified four variables of group learning in their GLKC model. They are collaboration, interpretation of explicit information, experimentation, and interpretation of tacit information.

The first three variables were tested with acceptable reliability (see Table 4) and validated in Groesbeck's (2001) research. This research adopts the variable "interpretation of tacit information" from the variable of "interpretation of explicit information" in Groesbeck's (2001) work. The interpretation of tacit information is a cognitive process, as is the interpretation of explicit information, except the interpretation of tacit information is a process of inward dwelling meaning, and the interpretation of explicit information is a process of outward dwelling meaning (Chang & Groesbeck, 2004).

Knowledge conversion

Knowledge conversion is the interplay of tacit and explicit knowledge in four modes of conversion: socialization, externalization, combination, and internalization. The four variables of

knowledge conversion tested and validated in Huang and Wang's (2002) work (see Table 4 for their reliability) is used in this study.

Outcome Variable Constructs – Team Effectiveness

Guzzo and Dickson (1996, p. 309) define effectiveness as " (1) group-produced outputs (quantity or quality, speed, customer satisfaction, and so on), (2) the consequences a group has for its members, or (3) the enhancement of a team's capability to perform effectively in the future". Cohen and Bailey (1997) categorize team effectiveness into three major dimensions. They include performance effectiveness, member attitudes, and behavioral outcomes. This study operationalizes group effectiveness with measures of group performance, satisfaction with team, and team viability.

INSTRUMENT CONSTRUCT

A survey questionnaire was administered on site in order to assess and investigate the relationship between group stewardship, group learning and knowledge conversion, and group effectiveness. The construct of the survey questionnaire was completed (refer to Appendix B) and fully utilized the existing instrument from prior research. Their sources and reliabilities are depicted below in Table 4. Unless otherwise noted, the response scale for each of the measures is a six-point Likert scale format (1=Strongly Disagree to 6=Strongly Agree). Items were coded such that high values indicate high levels of the construct except for four items that are reversed coding.

Measures for Antecedent Variables

Measures of task factors, group factors, organizational factors, and group stewardship derive from two sources: Groesbeck (2001) and Mohrman et al. (2003).

Measure for task factors

A clear purpose can facilitate work group performance (Cohen, Mohrman & Mohrman, 1999). A clear purpose can also help group members stay focused on the task and provide assurance that the risks they are taking with failure are likely to be worthwhile because the results of the interpersonal risks can be assessed against a desired end-state (Cannon & Edmondson, 2001).

Clear Purpose, the measure of four-items from Groesbeck (2001) and Wilson, van Aken and Frazier (1998) was used to assess the degree to which the work group has a well-defined mission or purpose that is understood by group members.

Task Interdependence, a three-item scale that measures the degree of task interdependence within a group was taken from Bailey et al. (1998) and Groesbeck (2001).

Measure for group factors

Both trust between team members and feedback given to a group are the must important factors in knowledge workgroups.

Affect-based trust, the measure of five items from Groesbeck (2001) and McAllister (1995) was used to assess the degree of willingness to take interpersonal risk due to emotionally-based relationship.

Evaluative feedback given to group, the measure of four-items from Groesbeck (2001) and London, Larsen and Thisted (1999) was used to assess the group receives feedback that helps them evaluate group performance.

Group stewardship, a five-item scale to assess the presence of group stewardship was tested in Groesbeck's (2001) research, but only three items were validated with acceptable reliability as displayed in Table 4, and were selected and used in this study.

Measure for organizational factors

The factor of "Organization's design is important because it shapes behavior through the distribution of resources....information;" (Mohrman et al., 2003, p. 10), and the tools provided to do the work (Galbraith, 1994). The two variables below assess organizational factors that can affect the dependent variables' outcome.

Investment in employee, the measure of four items from Groesbeck (2001) and Tsuit et al. (1997) was used to assess the member's perception of their organization taking a long-term view in developing employee skills and providing opportunities.

Quality of information technology, the measure of five items from Mohrman et al. (2003) work was used to assess the member's perception of the quality of information technology infrastructures in the organization.

Measures for Process Variables

Measure for group learning

The first three variables used to assess group learning in this study were tested in Groesbeck's (2001) work. A fourth variable, interpretation of tacit information, was adapted from the variable that assesses to interpretation of explicit information with a minor change to adapt the measure for interpretation of tacit information. These four variables are described below.

Collaboration. Groesbeck's (2001) 4-item scale assesses members' willingness to share information and resources within the team. A high aggregated score indicates members have high collaboration in their work (e.g., resource allocation, coordination of task priorities). A low aggregated score on this variable would indicate low collaboration between team members.

Interpretation of explicit information. Three items from Groesbeck's (2001) work assess the degree of team members' development or modification of their collective mental model of their work and place in the organization process.

Experimentation. Four items from Groesbeck's (2001) work assess team members' capability to conduct trial and error implementation. A high aggregated score on this variable would indicate that group members are very willing to try out new ideas and to observe the results of actions.

Interpretation of tacit information. Three items adapted and modified from Groesbeck's (2001) work were used to assess team members' degree of development or modification of personal mental model from interpretation of information.

Measure for knowledge conversion.

The four variables from the previous work (Huang & Wang, 2002) based on the theory of Nonaka's (1994), Nonaka and Takeuchi's (1995) spiral knowledge creation model, are used in this study to assess group knowledge conversion processes. The four variables are described below.

Socialization. Huang and Wang's (2002) 6-item measure assesses team members' interaction and sharing of tacit knowledge. A high aggregated score on this variable indicates that the members perceive a high degree of tacit knowledge sharing. A low score would indicate the lack of knowledge sharing on the part of team members.

Externalization. Huang and Wang's (2002) 6-item measure assesses team members' practice of expressing their tacit knowing explicitly. A high aggregated score on this variable indicates that the members convey what they know via explicit knowledge (e.g., weekly

report/status, technical papers). A low score would indicate fewer efforts by team members to do this.

Combination. Huang and Wang's (2002) 6-item measure assesses team members' abilities and practice of integrating existing knowledge to new explicit knowledge. A high aggregated score on this variable would indicate that members create new knowledge from existing ones (e.g., detail product design specification) through formal meeting. A low score would indicate less knowledge creation on the part of team members.

Internalization. Huang and Wang's (2002) 4-item scale assesses team members' abilities and practices of internalizing explicit knowledge to tacit knowledge. A high aggregated score on this variable would indicate that the members have better abilities to internalize new knowledge and understanding and what have been learning from own and others experiences.

The above two sections mentioned eight variables' measures of group learning and knowledge conversion will be only taken by team members and team managers.

Measure for Outcome Variables

Three outcome variables were measured as a determination of team effectiveness. Following Hackman (1987) overall team effectiveness was assessed with these three variables: Team Performance; Satisfaction with Team; Team Viability. Details of the three components for group effectiveness are listed in Table 4.

Team performance. The factor was measured by four items from Groesbeck (2001) and Kirkman and Rosen (1999) that assess the subjective perception of group performance. Data for measure were collected from team members, supervisors, and senior managers. A high aggregated score would indicate that the team performs effectively.

Satisfaction with team. Three items from Campbell and Hallam (1994) and Lewis (1999) assess team members' satisfaction with their team. A high aggregated score on this variable indicates that the respondents like being part of the team, and were happy to be a team member. A low score would indicate dissatisfaction on the part of team members. This measure was completed by team members and the supervisor of each participating teams.

Team viability. Another aspect of group effectiveness identified by Hackman (1987) was measured by three items designed to assess the future viability of the team. A high score on this variable indicates that the team would be effective in working together in the future. A low score indicates that the future viability of the team is dim. This measure was taken from team members and the supervisor of each participating team.

The above listed three measures of team effectiveness were completed by team members and their respective supervisor, while team performance and team viability measures were completed by senior managers.

Control Variables

Since prior research has identified relationships between other factors and team effectiveness, those factors were controlled in this study. Those control variables consist of the demographics in gender, age, education, professional tenure, tenure with the group, and tenure with the organization as described in Chapter II.

The final questionnaire instrument depicted in Appendix B.1 consists of three sections: (1) three antecedent factors (25 items) and group stewardship (3 items), which are group members' ratings of perceptions about their group tasks, group relationships and organizational resources; (2) group learning and knowledge conversion (35 items), which are group members' rating of perceptions about their group learning and knowledge conversion processes; (3) group

outcomes (10 items), which are group members rating of perceptions about their group effectiveness.

In Appendix B.2, the questionnaire instrument for group managers/supervisors, consists of three sections: (1) three antecedent factors (25 items) and group stewardship (3 items), which are group managers' ratings of perceptions about their group tasks, group relationships and organizational resources; (2) group learning and knowledge conversion (35 items), which are group managers rating of perceptions about their group learning and knowledge conversion processes; (3) group outcomes (10 items).

Appendix B.3 lists the questionnaire instrument on which senior managers (vice president) rate their suburbanite group performance. The questionnaire consists of a 7-item scale for rating each group performance and group viability.

INSTRUMENT PUBLISHED RELIABILITY

All the variables (Table 4) used in this study were tested from previous research and have reliabilities (using coefficient alphas) greater than 0.7 (Nunnally, 1978) which indicate acceptable reliability.

Table 4 - Instrument Source and Published Reliabilities

Construct	Operational Definition	Source	Reliability Published	No. of Items
Clear Purpose	The degree to which the work group has a well-defined mission/purpose that is understood by group members.	(Groesbeck, 2001; Wilson, van Aken & Frazier, 1998)	0.81	4
Task Inter-dependence	The degree to which the work group members completing tasks requires the interaction.	(Bailey et al., 1998; Groesbeck, 2001)	0.80	3
Feedback	The group receives feedback that helps them evaluate group performance.	Groesbeck, 2001; London, Larsen & Thisted, 1999)	0.82	4

Affect-based trust	A willingness to take interpersonal risk due to emotionally-based relationships.	(Groesbeck, 2001; McAllister, 1995)	0.89	5
Group Stewardship	A collectively held sense of responsibility to act as co-owners or partners in the best interest of the organization.	(Groesbeck, 2001)	0.78	3
Quality of Information Technology	The quality of organizational IT infrastructure.	(Mohrman et al., 2003)	0.83	5
Invest in Employees	The organization takes a long-term view in developing employee skills and providing opportunities.	(Groesbeck, 2001; Tsui et al., 1997)	0.70	4
Group Learning	An ongoing process of reflection and action leading to the creation of new knowledge. Collaboration, Interpretation Explicit, Experimentation, Interpretation Tacit	(Groesbeck, 2001)	 0.87 0.85 0.79 0.85	 3 3 4 3
Knowledge Conversion	A process of knowledge conversion between tacit and explicit knowledge. Socialization, Externalization, Combination, Internalization	(Huang & Wang, 2002)	 0.82 0.87 0.84 0.70	 6 6 6 4
Team Performance	The extent to which a group meets or exceeds its goals in a timely fashion.	(Groesbeck, 2001; Kirkman & Rosen, 1999)	0.89	4
Satisfaction with team	The extent to which individual member is happy being with his/her group.	(Campbell & Hallam, 1994)	0.89	3
Team Viability	The extent to which group members believe their group will do well in the future.	(Hackman, 1987; Lewis, 1999)	0.96	3

In summary, this section has presented detailed descriptions of the constructs of measuring variables in this study and their acceptable reliability and validity.

SURVEY ADMINSTRATION

The final survey instrument is a self-administered survey. After the surveys were administered, several steps were taken to prepare the data for hypothesis testing. Data from the surveys was entered manually into a spreadsheet. Preparatory and exploratory data analysis was performed to assure the data were entered correctly. Then factor analysis was conducted to assure the reliability and validity of the constructs as described in the following sections. After these tests were completed, the testing of the research hypotheses was performed.

Data Collection and Analysis

Survey procedure

The survey was administered and completed within seven ladder operations. Each ladder operation was administered to a minimum of 10 workgroups or maximum of 12 workgroups. The survey was designed with a key embedded into the instrument in order to identify each group from the sample data. The reason for this is that this survey was anonymous and administered to individual members and supervisors in the participating workgroups and the unit of analysis in this study is the group, so a group identification mechanic was necessary in order to sort the sample data accurately into teams. Each of the surveys was coded with a two-digit number embedded in the first page of survey letter (e.g., 01, 02, ...12 as depicted in Appendix A).

Survey type. The survey consists of three types of questionnaire. One was designed for workgroup members as depicted in Appendix B.1, one for workgroup supervisors as depicted in Appendix B.2, and one for senior managers as depicted in appendix B.3. All surveys were packed in a plain A4 size envelope before being delivered to the survey sites.

Survey delivery. The survey was hand delivered to each group member and supervisor in the participating workgroups by the researcher or assigned site coordinators. For senior managers, the researcher visited the senior managers respectively and hand delivered to each of them with group number/name marked group performance survey.

Duration of survey. The survey was pre-tested and could be completed within twenty to thirty-five minutes in normal circumstances. Participants had ample time to complete the survey. Participants received the survey in the morning and were asked to return the instrument to a designated mailbox as soon as they were completed, but no later then 5:00 PM on the same day. The designated boxes were placed at each floor's workgroup mailroom that was adjacent to their workplaces. The same day as the survey was administered, the researcher or assigned site coordinators retrieved the survey box and reviewed the response sheet to assure the group number was recorded properly. The completed questionnaires were collected by the researcher or assigned site coordinators and delivered to a central site for evaluation.

Number of survey respondents

There are many different guidelines concerning the number of survey respondents required to obtain factor analysis results that will be stable and that can be replicated. The most commonly cited guideline is five to ten subjects per item up to about three hundred subjects (Tinseley & Tinseley, 1987). DeVillis (1991) suggests 100 subjects would be too few for a twenty-item factor analysis, but 400 for a ninety-item factor analysis might be adequate (Groesbeck, 2001). The number of subjects required tends to increase when the number of factors increased, or lower correlation among variables, or fewer items per scale (Pedhazur & Schmelkin, 1991). Many of the scales being utilized had been previously tested and were believed to have relatively high within-scale correlation. The largest number of items tested

together during scale validation was 22. Given these requirements, rules of thumb suggest three to four hundred responses should be adequate for either exploratory or confirmatory factor analysis. This required a total sample size of 600 responses roughly. A total of 783 surveys including members and supervisors were administered in this study excluding the surveys for four senior managers that were conducted separately. However, a total of 641 survey responses were received, and no senior managers' responses were received.

Number of workgroups

The number of teams required for multiple regression analysis depends upon the number of independent variables in the equation, the expected effect size (the degree of correlation among variables), the type I error specified, the statistical power desired, and the degree of generalizability required (Hair, Anderson, Tatham, & Black, 1998). To maintain acceptable generalizability of results, the numbers of observations per independent variable should never fall below a five-to-one ratio; a ratio of 15:1 or more would be desirable (Hair et al., 1998).

An adequate number of workgroups was obtained: 73 workgroups with five or more responses and data from at least one-half of the group members. Given that no more than four independent variables were included in any structural equation modeling (SEM) hypotheses analysis, the ratio of observations to independent variables was greater than 18:1 in this study.

Response rate

The sample size consists of 641 individuals, which includes 568 members and 73 supervisors from 73 workgroups. A total of 75 workgroups and 783 workgroup members and supervisors were administered (excluding senior managers) listed in Table 5 (for details, see Table 35 in Appendix C.1).

Table 5 - Total Team Size and Respondents

Type	Total Number of workgroups	Total Members	# Workgroup Responded	# Respondents	% Response Rate
Total	75	783	73	641	81.8

Missing Data

The data from six respondents were dropped in this study. If a survey was missing any responses in the constructs related to group learning and knowledge conversion processes, the survey was dropped. For these sets of constructs, a missing data point might have been estimated by using the mean of other scale responses. However, this would tend to reduce within-scale variance and thereby influence factor analysis or aggregation decisions. Therefore, the conservative approach of dropping the surveys with missing responses was taken for these constructs central to this research. For other constructs, if only one response was missing, the construct mean was used to replace the missing data point. As the author expected there were responses with missing data points because the scales were coded only the extreme response levels of one to six. A total of six responses were missing data either in group learning or knowledge conversion, or both. Those six survey data were dropped completely from this study.

Outliers

After the questionnaires were returned, all data were initially grouped and gathered into a master Excel spreadsheet from the collected survey set. A voluntary research assistant keyed in the data of team members, and supervisors into a spreadsheet and kept the log of issues. Checks for out-of-range responses were conducted by utilizing Excel's MAX and MIN functions to check the minimum and maximum scores for each question. The author had reviewed the

accuracy of procedures and also checked ten percent of the data in each file for this purpose. Then survey questions were grouped according to the constructs. The scores for any reverse coded items were reversed (i.e., 6=1, 5=2, and 4=3).

During the confirmatory factor analysis (CFA) stage of analysis, AMOS's outlier diagnostics capabilities were also used to determine the Mahalanobis' distance for each observation while assessing the constructs. Observations with distances much higher than normal with p-values less than 0.001 were examined. If a reason for the outlier behavior was found the survey was dropped from the data set. The primary justification for dropping outliners was that the respondent was primarily using extreme responses (one or six) and gave inconsistent responses on the reverse coded questions within the survey. AMOS was also used to assure the multivariate normality of responses for items subjected to CFA.

Respondents Demographics

The population under study in each of workgroups was the members of workgroups in the organization. The workgroups have been formed at least more than six months within the organization. After dropping the unqualified survey of missing critical data, the resultant data for the respondents to the survey represents all workgroups were used for further analysis. Table 6 lists the statistics of demographics.

Table 6 - Statistics of Demographics

Statistics

		gender	age	education	tenure with profession	tenure with firm	tenure with group
N	Valid	635	635	635	635	635	635
	Missing	0	0	0	0	0	0
Mean		1.10	2.46	3.15	2.56	2.11	2.21

The demographics of the sample indicate majority of the respondents were male (90.2%, n=635, Table 7). The majority of respondents were at least with Bachelor degree (87.1%, n=635, Table 8). Additionally, 89.9% of the respondents are less then 44 years old, 75.7% with the company more than three years, and 84.3% of the respondents were with their current teams more than one year. The demographics indicate that the sample represents a typical high-tech engineering organization with tendency of highly educated and male dominated work forces in North Alabama.

The demographics of qualified respondents by gender, education level, age, tenure with the current profession, tenure with organization, and tenure with workgroup is reflected in Table 7 to 12 respectively.

Respondents by gender. The scales are 1 for male and 2 for female.

Table 7 - Respondents by Gender

GENDER

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	573	90.2	90.2	90.2
	2	62	9.8	9.8	100.0
	Total	635	100.0	100.0	

Respondents by education level. The scales are 1 for high school, 2 for associate degree, 3 for bachelor degree, 4 for master degree, and 5 for doctorate degree.

Table 8 - Respondents by Education Level

DEGREE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	4	.6	.6	.6
	2	78	12.3	12.3	12.9
	3	376	59.2	59.2	72.1
	4	170	26.8	26.8	98.9
	5	7	1.1	1.1	100.0
	Total	635	100.0	100.0	

Respondents by age. The scales are 1 for 20-26 years, 2 for 27-34 years, 3 for 35-44 years, 4 for 45-55 years, and 5 for 56 years up.

Table 9 - Respondents by Age

AGE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	71	11.2	11.2	11.2
	2	274	43.1	43.1	54.3
	3	226	35.6	35.6	89.9
	4	56	8.8	8.8	98.7
	5	8	1.3	1.3	100.0
	Total	635	100.0	100.0	

Respondents by tenure of current profession. The scales are 1 for 0-3 years, 2 for 4-8 years, 3 for 9-13 years, 4 for 14-17 years, and 5 for 18 years up.

Table 10 - Respondents by Tenure of Current Profession

PROFESSI

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	109	17.2	17.2	17.2
	2	216	34.0	34.0	51.2
	3	192	30.2	30.2	81.4
	4	80	12.6	12.6	94.0
	5	38	6.0	6.0	100.0
	Total	635	100.0	100.0	

Respondents by organization tenure. The scales are 1 for 0-3 years, 2 for 4-8 years, 3 for 9-13 years, 4 for 14-17 years, and 5 for 18 years up.

Table 11 - Respondents by Organization Tenure

WITH_CO

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	154	24.3	24.3	24.3
	2	297	46.8	46.8	71.0
	3	151	23.8	23.8	94.8
	4	23	3.6	3.6	98.4
	5	10	1.6	1.6	100.0
	Total	635	100.0	100.0	

Respondents by group tenure. The scales are 1 for 0-1 year, 2 for 2-3 years, 3 for 4-6 years, 4 for 7-9 years, and 5 for 10 years up.

Table 12 - Respondents by Group Tenure

WITH_GRO

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	100	15.7	15.7	15.7
	2	335	52.8	52.8	68.5
	3	173	27.2	27.2	95.7
	4	21	3.3	3.3	99.1
	5	6	.9	.9	100.0
	Total	635	100.0	100.0	

ANALYSIS OF MEASURE

After the data was initially prepared and exploratory data analysis was conducted, the data was exported into SPSS for further assessment. SPSS is chosen because of the variety of statistical techniques that it supports. Initially, descriptive statistics were used to report on the demographic information. However, the author then further conducted the four-step procedures as described below for the data analysis.

First, exploratory factor analysis was used to assure scale items loaded to a common factor. Although most scales of the instrument were from prior research, the research in the areas of group stewardship, group learning and knowledge conversion are still in infancy. Thus, to conduct exploratory factor analysis for these constructs in this study is believed to be necessary. Second, internal reliabilities of scale were assessed using the coefficient alpha, generally referred to as Cronbach's alpha (Cronbach, 1951). Third, to assure constructs are distinct, exploratory factor analysis with orthogonal rotation was conducted using scale items from related constructs. The correlations among constructs emerging from factor analysis were reviewed. The emerging constructs were subjected to confirmatory factor analysis (CFA) to determine the reliability of the scale items for each construct and validity of the constructs prior to the hypotheses analysis.

Lastly, a baseline model was used in identifying the model in SEM terminology and refers to a model incorporating the reliable scales and their respective items measuring each construct in the model determined by the CFA, plus the significant paths hypothesized between the constructs. Further SEM techniques used to test the hypotheses are described in the next chapter.

Validity

Validity refers to the extent to which differences found in a measurement reflects true differences among respondents being tested (Cooper & Schindler, 1998; Hair, Anderson, Tatham & Black, 1998). In other words, in assessing validity, the researcher is concerned with determining the extent to which it measures what it is supposed to measure (Zikmund, 1997). There are several types of validity to be considered: face/content validity (i.e., the agreement among professionals that the scale is measuring what it suppose to be measuring), criterion validity (i.e., the degree of correspondence between a measure and a criterion variable, usually measured by their correlation) and construct validity (i.e., the ability of a measure to confirm a network of related hypotheses generated from a theory based on the constructs) (Bollen, 1989, p. 184-189; Zikmund, 1997).

Schwab (1980) defines construct validity as representing the correlation coefficient between the construct and the measure. It identifies the underlying constructs being measured and determines how well the test represents them. Further, construct validity is addressed by analyzing both convergent validity (i.e., the items and constructs that are suppose to be correlated with one another are) and discriminant validity (i.e., the items and constructs that are not suppose to be correlated with one another aren't). Campbell and Fiske (1959) indicate that correlations of different measures of the same trait (i.e., construct) be statistically significant and

sufficiently large, while discriminate validity would be applied as the differences between measures being statistically significantly and sufficiently large. A significant correlation at the .05 level would represent a scale with convergent validity (i.e., the items and constructs that are supposed to be correlated with each other, are). CFA provides a statistical tool, to evaluate both convergent and discriminate validity.

Factor Analysis

Factor analysis was performed on the measure using SPSS for Windows. Principal components analysis was used for the extraction method using the VARIMAX method for rotation. An iterative approach was used to conduct factor analysis. An eigenvalue of 1.0 is a cutoff point – any factor should account for at least the variance of a single variable. If not, and its eigenvalue is less than 1.0, then it is dropped. Items that did not make the loading cutoff and/or items that loaded on more than one factor were dropped from the analysis. The remaining items were than resubmitted into another round of factor analysis. This process continued until it obtained a meaningful factor structure.

The results are reported here for the factor analysis that investigated whether multiple variables measured the same concept. Hair et al. (1998) argued that loadings greater than 0.50 are considered very significant.

Antecedents factors analysis

The antecedent factor analyses include task factor, group factor, and organizational factor. The antecedents' factor analyses were depicted as below.

Task factor scale. This task antecedent consists of seven items from Groesbeck (2001). The scale asks the member and supervisor to assess perceptions and opinions regarding clear purpose (CP1 to CP4) and task interdependence (TI1 to TI3) residing within the group.

Group factor scale. This group antecedent consists of nine items from Groesbeck (2001). The scale asks the member and supervisor to assess perceptions and opinions regarding knowledge of feedback on group performance (FB1 to FB4) and affective trust (TR1 to TR5) residing within the group.

Organization factor scale. The organizational antecedents consist of nine items from Groesbeck (2001) and Mohrman et al. (2003). The scale asks the member and supervisor to assess perceptions and opinions regarding quality of information technology infrastructure (IT1 to IT5) and employee empowerment (EM1 to EM4) within the organization.

Group stewardship factor scale. The group stewardship variable consists of three items from Groesbeck (2001). The scale asks the member and supervisor to assess perceptions and opinions regarding stewardship residing within the group.

The 25 team input items from the seven antecedent variables including three items from group stewardship loaded on seven factors respectively and all loaded with appropriate loading coefficient (>.50) as displayed on Table 13.

Table 13 – Factor Analysis of Antecedent Variables

Rotated Component Matrix[a]

	Component						
	1	2	3	4	5	6	7
CP1	8.547E-03	.133	.166	.228	.778	.168	.151
CP2	.210	.186	.296	.111	.750	.126	5.724E-02
CP3	.168	.350	.351	3.608E-02	.633	5.450E-02	8.256E-02
CP4	.161	9.459E-02	.225	.327	.753	9.545E-02	.123
TI1	.390	.114	-.162	-9.51E-02	6.806E-02	.790	-.107
TI2	.203	3.271E-02	-6.06E-02	.145	.418	.707	.130
TI3	1.726E-02	-5.81E-02	.217	.168	5.815E-02	.851	.155
TR1	.694	.140	.196	.109	.306	.144	.118
TR2	.779	3.584E-02	.165	.281	4.735E-02	.109	.110
TR3	.697	.285	6.299E-02	.182	8.192E-03	4.600E-02	-2.39E-03
TR4	.735	.249	1.543E-02	.266	.131	9.442E-02	8.118E-02
TR5	.636	4.839E-02	.215	.145	.133	.390	6.326E-02
FB1	.327	.217	.653	6.744E-02	.285	.197	.116
FB2	.300	.313	.725	6.175E-02	.188	-4.46E-02	.210
FB3	-4.50E-02	.112	.755	.283	.277	5.328E-02	6.070E-02
FB4	9.947E-02	2.913E-02	.851	.177	.201	-1.20E-02	.102
GS1	.247	.162	.142	.180	.134	.188	.775
GS2	-.115	.107	6.714E-02	1.552E-02	.131	-6.86E-02	.837
GS3	.201	5.809E-02	.155	.160	5.458E-02	.103	.837
EM1	.287	.154	.116	.827	.250	.108	.132
EM2	.287	9.847E-02	.110	.815	.192	.123	.138
EM3	.323	.122	.248	.784	.210	.125	7.647E-02
EM4	.132	.173	.477	.582	6.898E-02	-.121	.119
IT1	.331	.768	.117	.101	.153	1.597E-02	.164
IT2	.431	.687	5.343E-02	.133	.162	-.176	.205
IT3	.145	.776	.186	3.495E-02	.313	-4.74E-02	6.859E-02
IT4	.195	.815	.132	3.936E-02	4.930E-02	1.516E-02	1.864E-02
IT5	-.183	.718	7.918E-02	.261	4.979E-02	.270	4.872E-02

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 8 iterations.

Process factors analysis

Group learning scale. The scale of Group Learning (GL) consists of ten items from Groesbeck (2001). The scale asks the members and supervisors to assess perceptions and opinions regarding collaboration (CO1 to CO3), interpretation of explicit information (IG1 to

IG3), experimentation (EX1 to EX4), and interpretation of tacit information (SY1 to SY3) residing within the group. The ten items on this scale did not load on a single factor, or on four factors. Rather, they loaded on three factors as expected. The fourth scale variable (interpretation of tacit information) was from the second scale variable (interpretation of explicit information) with minor word changes. For example, the item SY1 from fourth scale reads, "I often think about how my work fits into the "bigger picture" at our organization", and item IG1 from the second scale reads, "We often think about how our work fits into the "bigger picture" at our organization". The results for the constructs are summarized in Table 14.

Table 14 – Group Learning Factor Analysis

Rotated Component Matrix [a]

	Component		
	1	2	3
CO1	.223	.337	.804
CO2	.194	.135	.870
CO3	7.770E-02	.243	.826
IG1	.873	4.847E-02	1.852E-02
IG2	.872	2.840E-02	.205
IG3	.844	.182	.149
EX1	5.361E-02	.821	.221
EX2	.110	.766	.277
EX3	.149	.821	9.671E-02
EX4	3.421E-02	.827	.136
SY1	.872	4.760E-02	2.693E-02
SY2	.868	2.825E-02	.204
SY3	.834	.194	.153

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

Knowledge conversion scale. The scale of Knowledge Conversion (KC) consists of 22 items from Huang and Wang (2002). The scale asks the member and supervisor to access

perceptions and opinions regarding knowledge socialization (S1 to S6), externalization (E1 to E6), combination (C1 to C6), and internalization (I1 to I4) residing within the group. The ten items on this scale did not load on a single factor; rather, they loaded on all five factors. One item (S2) loaded with two factors and one (0.447) is less than significant (Hair et al., 1998), so it was dropped from further analysis. Resubmitting the 21 items, they loaded on all four factors. The results are summarized in Table 15 and 16 for Analysis I and II respectively.

Table 15 – Knowledge Conversion Factor Analysis –I

Rotated Component Matrix [a]

	Component				
	1	2	3	4	5
S1	.237	.143	.193	.770	7.069E-02
S2	-4.82E-02	6.708E-02	.244	.435	.650
S3	.139	.244	.268	.580	.433
S4	.209	.191	4.469E-02	.799	6.644E-02
S5	2.789E-03	.269	.224	.740	.150
S6	.237	.186	.177	.517	.467
E1	.667	.141	.204	.302	.232
E2	.729	.129	2.350E-02	6.403E-02	.370
E3	.800	2.100E-02	-4.54E-02	-4.52E-02	3.976E-02
E4	.757	-7.94E-02	.220	.136	-.137
E5	.808	2.918E-02	-6.89E-02	.225	-.257
E6	.676	.197	.241	.162	.209
C1	.189	.659	.129	8.828E-02	.480
C2	.154	.593	3.723E-02	.144	.415
C3	.128	.697	2.059E-02	.371	-7.04E-02
C4	-.128	.857	.106	9.865E-02	-4.60E-03
C5	-3.54E-03	.774	.238	.114	.193
C6	.215	.770	.277	.258	-7.18E-02
I1	4.208E-03	8.374E-02	.830	.159	.131
I2	9.689E-02	.128	.891	1.050E-02	.166
I3	.219	.140	.695	.236	-5.22E-02
I4	6.217E-02	.240	.805	.213	.107

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 7 iterations.

Table 16 – Knowledge Conversion Factor Analysis –II

Rotated Component Matrix [a]

	Component			
	1	2	3	4
S1	.141	.229	.752	.177
S3	.299	.125	.676	.286
S4	.177	.189	.805	2.777E-02
S5	.283	-1.14E-04	.724	.212
S6	.236	.209	.663	.202
E1	.171	.653	.375	.215
E2	.197	.731	.154	4.957E-02
E3	4.701E-02	.812	-5.22E-02	-4.13E-02
E4	-9.07E-02	.763	8.954E-02	.206
E5	-1.61E-02	.798	.177	-9.25E-02
E6	.227	.666	.228	.252
C1	.735	.188	.181	.157
C2	.656	.149	.228	6.038E-02
C3	.665	.112	.335	-2.56E-03
C4	.842	-.136	6.914E-02	9.156E-02
C5	.785	-2.24E-02	.164	.241
C6	.745	.206	.211	.254
I1	.103	3.591E-03	.179	.832
I2	.152	9.262E-02	5.691E-02	.900
I3	.122	.210	.226	.682
I4	.244	4.957E-02	.245	.803

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

Outcome factors analysis

Group effectiveness scale. The three scales measuring the dependent outcome variables consist of ten items including from Groesbeck (2001) and Kirkman and Rosen (1999) for group performance (GP1 to GP4); Campbell and Hallam (1994) for satisfaction with team (TS1 to TS3); Hackman (1987) and Lewis (1999) for team viability (GV1 to GV3). The three scales ask the member and supervisor to assess perceptions and opinions regarding group performance, team satisfaction, and team viability residing within the group respectively. The ten items on

three scales did not load on a single factor; rather, they loaded on three factors. The results are summarized in Table 17.

Table 17 – Group Effectiveness Factor Analysis

Rotated Component Matrix [a]

	Component		
	1	2	3
GP1	7.627E-02	.823	.315
GP2	-9.96E-02	.741	.405
GP3	.500	.706	6.836E-02
GP4	.412	.743	-1.92E-02
TS1	.186	.239	.795
TS2	.334	.183	.789
TS3	.430	.129	.676
GV1	.878	.159	.302
GV2	.882	.116	.254
GV3	.808	.214	.340

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 9 iterations.

Reliability of the Instrument

Reliability deals with error free measurement. It can be said that reliability is high if the measurement gives the same result every time the same property is measured in the same way (Reaves, 1992). Babbie (1998) also points out that reliability will yield the same results over time when they are applied in the same context. There are several procedures used to test the reliability of measurement (test-retest, parallel forms, and internal consistency).

One of the most widely used approaches is to test the internal consistency of the measurement (Churchill, 1979; Schwab, 1980). It measures the degree to which measurement items reflect the same underlying constructs. It assesses the consistency or homogeneity among

items (Cooper & Schindler, 1998). To measure the reliability of constructs used in this study, the internal consistency method was employed. An internal consistency method measures consistency and homogeneity among items that comprise the measurement. One such technique is Cronbach's coefficient alpha, which is commonly used in social science research. An alpha value of more than 0.7 is desirable (Nunnally, 1978). The alpha values in this study varied from .8048 (Task interdependence) to .9346 (Team viability). As a result of the factor analysis, most of the variables used in this study have been unchanged, except the item S2 from socialization of knowledge conversion was dropped due to below 0.5 loading (Hair et al., 1998).

All variables in this study have reliability indices greater than 0.80, indicating acceptable reliabilities. The test results reflect sufficient consistency for further data analyses. Table 18 lists the results.

Table 18 - Cronbach's Alpha Reliability Analysis

Variables	**Number of Items**	**Number of respondents (N)**	**Reliability**
Clear Purpose	4	635	0.8697
Task Interdependence	3	635	0.8048
Affect-based trust	5	635	0.8616
Feedback	4	635	0.8676
Group Stewardship	3	635	0.8230
Invest in Employees	4	635	0.8976
Quality of Information Technology	5	635	0.8732
Group Learning (GL)			
- Collaboration	3	635	0.8622
- Interpretation of explicit information	3	635	0.8517
- Experimentation	4	635	0.8551
- Interpretation of tacit information	3	635	0.8467

Knowledge Conversion (KC)			
- Socialization	5	635	0.8536
- Externalization	6	635	0.8538
- Combination	6	635	0.8720
- Internalization	4	635	0.8699
Team Effectiveness (TE)			
- Team Performance	4	635	0.8239
- Satisfaction with team	3	635	0.8180
- Team viability	3	635	0.9346

Confirmatory Factor Analysis

Confirmatory factor analyses (CFAs) examined the structure of the scales. CFAs are most appropriate, as all the scales have been previously used and validated in organizational learning and knowledge creation research, but it is important to ensure that the scale factors are present as predicted. CFA provides the statistical analysis necessary to determine the reliabilities of each scale item in the measurement of each scale representing the constructs in the theoretical model. Bollen (1989, p. 228) states that CFA is a better method of analysis than exploratory factor analysis (i.e., principal component factor analysis) in situations where hypothesis about plausible models exist, as in the case of this study.

Additionally, the CFA procedure can identify potential problems with multicollinearity between items within each scale and it can identify scale items that cross-load on other constructs in the model (i.e., convergent and discriminant validity). CFAs were also carried out as a further check on the convergent and discriminant validity of the multiple-item scales for team inputs (independent variables), group learning and knowledge conversion (mediated variables), and team effectiveness (dependent variables).

The two CFA measurements employed for the analysis are the factor loadings and the squared multiple correlations. The factor loadings represent the direct effects of the scale items on the measurement of the construct (Bollen, 1989, p.230). The factor loadings are recommended to be above .50 to be acceptable in the CFA procedure (Hair et al., 1998). The

squared multiple correlation is the measure of each item in the scale when it is regressed on the remaining items in the same scale. It is a measure of the degree of collinearity of the scale item with the other items in the same scale and is considered a measure of reliability for each scale item (Bollen, 1989, p. 288).

The objective of the CFA procedure in the data analysis is to refine the scale items and the scales measuring the constructs so that they are represented in the SEM to be utilized by reliable and valid measurements. One important consideration is that each construct in the SEM should be represented by at least two scale items or composite indices, however, three or more items were preferred (Bollen, 1989).

To conduct the CFA tests the author applied AMOS 4.0 (Joreskog, 1993; Joreskog & Sorbom, 1996) and its outlier diagnostic capability to check the observed data set was used to determine the Mahalanobis' distance for each observation while assessing the constructs before the CFA processes. There was no outlier behavior detected during the diagnostic testing.

There are a number of goodness-of-fit indices that could be utilized, but this study concentrated on four most commonly used measurement indices: the chi-square significance (χ^2), the goodness-of-fit index (GFI), the Tucker-Lewis Index (TLI), the Comparative Fit Index (CFI) and the root mean square error of approximation (RMSEA). These measures are described below.

- Chi-Square (χ^2): A χ^2 is a test statistic for the null hypothesis that the covariance matrix implied by the specified model exactly equals the population covariance matrix of the observed variables. A significant test statistic relative to the degrees of freedom indicates that the observed and estimated matrices differ, and therefore, the model may not be specified correctly. A non-significant χ^2 indicates that the data fit

the model but that an uncertainty will always persist because other models are possible that may fit the data (Bollen & Long, 1993; Schumacker & Lomax, 1996). However, χ^2 is sensitive to sample size. χ^2 is likely to indicate a more significant probability level as sample size increases, and is likely to indicate a less significant probability level as sample size decreases (Schumacker & Lomax, 1996). Joreskog (1969) noted that in large samples even trivial deviations of a model from the actual structure could be detected and could lead to a rejection of the null hypothesis. An alternative measure of overall model fit recommended by Wheaton, Muthen, Alwin, and Summers (1977) is that of Chi-Square divided by the degree of freedom, with the recommended criterion for the ratio varying from 2, 3, or as high as to 5.

- RMSEA: The Root Mean Square Error of Approximation (RMSEA) assesses the degree of lack of fit of the model. The measure of the error of approximation (RMSEA) measures the discrepancy per degree of freedom for the model, making it sensitive to the number of estimated parameters in the model. A value of 0.05 or less would indicate a good fit of the model in relation to its degree of freedom. A value of about 0.08 or less would indicate a reasonable error of approximation with a closed fit of the model, and a value of 0.1 would indicate a poor fit of the model (Brown & Cudeck, 1993).
- GFI: Goodness of fit (GFI) and adjusted GFI estimate the extent to which the sample variances and covariances are reproduced by the hypothesized model. The GFI is based on a ratio of the sum of the squared differences between the observed and reproduced matrices to the observed variances, thus allowing for scale. Values close to 0.9 reflect a good fit of model (Schumacker & Lomax, 1996).

- PGFI: Parsimony Goodness of fit Index (PGFI) is a way of simultaneously assessing the goodness of fit of the model (measured by GFI) and the parsimony of the model (GFI adjusted by the percentage of parameters freed up to estimate the model) (Mulaik, James, van Alstine, Bennett, Lind, & Stilwell, 1989). According to Mulaik et al. (1989), when GFI indices are about .90, PGFI indices in the range of .50 are not unexpected.
- TLI: Tucker-Lewis index (TLI) is nonnormed fit index that compare a chi-square for the model tested to one from baseline null model. A value of 0.9 is acceptable and 0.95 indicates a good fit to the data (Hu & Bentler, 1999).
- CFI: Comparative fit index (CFI) measures the improvement in noncentrality in going from the least restrictive model to the proposed model. A value of 0.9 indicates a good fit to the data (Schumacker & Lomax, 1996).

Analysis of antecedent factors

The antecedent scales included group stewardship and six other related constructs: clear purpose, task interdependence, affective trust, feedback, invest in employee, and quality of information technology. All of these constructs are from Groesbeck's (2001) work, except the scale Quality of Information Technology, which is from Mohrman et al. (2003).

Group stewardship scale. This scale consists of three items that ask the member and supervisor to assess perceptions and opinions regarding stewardship (GS1 to GS3) residing within the group.

Task factor scale. The construct consists of two sub scales and seven items totally. First scale asks the member and supervisor to assess perceptions and opinions regarding clear

purpose (CP1 to CP4), and the other scale asks for task interdependence (TI1 to TI3) residing within the group.

Group factor scale. This construct consists of two sub scales and nine items. One scale ask the member and supervisor to assess perceptions and opinions regarding knowledge of feedback on group performance (FB1 to FB4), and the other scale asks for affective trust (TR1 to TR5) residing within the group.

Organization factor scales. This construct consists of two sub scales and nine items in total. One scale asks the member and supervisor to assess perceptions and opinions regarding quality of information technology infrastructure (IT1 to IT5), and the other scale asks for employee empowerment (EM1 to EM4) within the organization.

Table 19 lists the results from the confirmatory factor analysis. The results suggest that group stewardship, clear purpose, task interdependence, affective trust, group feedback, invest in employee, and quality of information technology latent variables are seven distinct, but correlated, constructs. The smallest loading of IT5 on quality of information technology factor was .531 that still exceeds the acceptable level (0.50).

Table 19 - Model Statistics of Antecedent Variables

Independent variable Sample size Model	χ^2 (df) P	RMSEA	GFI/ PGFI	TLI	CFI
Team Inputs (635) Seven factors (GS, CP, TI, TR, FB, EM, and IT)	198.54 (64) 0.000	0.053	0.976/ 0.501	0.979	0.990

While the χ^2 statistic is significant, indicating that the model may not be specified correctly, the value of χ^2 statistic divided by degrees of freedom and other goodness-of-fit statistics suggest that the model is a good fit to the data (χ^2/df=3.09; RMSEA<0.08; GFI, TLI &

CFI >0.90). However, in path analysis the seven-factor solution for team inputs (antecedents) shows that the seven latent variables are distinct, but correlated, constructs (see Figure 5 in Appendix C.2). Table 20 presents statistics for the seven constructs. The scale reliability of the measures included in the model range from 0.78 to 0.91, and exceeds Bagozzi and Yi's (1988) minimum value of 0.60. This supports the reliability of the measures integrated in the hypothesized model. Further, convergent validity is supported because all loadings are highly statistically significant ($p < 0.01$) and the average variance extracted estimates exceed the recommended value 0.50 (Hildebrandt, 1987).

Table 20 - Scale Statistics for Antecedent Variable Constructs

Construct	Item	Standardized Loading *	Scale Reliability	Variance Extracted Estimate
Group Stewardship	GS1	0.894	0.831	0.624
	GS2	0.690		
	GS3	0.773		
Clear Purpose	CP1	0.781	0.874	0.634
	CP2	0.831		
	CP3	0.736		
	CP4	0.833		
Task Interdependence	TI1	0.707	0.779	0.572
	TI2	0.858		
	TI3	0.692		
Affective Trust	TR1	0.779	0.863	0.559
	TR2	0.768		
	TR3	0.672		
	TR4	0.793		
	TR5	0.721		
Feedback	FB1	0.779	0.873	0.623
	FB2	0.819		
	FB3	0.767		
	FB4	0.814		
Invest in Employee	EM1	0.936	0.909	0.718
	EM2	0.904		
	EM3	0.901		
	EM4	0.607		

Quality of Information Technology	IT1 IT2 IT3 IT4 IT5	0.867 0.840 0.797 0.765 0.531	0.876	0.592
* <.01			Good >.70 Min >.60	Good>.50

Moreover, the path analysis was applied with AMOS 4.0 and its result and model diagram depicted in Figure 5 (see in Appendix C.2). The path analysis model displays the seven-factor model of antecedent variables with standardized coefficients.

Analysis of process factors

Group learning. This scale of Group Learning (GL) consists of ten items from Groesbeck (2001) included collaboration, interpretation of explicit information, interpretation of tacit information, and experimentation. The scale asks the member and supervisor to assess perceptions and opinions regarding collaboration (CO1 to CO3), interpretation of explicit information (IG1 to IG3), experimentation (EX1 to EX4), and interpretation of tacit information (SY1 to SY3) residing within the group. Table 21 lists the results from the confirmatory factor analysis. The result shows the ten items loaded strongly with four factors, loading between .737 and .899, but the correlation coefficient between IG and SY constructs suggests that these two latent variables were not distinct. The result was as expected and consistent with the result of prior research (Groesbeck, 2001).

Table 21 - Model Statistics of Group Learning Variables

Dependent variable Sample size Model	χ^2 (df) P	RMSEA	GFI/ PGFI	TLI	CFI

Group Learning (635) Four factors (CO, IG, SY, EX)	182.88 (48) 0.000	0.067	0.967/ 0.501	0.973	0.982

While the χ^2 statistic is significant, indicating that the model may not be specified correctly, the value of χ^2 statistic divided by degree of freedom and other goodness-of-fit statistics suggest that the model is a good fit to the data (χ^2/df=; RMSEA<0.08; GFI & CFI >0.90). However, the four-factor solution for group learning, shows that the latent variables are correlated (see Figure 6 in Appendix C.3). The author assessed discriminant validity among these four variables by conducting alternative analyses using three-factor solution. The fit of the data to the model worsened as the number of factors decreased (the fit indices GFI, PGFI, and CFI decreased, while the RMSEA and χ^2/df values increased). Table 22 presents statistics for the four constructs. The scale reliability of the measures included in the model range from 0.85 to 0.86, and exceeds Bagozzi and Yi's (1988) minimum value of 0.60. This supports the reliability of the measures integrated in the hypothesized model. Further, convergent validity is supported because all loadings are highly statistically significant ($p < 0.01$) and the average variance extracted estimates exceed the recommended value 0.50 (Hildebrandt, 1987).

Table 22 - Scale Statistics for Group Learning Constructs

Construct	**Item**	**Standardized Loading ***	**Scale Reliability**	**Variance Extracted Estimate**
Collaboration	CO1 CO2 CO3	.899 .823 .737	.862	.676
Interpretation of Explicit Information &	IG1 IG2 IG3	.816 .829 .787	.852	.657
Experimentation	EX1 EX2 EX3 EX4	.809 .782 .746 .749	.855	.596

Interpretation of Tacit Information	SY1 SY2 SY3	.817 .817 .780	.847	.648
* <.01			Good>.70 Min>.60	Good>.50

Moreover, the path analysis was applied with AMOS 4.0 and its result and model diagram depicted in Figure 6 (See in Appendix C.3). The path analysis model displays the four-factor model of group learning with standardized coefficients.

Knowledge conversion. The scale of Knowledge Conversion (KC) consists of 22 items from Huang and Wang (2002), with four dimensions: socialization, externalization, combination, and internalization. The scale asks the member and supervisor to access perceptions and opinions regarding knowledge socialization (S1, S3, to S6), externalization (E1 to E6), combination (C1 to C6), and internalization (I1 to I4) residing within the group. Table 23 lists the results from the confirmatory factor analysis. The results suggest these constructs are four distinct, but correlated, constructs that is consistent with prior research (Huang & Wang, 2002).

Table 23 – Model Statistics of Knowledge Conversion Variables

Dependent variable Sample size Model	χ^2 (df) P	RMSEA	GFI/ PGFI	TLI	CFI
Knowledge Conversion (635) Four factors (S, E, C, I)	196.05 (54) 0.000	0.064	0.978/ 0.476	0.986	0.992

While the χ^2 statistic is significant, indicating that the model may not be specified correctly, the value of χ^2 statistic divided by degree of freedom and other goodness-of-fit statistics suggest that the model is a good fit to the data (χ^2/df=; RMSEA<0.08; GFI & CFI >0.90). However, the four-factor solution for knowledge conversion shows that the latent variables are distinct, but correlated, constructs. (See Figure 7 in Appendix C.4). Table 24

presents statistics for the four constructs. The scale reliability of the measures included in the model range from 0.86 to 0.88, and exceeds Bagozzi and Yi's (1988) minimum value of 0.60. This supports the reliability of the measures integrated in the hypothesized model. Further, convergent validity is supported because all loadings are highly statistically significant ($p < 0.01$) and the average variance extracted estimates exceed the recommended value 0.50 (Hildebrandt, 1987).

Table 24 - Scale Statistics of Knowledge Conversion Constructs

Construct	Item	Standardized Loading *	Scale Reliability	Variance Extracted Estimate
Socialization	S1	.734	.859	.550
	S3	.795		
	S4	.731		
	S5	.725		
	S6	.720		
Externalization	E1	.754	.860	.506
	E2	.729		
	E3	.661		
	E4	.674		
	E5	.704		
	E6	.742		
Combination	C1	.708	.874	.539
	C2	.617		
	C3	.664		
	C4	.754		
	C5	.803		
	C6	.837		
Internalization	I1	.779	.876	.641
	I2	.888		
	I3	.655		
	I4	.861		
* <.01			Good>.70 Min>.60	Good>.50

Moreover, the path analysis was applied with AMOS 4.0 and its result and model diagram depicted in Figure 7 (see in Appendix C.4). The path analysis model displays the four-factor model of knowledge conversion with standardized coefficients.

Analysis of outcome factors

The dependent outcome variable consists of ten items from Groesbeck (2001) and Kirkman and Rosen (1999) for group performance (GP1 to GP4); Campbell and Hallam (1994) for satisfaction with team (TS1 to TS3); Hackman (1987) and Lewis (1999) for team viability (GV1 to GV3). The scale asks the member and supervisor to assess perceptions and opinions regarding group performance, team satisfaction, and team viability residing within the group. Table 25 lists the results from the confirmatory factor analysis. The result suggests that team performance, member satisfaction with team, and team viability are three distinct constructs.

Table 25 - Model Statistics of Outcome Variables

Dependent variable Sample size Model	χ^2 (df) P	RMSEA	GFI/ PGFI	TLI	CFI
Team Effectiveness (635) Three factors (GP, TS, GV)	69.287 (17) 0.000	0.070	0.979/ 0.503	0.966	0.987

While the χ^2 statistic is significant, indicating that the model may not be specified correctly, the χ^2 statistic value divided by degree of freedom and other goodness-of-fit statistics suggest that the model is a good fit to the data (χ^2/df=4.076; RMSEA<0.08; GFI, TLI & CFI >0.90). The three-factor solution for team effectiveness shows that these three latent variables were distinct, but correlated, constructs (see Figure 8 in appendix C.5). Table 26 presents statistics for the three constructs. The scale reliability of the measures included in the model

range from 0.82 to 0.94, and exceeds Bagozzi and Yi's (1988) minimum value of 0.60. This supports the reliability of the measures integrated in the hypothesized model. Further, convergent validity is supported because all loadings are highly statistically significant ($p < 0.01$) and the average variance extracted estimates exceed the recommended value 0.50 (Hildebrandt, 1987).

Table 26 - Scale Statistics for Outcome Variable Construct s

Construct	Item	Standardized Loading *	Scale Reliability	Variance Extracted Estimate
Team Performance	GP1 GP2 GP3 GP4	.739 .605 .813 .767	.823	.540
Member Satisfaction with Team	TS1 TS2 TS3	.730 .840 .759	.821	.605
Team Viability	GV1 GV2 GV3	.945 .906 .883	.937	.831
* <.01			Good>.70 Min>.60	Good>.50

Moreover, the path analysis was applied with AMOS 4.0 and its result and model diagram depicted in Figure 8 (see in Appendix C.5). The path analysis model displays the three-factor model of team effectiveness with standardized coefficients.

TEAM-LEVEL DATA AGGREGATION

Team Level of Analysis

The unit of analysis is team-level in this study, while the data were collected at individual level. To avoid committing an ecological fallacy that assumes that individual-level correlations are the same as aggregate-level correlations (Kozlowski & Klein, 2000; Rousseau, 1985), these individual-level items were aggregated to the team level and expressed as a team-level value. Although the study variables were gathered from individual team members, the focus of all of

these items was team. For example, an item of "socialization" from the Knowledge Conversion scale reads, "In team discussions, we actively share our experiences with each other;" an item of "collaboration" from Group Learning scale reads, "We ask other group members questions when we are uncertain about something;" and another example of "group stewardship" scale reads, "Our group members feel a shared sense of responsibility for our work". By focusing on the team, the wording of these items helps assure that an aggregation of individual-level responses is meaningful at the team level.

In addition, the group-level scores of each variable have theoretical, conceptual meanings. For example, the group-level aggregation of group members' collaboration reflects the extent of teamwork among team members (Groesbeck, 2001); the group-level aggregation of socialization reflects how well the team is able to share their knowledge, expertise, and create new ideas with each other to solve a problem. The meaning of each group-level construct is described in more detail in the section of Instrument Constructs.

Justification for the Aggregation

In order to justify aggregating individual member scores to the team level, one needs to show not only that the concepts are meaningful at the team level, but also that such aggregations are statistically appropriate. The statistical appropriateness for aggregating individual-level responses to the team level can be demonstrated by high within-group agreement (James, Demaree, & Wolf, 1984) or by high within-group agreement compared to between-group agreement. There is considerable debate about which method is preferred (e.g., George, 1990; Yammarino & Markham, 1992), so the author analyzed measures using two strategies, employing eta-squared to assess within-group agreement and one-way ANOVAs to assess the ratio of within-group and between-group variance. One-way ANOVA can be used to determine

how much variance in the measure is due to between-team effects compared with variance due to within-team effects. To justify aggregation, there must be significant differences across teams (a between-team effect, based on an F-statistic) (Lewis, 1999).

First, aggregation to the team level was justified by the value of the eta-squared statistic (η^2). This statistic, which is closely related to the interclass correlation coefficient, indicates the level of agreement/similarity among the responses of individuals who provided the data that were subsequently aggregated to the team level. The extent of such agreement indicates what portion of the variance in the individual responses is explained by the cluster (i.e., team or group) (Georgopoulos, 1986). These results of eta-squared (η^2) statistic exceed Georgopoulos' (1986) minimum criteria of 0.20 for aggregating individual responses to group level variables. These results are listed in Table 27.

A second statistic, the intraclass correlation coefficient (ICC), also supported aggregation to the team level of analysis. Kenny and LaVoie (1985) recommend calculating the intraclass correlation coefficient for each variable. The ICC statistic is considered to be significant if the F-test for one-way ANOVA with group as the independent variable is significant. If the ICC is significant, then the group mean of individual scores is used to test relationships between variables.

The level of significance of R, the ICC, is identical with that of the corresponding F. In other words, the hypothesis that an observed R could have come from a population with zero R can be tested by the F-ratio computed from the same mean squares, with the appropriate d.f., as were used to obtain R (Haggard, 1958, p. 19-20). All but two of the scales in this study had significant F statistics ($p<.05$), implying greater between-team differences than within-team differences, and supporting aggregation.

The F-statistic for both constructs of Clear Purpose and Quality of Information Technology were not significant at the alpha <.1 level (F=1.079 and F=1.241 respectively), implying that the between-team effects did not differ significantly from the within-team effects. However, both eta-squared values for Clear Purpose (0.451) and Quality of Information Technology (0.509) exceed the Georgopoulos' (1986) minimum criteria of 0.2, and this indicates within groups there is agreement (Georgopoulos, 1986). The results of F-tests are listed in Table 27.

Table 27 - ANOVA & eta-squared (η^2) for the Variables

Code	Variable	(η^2)	ANOVA F-statistic
CP	Clear Purpose	0.451	F(72,562)=1.079!
TI	Task Interdependency	0.344	F(72,562)=1.215*
TR	Affective Trust	0.512	F(72,562)=1.552**
FB	Feedback on Group	0.489	F(72,562)=1.639**
EM	Invest on Employee	0.543	F(72,562)=2.430**
IT	Quality of Information technology	0.509	F(72,562)=1.241!
GS	Group Stewardship	0.367	F(72,562)=1.760**
S	Socialization	0.422	F(72,562)=2.652**
E	Externalization	0.390	F(72,562)=2.343**
C	Combination	0.455	F(72,562)=1.995**
I	Internalization	0.296	F(72,562)=2.788*
CO	Collaboration	0.440	F(72,562)=2.283**
IG	Interpretation of explicit information	0.367	F(72,562)=1.246*
EX	Experimentation	0.301	F(72,562)=1.415**
SY	Interpretation of tacit information	0.423	F(72,562)=1.268*
GP	Group Performance	0.308	F(72,562)=1.244*
TS	Team satisfaction	0.387	F(72,562)=2.589**
GV	Group Viability	0.411	F(72,562)=1.661**
** p<.01, * p<.05, ! p<.10			

Aggregation to the team level was justified by both tests listed above of the values of the eta-squared (η^2) statistic and significant of the F-test for one-way ANOVA tests.

SUMMARY OF THIS CHAPTER

This chapter presented the research methodological issues and strategies pertaining to the study. It began with a review of the research, followed by the description of sample frame, sample size. Details of the development of the measurement instrument, the data collection process, test of instrument validity and reliability, and an explanation of the data analysis methods and tools used for performing the statistical analysis were also provided. The result of testing on each research hypotheses is presented in Chapter IV. Conclusions and interpretations to tie together what has been learned and what is envisioned for future research are presented in Chapter V.

CHAPTER IV
ANALYSIS AND FINDINGS

INTRODUCTION

This chapter presents the results of the statistical analysis methods described in the previous chapter. It begins with a summary of the survey results, followed by a description of various demographic classifications of the study respondents. An analysis of the hypotheses testing is then conducted. This chapter includes an interpretation of the results and the limitations of the study. A discussion of the implications of the findings appears in Chapter V.

Preliminary Structural Equation Model Analysis

The following is an analysis of the results as applied to each of the hypotheses that are the basis of this study. Each of the hypotheses is examined for statistical significance. Structural equation model (SEM) analysis was used to test the hypotheses concerning the relationships of input variable (group stewardship) and knowledge work process variables (group learning, knowledge conversion) and on team effectiveness variables (team performance, satisfaction with team, and team viability.

Test of preliminary SEM model

A preliminary baseline model construct depicted in Figure 9 has been tested (using AMOS 4.0). The result shows a standardized regression coefficient of 0.99 between knowledge conversion and group learning. The detailed results of the preliminary model path analysis are displayed in Figure 9. This preliminary baseline model appears to be not admissive. Although, the goodness fit and other indices in Table 28 show the model fit to the data but indices are not reliable when the model is not admissive. If a model is not admissive in AMOS that indicates the

model does not fit the data. Thus, the test of three separated SEM models for the hypothesis analyses was necessary. Table 28 lists the indices with the standardized coefficient while Figure 9 displays the preliminary baseline model (For the details of regression weights, see Table 36 in Appendix D).

Table 28 - Model fit

Fit Measures	CMIN	DF	P	RMSEA	GFI	PGFI	TLI	CFI
Default model	129.696	116	0.182	0.04	0.847	0.575	0.987	0.99
Saturated	0	0			1			1
Independence	1533.46	153	0	0.354	0.118	0.106	0	0
Minimum was achieved, but the solution is not admissible.								

The presentation of the three SEM models for hypotheses testing are in order of Part A for H2, Part B for H1a, H3a, H3b, and H3c, and Part C for H1b, H3d, H3e, H3f with following of H1 and H3. H2 is the hypothesis related to correlation analysis between group learning and knowledge conversion. H1a, H3a, H3b, and H3c are the hypotheses related knowledge conversion while H1b, H3d, H3e, and H3f are the hypotheses related to group learning.

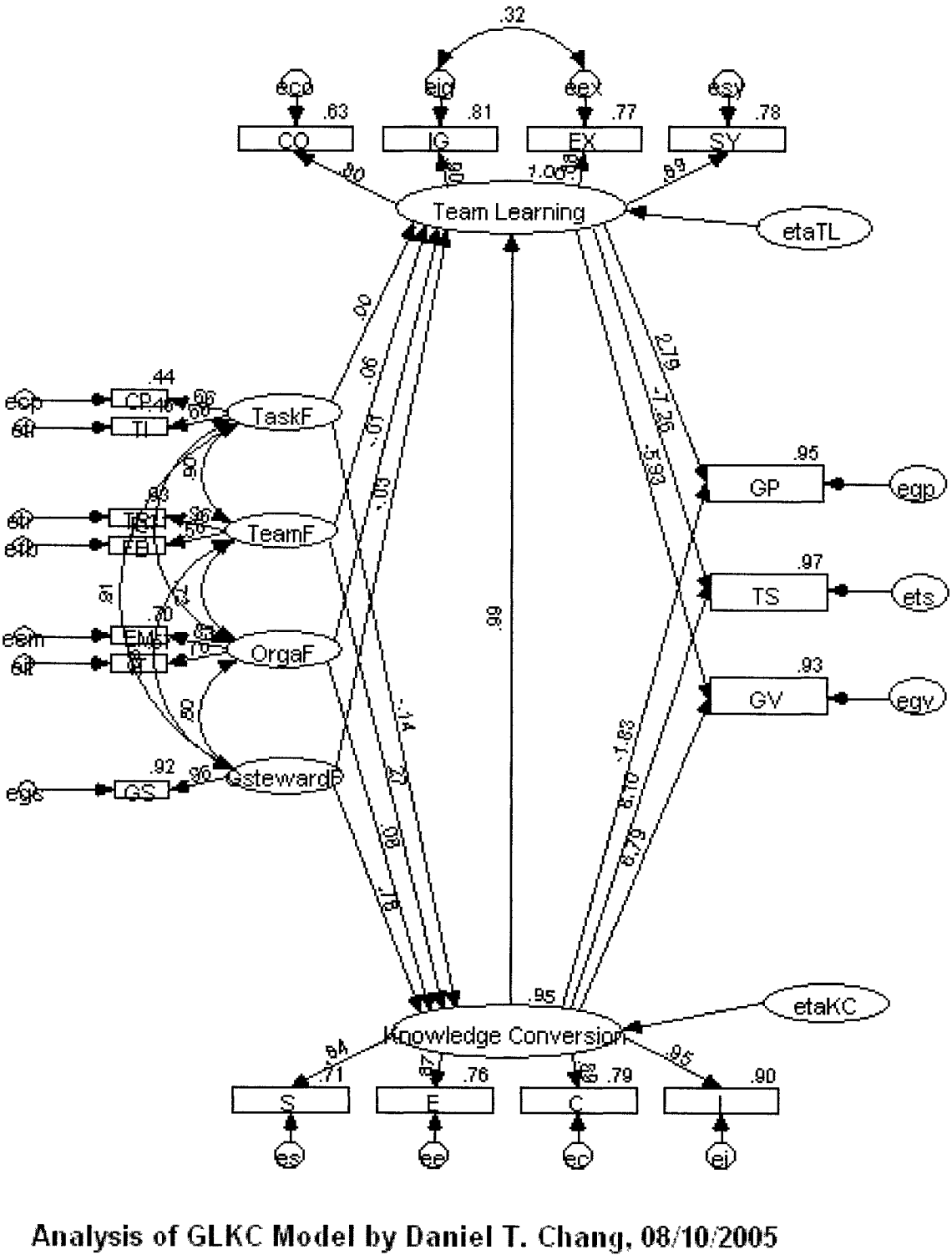


FIGURE 9 – PRELIMINARY BASELINE MODEL

Analysis of Hypothesis Part A – Group Learning and Knowledge Conversion

Result and Analysis of Hypothesis 2

H2: Knowledge conversion is positively related to group learning.

Result: Knowledge conversion is positively related to group learning.

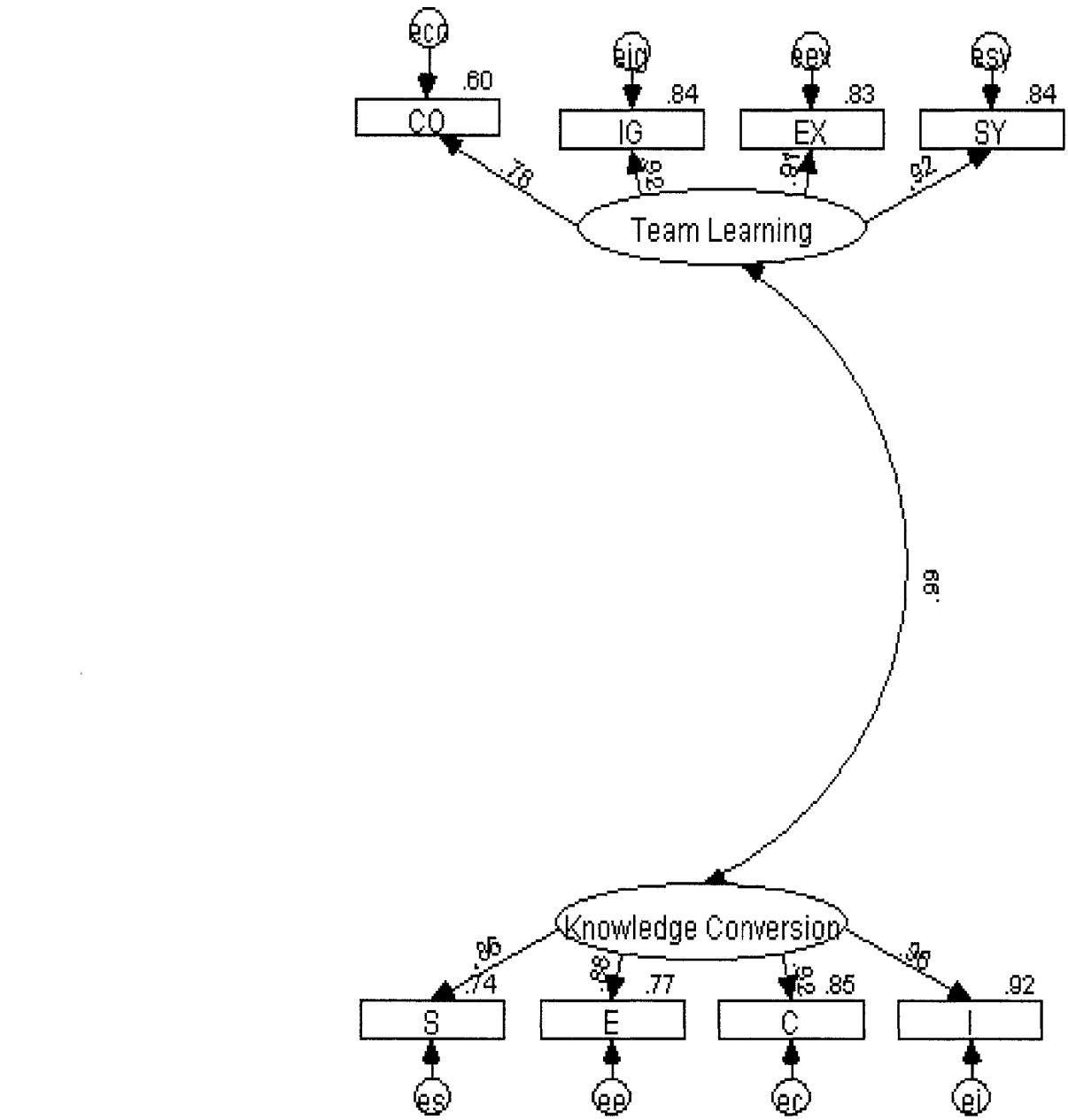
A structured equation model (SEM) analysis applied with AMOS 4.0 was performed. The SEM method is particularly appropriate because all relevant paths are simultaneously tested and complications, such as measurement error and feedback, are incorporated directly into the model (Venkataraman, 1989). To test hypothesis 2, a structural path analysis was performed with the two relevant constructs (team learning and knowledge conversion) in the model as depicted in Figure 4.2. Standardized parameter estimates, t-values, and significance level for the structural paths are shown in Table 29. Overall, the model fix indices suggest a reasonably good fit with the data (χ^2 =26.379, d.f.=19, p>.05; RMSEA=.073; GFI=.927, PGFI=.489; TLI=.984, CFI=.989). Group learning (GL) and knowledge conversion (KC) are highly correlated with correlation coefficient of 0.99, as depicted in Table 29 and Figure 10. Although these indices show the model fits well to the data and also indicate that there is a significant statistical evidence for the positive relationship between KC and GL. So, Hypothesis 2 is supported.

Table 29 – GLKC Standardized Parameter Estimates

Path in SEM model	Std. Coefficient	*t*-value
Team Learning ←→ Knowledge Conversion	0.988	5.604 **
* p<.05, ** p<.01		

Table 30 – GLKC Model Fit

Fit Measures	CMIN	DF	P	RMSEA	GFI	PGFI	TLI	CFI
Default model	26.379	19	0.12	0.073	0.927	0.489	0.984	0.989
Saturated	0	0			1			1
Independence	720.878	28	0	0.586	0.186	0.144	0	0



Analysis of GLKC Model by Daniel T. Chang, 08/10/2005

FIGURE 10 – TEAM LEARNING & KNOWLEDGE CONVERSION

Analysis of Hypothesis Part B – Group Stewardship and Knowledge Conversion

Result and Analysis of Hypothesis 1a, 3a, 3b, 3c

H1a: Group stewardship is positively related to knowledge conversion.

Result: Group stewardship is positively related to knowledge conversion.

H3a: Knowledge conversion is positively correlated with team performance rating.

Result: Knowledge conversion is positively correlated with team performance rating.

H3b: Knowledge conversion is positively correlated with team member satisfaction.

Result: Knowledge conversion is positively correlated with team member satisfaction

H3c: Knowledge conversion is positively correlated with team viability.

Result: Knowledge conversion is positively correlated with team viability.

A structured equation model (SEM) analysis applied with AMOS 4.0 was performed. The SEM method is particularly appropriate because all relevant paths are simultaneously tested and complications, such as measurement error and feedback, are incorporated directly into the model (Venkataraman, 1989). To test hypothesis 1b, 3d, 3e, and 3f, a structural path analysis was performed with the eight relevant constructs (task factor, team factor, organizational factor, group stewardship, team learning, and team performance, team satisfaction, and team viability) in the model as depicted in Figure 11. Standardized parameter estimates, t-values, and significance level for the structural paths are shown in Table 31.

The result shows the path coefficients of task, team, and organization factors to knowledge conversion were not at a significant level that implies the model did not support a correlated relationship among these three factors to knowledge conversion. However, it does show strong path coefficients among other four paths at significant level. These four paths are group stewardship to knowledge conversion, and knowledge conversion to group performance

team satisfaction, and team viability. Overall, the model fix indices listed in Table 31 suggest a reasonably model good fit (χ^2=93.422, d.f.=68, p=.022, χ^2 /d.f. =1.374; RMSEA=.072; GFI=.859, PGFI=.556; TLI=.965, CFI=.974) with the data as displayed in Table 32.

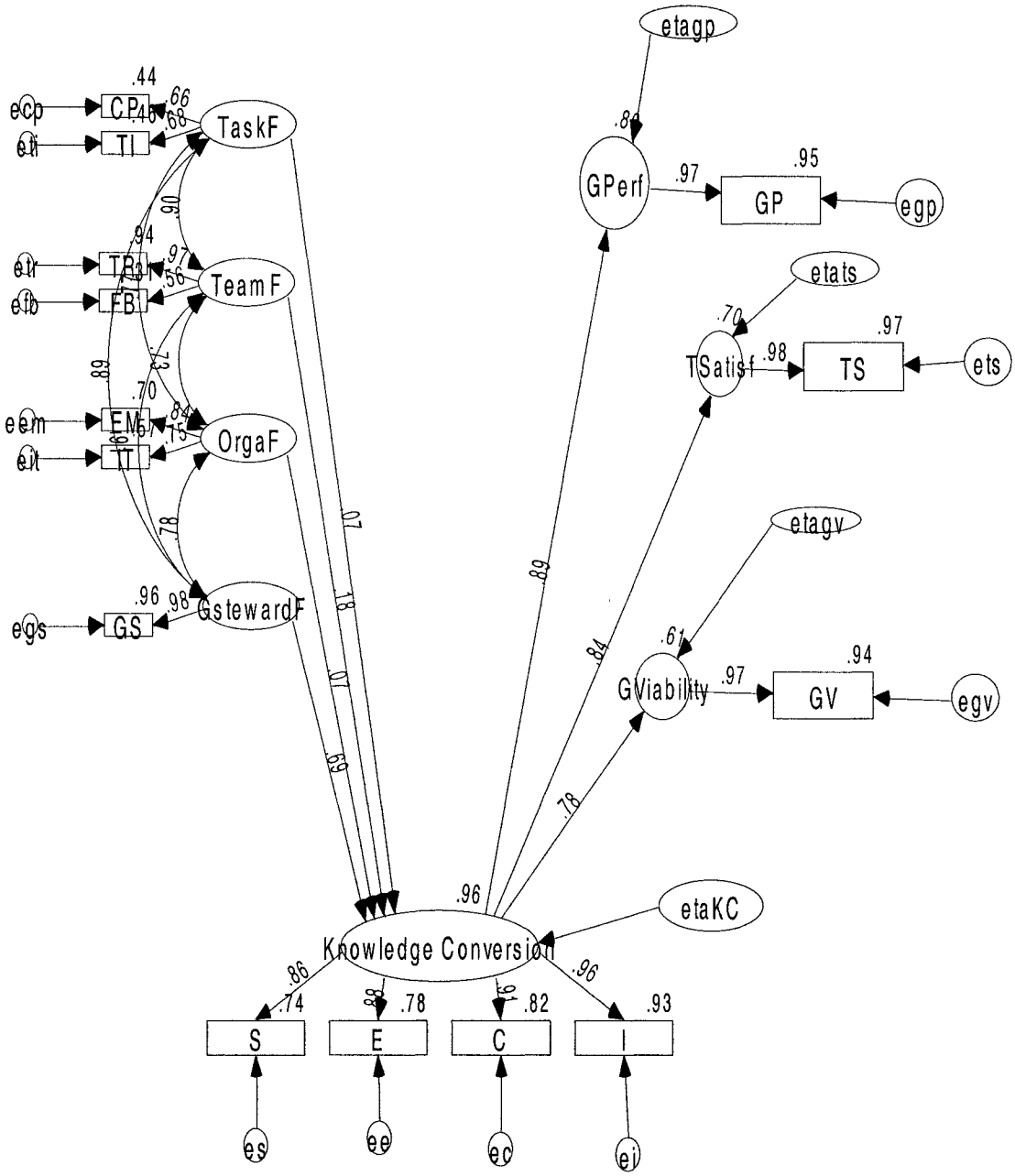
Group stewardship (GS) and knowledge conversion (KC) was strongly correlated (.692) as depicted in Figure 11. This indicates there is significant statistical evidence for a positive relationship between group stewardship to knowledge conversion. The indices also show strong positive relationships from knowledge conversion to group performance (.892), team satisfaction (.838), and team viability (.782) at significant level respectively. So, Hypothesis 1a, 3a, 3b, 3c were supported.

Table 31 – GS, KC & TE Standardized Parameter Estimates

Paths in SEM model	Std. Coefficient	*t*-value
Task Factors → Knowledge Conversion	.066	.287!
Team Factors → Knowledge Conversion	.183	.934!
Organizational Factors → Knowledge Conversion	.072	.798!
H 1a. Group Stewardship → Knowledge Conversion	.692	4.406**
H 3a. Knowledge Conversion → Group Performance	.892	13.254**
H 3b. Knowledge Conversion → Team satisfaction	.838	11.314**
H 3c. Knowledge Conversion → Team Viability	.782	9.290**
!p<.10, * p<.05, ** p<.01		

Table 32 – GS, KC & TE Model Fit

Fit Measures	CMIN (χ^2)	DF	P	RMSEA	GFI	PGFI	TLI	CFI
Default model	93.422	68	0.022	0.072	0.859	0.556	0.965	0.974
Saturated	0	0			1			1
Independence	1055.309	91	0	0.384	0.161	0.139	0	0



Analysis of GLKC Model by Daniel T. Chang, 08/10/2005

FIGURE 11 - KNOWLEDGE CONVERSION MODEL

Analysis of Hypothesis Part C – Group Stewardship and Group Learning

Result and Analysis of Hypothesis 1b, 3d, 3e, 3f

H1b: Group stewardship is positively related to group learning.

Result: Group stewardship is positively related to group learning.

H3d: Group learning is positively correlated with team performance rating.

Result: Group learning is positively correlated with team performance rating.

H3e: Group learning is positively correlated with team member satisfaction.

Result: Group learning is positively correlated with team member satisfaction.

H3f: Group learning is positively correlated with team viability.

Result: Group learning is positively correlated with team viability.

A structured equation model (SEM) analysis applied with AMOS 4.01 was performed. The SEM method is particularly appropriate because all relevant paths are simultaneously tested and complications, such as measurement error and feedback, are incorporated directly into the model (Venkataraman, 1989). To test hypothesis 1b, 3d, 3e, and 3f, a structural path analysis was performed with the eight relevant constructs (task factor, team factor, organizational factor, group stewardship, group learning, and team performance, team satisfaction, and team viability) in the model as depicted in Figure 12. Standardized parameter estimates, t-values, and significance level for the structural paths are shown in Table 33.

The result shows the path coefficients of task, team, and organization factors to group learning were not at significant level that implies the model did not support a correlated relationship among these three factors to group learning. However, it does show strong path coefficients among other four paths at significant level. These four paths are group stewardship to group learning, and group learning to group performance, team satisfaction, and team

viability. Overall, the model fix indices listed in Table 34 suggest a reasonably model good fit (χ^2=26.379, d.f.=19, p>.05; RMSEA=.073; GFI=.927, PGFI=.489; TLI=.984, CFI=.989) with the data as displayed in Table 33.

Group stewardship (GS) and group learning (GL) was strongly correlated (.541) as depicted in Table 33 and Figure 12. This indicates that there is significant statistical evidence for the positive relationship between group stewardship and group learning. The indices also show strong positive relationships from group learning to group performance (.899), team satisfaction (.823), and team viability (.781) at significant level respectively. So, Hypothesis 1b, 3d, 3e, and 3f were supported.

Table 33 – GS, GL & TE Standardized Parameter Estimates

Path in SEM model	Std. Coefficient	*t*-value
Task Factors → Group Learning	.157	.583!
Team Factors → Group Learning	.219	1.138!
Organizational Factors → Group Learning	.105	1.000!
H 1b. Group Stewardship → Group Learning	.541	2.984**
H 3d. Group Learning → Group Performance	.899	8.766**
H 3e. Group Learning → Team satisfaction	.823	7.862**
H 3f. Group Learning → Team Viability	.781	7.202**
! p<.10, * p<.05, ** p<.01		

Table 34 – GS, GL & TE Model Fit

Fit Measures	CMIN (χ^2)	D.F.	P	RMSEA	GFI	PGFI	TLI	CFI
Default model	84.149	68	0.0892	0.057	0.862	0.558	0.976	0.982
Saturated	0	0			1			1
Independence	977.494	91	0	0.368	0.165	0.143	0	0

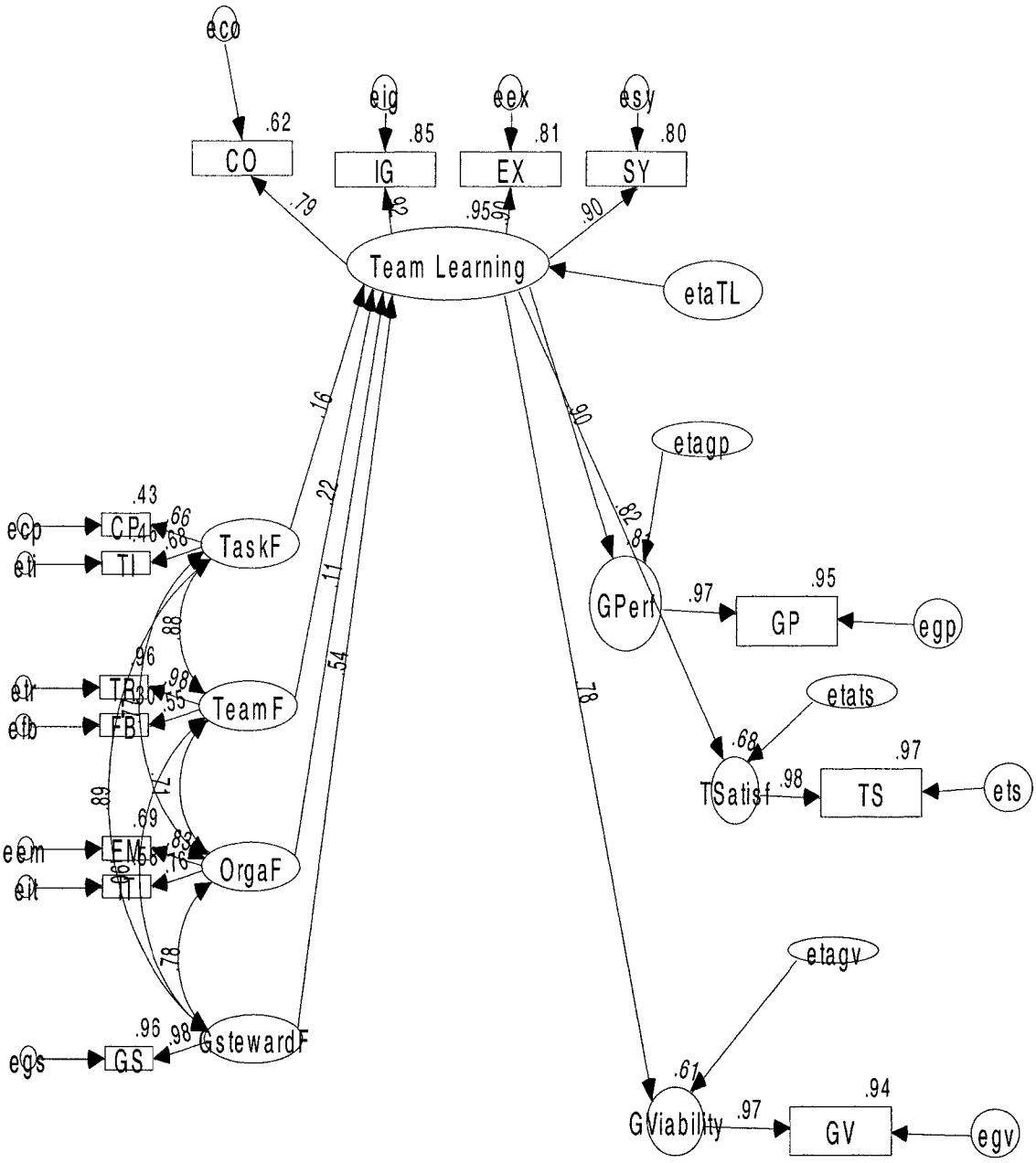


FIGURE 12 – GROUP LEARNING MODEL

Analysis of Hypothesis 1

H1: Group stewardship is positively related to group learning and knowledge conversion.

Result: Group stewardship is positively related to group learning and knowledge conversion.

The hypotheses analyses in Part B and C show the standardized path coefficients as displayed in Table 31 and 33 that confirmed a positive relationship occurred between group stewardship to group learning and knowledge conversion. Thus, group stewardship is positively related to group learning and knowledge conversion. The hypothesis H1 is supported.

Analysis of Hypothesis 3

H3: Group learning and knowledge conversion are positively related to team effectiveness.

Result: Group learning and knowledge conversion are positively related to team effectiveness.

The hypotheses analyses in part B and C show the standardized path coefficients as displayed in Table 31 and 33 that confirmed a positive relationships occurred from both group learning and knowledge conversion to group performance, team satisfaction, and team viability respectively. Thus, group learning and knowledge conversion are positively related to team effectiveness. Hypothesis 3 is supported.

SUMMARY OF THIS CHAPTER

In this chapter, the results for each of the hypotheses were presented, along with the results for each of the hypotheses that were described in the research design. To summarize briefly the major findings of this dissertation are described below:

1. Group stewardship positively influences both group learning and knowledge conversion.

2. Knowledge conversion positively influences group learning. The result anticipated a strong correlation coefficient of 0.99 between the group learning and the knowledge that exceeds Hayduk's .90 (1987).
3. Group learning and knowledge conversion positively influence team effectiveness.
4. Knowledge conversion positively influences all of the three team-outcome matrices: team performance, team member satisfaction, and team viability.
5. Group learning also positively influences all of the three team-outcome matrices: team performance, team member satisfaction, and team viability.

CHAPTER V
CONCLUSION AND FUTURE RESEARCH

INTRODUCTION

This chapter presents the conclusions of this study. It is divided into five sections. The first section summarizes and interprets the results. The second section presents the limitations. The third and fourth sections discuss the contributions and implications to group learning and knowledge creation in knowledge management field. The final sections discuss future research and conclusion remarks based on the results of this study.

SUMMARY

This dissertation examined how group stewardship influences group learning, knowledge conversion processes and group effectiveness in a large engineering and manufacturing firm. This examination conducted an integrative research framework based on Chang and Groesbeck's (2004) group learning and knowledge conversion model, and empirically tested the process in relations to group stewardship (antecedent) and group effectiveness (outcome). Three research questions are examined: (1) How does group stewardship affect group learning and knowledge conversion? (2) How does knowledge conversion affect group learning? (3) How do group learning and knowledge conversion affect group outcomes?

Addition to four surveys conducted separately to senior managers, 783 individual including members and supervisors were surveyed from 75 workgroups in the participating organization. A total of 635 usable questionnaires from 73 workgroups were received. Unfortunately no survey was received from senior managers. Factor analysis, discriminant validity analysis and structural equation model analysis were used to analyze the research model.

The study hypothesized three leading relationships among group stewardship, group learning and knowledge conversion, group performance, team satisfaction, and team viability: 1). The relationship between group stewardship and group learning and knowledge conversion, 2). The relationship between group learning and knowledge conversion, 3). The relationship between group learning and knowledge conversion and team effectiveness.

The findings confirmed certain hypotheses that were tested in prior research. Group stewardship is positively correlated to group learning and knowledge conversion, and group learning and knowledge conversion are positively correlated to group effectiveness that were consistent with prior research (Groesbeck, 2001; Huang & Wang, 2002). Moreover, knowledge conversion does affect group learning; they are strongly correlated. This finding confirms that the four SECI practices may be supporting four group learning processes in a sequential process as they hypothesized in the GLKC model (Chang & Groesbeck, 2004). Thus, more investigations are needed to pursue further understanding of the implications of the group learning and knowledge conversion model.

CONCLUSIONS AND RELATED LITERATURE

The following discusses how these research findings answer the questions addressed in this study.

Knowledge Creation

Marsick and Watkins (1999a) stress the importance of extending capacity to use learning as strategic tool to generate new knowledge in the form of products, patents, processes and services, and to use technology to capture knowledge. Unless individual knowledge is somehow shared with other organizational members or groups, the knowledge will not be captured by the organization (Kim, 1993). The four SECI practices enable individual knowledge shared and

captured by other members of the organization (Nonaka & Takeuchi, 1995). Moreover, the tacit knowledge held by individuals lies at the heart of the knowledge creation process, gaining access to the benefits of that knowledge requires dynamic interaction between four modes of knowledge conversion (Nonaka, 1994). The study research questions were answered by eleven formulated hypotheses. First, the research question asked, "How do group learning and knowledge conversion affect group outcomes"? The findings reveal that both group learning processes and knowledge conversion practices are strongly correlated to group effectiveness.

Motivation of Knowledge Creation

Team effective learning and knowledge conversion are truly voluntary internalized behaviors, and are based upon internal value systems of the knowledge workers in contrast to pride and identity that characterize social influences based upon identification (Malhotra & Galletta, 2003). The knowledge workers' intrinsic motivation comes from need satisfaction (Leonard-Barton, 1995) while engaging in activities, and they continue to focus on innate needs for competence and autonomy (Deci & Ryan, 2000). Deci and Ryan further proposed that socialization can transfer external regulations into inner values, and that individuals can be self-determined while enacting external regulations.

Davis et al. (1997) proposed that stewards are motivated to act in the best interests of their principals, internally motivated, and willing to act in concert with others. Group stewardship is as a collectively held sense of responsibility to oversee and improve performance in the group area of responsibility in accordance with the best interests of the organization (Groesbeck, 2001). The research question asked "How does group stewardship affect group learning and knowledge conversion?", the findings answered this question. Group stewardship displayed a positive effect on group learning and knowledge conversion.

Knowledge Creation Model

The GLKC model (Chang & Groesbeck, 2004) portrays the vital role of group learning as a key link between individual and organizational learning, further, organizational knowledge creation occurs when all four modes of SECI knowledge conversion practices interacted with group learning to form a continual cycle. For example, Polanyi (1966, p. 61) talked about how the transfer of tacit knowledge requires the transferor to have a deep awareness of the meaning of communicable details and for the transferee to undertake the "same kind of indwelling", with this tacit knowledge to allow the deeper meaning to emerge. Thus, the second research question asked "How does knowledge conversion affect group learning?".

The findings confirm that there is strongly correlated relationship between group learning and knowledge conversion. These findings anticipated that a strong correlation between group learning processes and knowledge conversion practices exceed .90 (Hayduk, 1987). This shed light on the GLKC model as Chang and Groesbeck (2004) proposed that the four practices of the SECI model (Nonaka, 1994) work to support the processes of group learning (Groesbeck, 2001; Marsick & Watkins, 1993, 1996). First, tacit knowledge is accessed from private meaning structures to enable collaboration through dialogue and other forms of sharing information. Second, the accessible knowledge is translated, categorized and contextualized as group members interpret explicit information to make sense of it and see where it fits within their focused area and overall within the organization. Third, new knowledge is put into action through experimentation to allow its conversion from explicit to tacit as individuals learn by doing. Lastly, the tacit knowledge gained from experimenting is interpreted within individuals' private meaning structures. This forms a continual cycle as knowledge is created.

LIMITATIONS OF THE STUDY

Before considering the implications of these results, it is important to acknowledge the limitations of the research. There were a number of limitations that could have affected the accuracy of this research result.

A primary limitation of this research is the cross-sectional nature of the study. Given the desire to develop a measure of GLKC model and to validate the multidimensional nature of group learning and knowledge conversion, a cross-sectional approach was appropriate. However, a study conducted at one point in time cannot establish cause and effect relationships.

A second limitation of this research is related to the data sample, sample size, and method of this study. The survey questionnaire was the only instrument used to collect data, and the sample of 73 teams was collected from a single company. Thus, a large part of the reliability of the collected data depends on the respondents' attention to detail when answering the questions.

A third limitation relates to the need for analysis construct and the degree of analysis required by groups in this study. The need for analysis measure used in this research had sufficient reliability for exploratory research, but a more reliable measure is needed. For example, additional antecedent factors that may affect the group learning and knowledge conversion were not considered as part of this analysis.

POTENTIAL CONTRIBUTIONS

A central contribution of this study is the empirical result and confirmation of the anticipated strong correlation between group learning and knowledge conversion as Chang and Groesbeck (2004) argued. A second contribution was the development of the survey instrument comprised in three sections of constructs: team inputs, group learning and knowledge conversion, and team effectiveness. Incorporating multiple theories and addressing different

aspects of group learning and knowledge conversion derived the set of constructs. Although the instrument modules used in this study had been individually validated in prior research, it is necessary to revalidate them through a rigorous process when used for a newly compiled set of constructs. Thus, exploratory factor analysis and confirmatory factor analysis were simultaneously conducted in this study.

Third, this study extends Chang and Groesbeck's (2004) group learning and knowledge conversion model to the next avenue of research, and provides possible applications to practitioners. For instance, the confirmation of strong relationship between group learning processes and knowledge conversion practices enables future research in determining whether socialization and externalization practices are most strongly associated with the presence of collaboration, or if other three knowledge conversion practices are also strongly associated with other three group learning processes in similar patterns.

IMPLICATIONS FOR THEORY

The study of group learning and knowledge conversion in both theory and practice is still in its infancy stage. The emerging streams of research started in the 1980s, focusing on the investigation of general and conceptual principles of organizational learning (Argyris & Schön, 1978, 1996) and learning organization (Dixon, 1994; Senge, 1990), and evolved to the organization knowledge creation theory (Nonaka, 1994; Nonaka & Takeuchi, 1995) and group learning (Watkins & Marsick, 1993, 1996) at the same time period. Yet, these streams of research have developed in parallel with little exchange of ideas (Argote et al., 2001).

The group learning and knowledge conversion model bridged the gap of these research streams. For instance, Senge (1990) stated that, unless groups can learn, organizations cannot learn. Organizational learning is achieved through a synergistic relationship between tacit and

explicit knowledge in the organization, and through the design of social practices that create new knowledge by converting tacit knowledge into explicit knowledge (Choo, 1996). Teamwork and team learning are the critical link between the learning individual and the learning organization. With continual collaboration and experimentation coupled with ongoing reflection, a team utilizes its potential to generate new ideas, thereby increasing its ability to produce the desired business results. Thus, understanding and mastering the implications between group learning and knowledge conversion are vital for organizational knowledge creation.

IMPLICATIONS FOR PRACTICE

There are a number of possible applications for managers derived from this study. For example, through organization design arrived at by applying the group learning and knowledge conversion model as a framework, one is able to access both learning-enabling practices and the processes that take place as people learn. The practices which support learning are means to support the group learning processes, not an end in themselves. The tendency to put broad-based, organization-wide programs in pace will not be successful unless the processes through which people act and think change.

FUTURE RESEARCH

Several areas for future research have surfaced from the results of our work. Initially, this study utilized quantitative methods and relative questionnaires to collect data; future research will also utilize qualitative methods. Real observation of group learning and knowledge conversion could help us better understand how actual group learn and knowledge conversion takes place. Alternatively, a longitudinal research of group learning and knowledge conversion may also provide comprehension of the extent or rate of change in learning and knowledge creation outcomes. Longitudinal research would also permit further understanding of the cause

and effect relationships among constructs influencing group stewardship, group learning and knowledge conversion.

Second, a study needs to test the hypothesized relationships among the constructs of group learning and knowledge conversion in GLKC model (Chang & Groesbeck, 2004). Research could be done to study the strength of the correlation or causation between each of the group learning processes and the four SECI practices. For example, such research could determine if the socialization and externalization practices are most strongly correlated in the presence of collaboration process.

CONCLUDING REMARKS

The input-process-output (IPO) model (Cohen & Bailey, 1997) has been the most researched model of team effectiveness. IPO models posit that inputs such as task design, group characteristics, and organizational support influence group processes that in turn influence group outputs. This study applies the IPO model to the context of workgroups based knowledge organization.

A comprehensive literature review was conducted, factors that contribute to group learning and knowledge conversion were identified, and eleven hypotheses were proposed. A survey instrument was then developed to collect data from workgroup member individuals. Structural equation model techniques were used to test the hypotheses.

Some of the valuable findings in this study are first, the strongly positive correlated relationship between group learning and knowledge conversion; second, the positive relationship between group stewardship knowledge conversion; third, the positive relationship between knowledge conversion and group effectiveness. These findings contribute significantly to the

literature for both of knowledge management and knowledge creation, as well as group learning and group effectiveness.

Limitations of this research were discussed. Implications for both research and practice were also explored, as the author suggested some future research in areas of group learning and knowledge conversion in the contexts of team knowledge work processes, and impacts of their effectiveness should be done.

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APPENDIX A

Survey Letter

Background

This survey is part of an important research project that investigates the success of group learning and knowledge conversion in workplaces. As a respondent to this survey, you have been identified as a group member of a workgroups in your organization, but the result of your survey will be aggregated to group level for further analysis. Therefore individual answer to this survey will be not identified.

Group learning and knowledge sharing are the important outset to leverage the expertise of individuals and the efficient transfer of knowledge within your organization. They can be used to disseminate information to make more effective decisions. The research is being conducted as part of the fulfillment of requirements, by the researcher, for the Doctorate of Business Administration Program at Nova Southeastern University, Fort Lauderdale, FL.

Confidentiality

Individual responses will be used only to form grouped summary result values and the individual responses will not be communicated in any way. The confidentiality of your responses will be strictly protected. At the end of the survey, you have the option of including your name, telephone number and/or email address. If you chose to participate, your individual confidentiality will be maintained, unless permission is granted otherwise.

Questions

You may direct any questions or comments regarding this survey to the researcher:

Daniel T. Chang, 01
8901 Willow Hills Drive
Huntsville, AL, 35802
(256) 489-5566
dtchang@nova.edu

Directions for Completing the Survey

Please respond to all questions, indicating the one response that best reflects your answer to the question.

Thank you for you participation in this important research project.

APPENDIX B.1

Survey instrument for group members

Demographics
Please indicate your responses to the following questions on your answer sheet.

What is your gender? _____Male or _____female.

What is your highest level of education?
_____High school graduate or high school equivalency.
_____Graduated form vocational school or associate degree.
_____Graduated from college or university.
_____Completed a master degree.
_____Completed a doctorate degree.

What is your age in years?
_____20-26, _____27-34, _____35-44, _____45-55, _____56 or more

Years of service in the current type of your job?
_____0-3, _____ 4-8, _____ 9-13, _____14-17, _____18 or more

How long have you worked for this organization?
_____0-3, _____4-8, _____9-13, _____14-17, _____18 or more

How many years have you been part of your present work group?
_____0-1, _____2-3, _____4-6, _____7-9, _____10 or more

PART 1 - Questions related to your group work environment.
Please indicate how you personally feel about your job by indicating how much you agree with each of these statements.
Each of the statements is accompanied by a 6-point scale anchored at the ends by the labels "1 strongly disagree" (SD), "2 moderately disagree (MD)", "3 somewhat disagree (SWD)", " 4 somewhat agree (SWA)", " 5 moderately agree (MA)", "6 strongly agree" (SA).

Input Variables

	Code	Questionnaire	SD	MD	SWD	SWA	MA	SA
1	Cp1	Goals and objectives we must achieve to fulfill our work groups' purpose are clear.	1	2	3	4	5	6
2	Cp2	My work group has a clearly defined purpose.	1	2	3	4	5	6
3	Cp3	Our purpose and goals clearly define what is expected of our work group.	1	2	3	4	5	6
4	Cp4	My entire work group understands our group's purpose.	1	2	3	4	5	6

5	Ti1	I cannot accomplish my task without information or materials from other members of my group.	1	2	3	4	5	6
6	Ti2	Other members of my work group depend on me for information or materials needed to perform tasks.	1	2	3	4	5	6
7	Ti3	Within my work group, jobs performed by group members are dependent on one another.	1	2	3	4	5	6
8	Tr1	We have a sharing relationship. Group members can freely share ideas, feelings, and hopes.	1	2	3	4	5	6
9	Tr2	We can talk freely to group members about difficulties we are having at work and know that they will want to listen.	1	2	3	4	5	6
10	Tr3	We would feed a sense of loss if a group member was transferred and we could no longer work together.	1	2	3	4	5	6
11	Tr4	If we share problems with group members, we know they will be helpful and caring.	1	2	3	4	5	6
12	Tr5	Our group has worked together to form close working relationships.	1	2	3	4	5	6
13	Fb1	The feedback our group receives compares our performance to our goals.	1	2	3	4	5	6
14	Fb2	Our group receives feedback that shows how our performance has changed over time.	1	2	3	4	5	6
15	Fb3	Our group receives feedback that helps determine the areas in which we need education and development.	1	2	3	4	5	6
16	Fb4	The feedback our group receives helps us understand how others view our performance.	1	2	3	4	5	6
17	Gs1	Our group members feel a shared sense of responsibility for our work.	1	2	3	4	5	6
18	Gs2	Our work group feels a sense of accountability for the work we do.	1	2	3	4	5	6
19	Gs3	Our group members want to do what is best for the organization.	1	2	3	4	5	6
20	Em1	This organization provides employees the opportunity to learn new skills.	1	2	3	4	5	6
21	Em2	In this organization, employees are trained on skills that prepare them for future jobs.	1	2	3	4	5	6
22	Em3	This organization provides employees with employment security.	1	2	3	4	5	6
23	Em4	This organization fills job openings by promoting capable employees within the organization.	1	2	3	4	5	6
24	It1	We have easy computer access to the information we need to do our jobs.	1	2	3	4	5	6
25	It2	We have state of the art computer tools.	1	2	3	4	5	6
26	It3	Our computer tools help people from multiple functions to work together effectively.	1	2	3	4	5	6
27	It4	We have excellent computer systems for coordinating with each other.	1	2	3	4	5	6
28	It5	Our information and computer (networking) systems are flexible.	1	2	3	4	5	6

PART 2 - Questions related to your group learning and knowledge sharing.
Please indicate how you personally feel about your job by indicating how much you agree with each of these statements.

Each of the statements is accompanied by a 6-point scale anchored at the ends by the labels "1 strongly disagree" (SD), "2 moderately disagree (MD)", "3 somewhat disagree (SWD)", " 4 somewhat agree (SWA)", " 5 moderately agree (MA)", "6 strongly agree" (SA).

Process Variables

	Code	Questionnaire	SD	MD	SWD	SWA	MA	SA
1	S1	In team discussions, we actively share our experiences with each other.	1	2	3	4	5	6
2	S2	In my work team, my teammates and I share life or work experiences with each other.	1	2	3	4	5	6
3	S3	During group discussion, we try to find out each other's opinions, thoughts and other information.	1	2	3	4	5	6
4	S4	During discussion, we bring out concepts, thoughts or ideas.	1	2	3	4	5	6
5	S5	We often encourage others to express their thoughts.	1	2	3	4	5	6
6	S6	We observe each other's expertise through practice and demonstrations.	1	2	3	4	5	6
7	E1	When others can't understand me, I am usually able to give them examples to help explain.	1	2	3	4	5	6
8	E2	Most of the time, I can transcribe unorganized thoughts into concrete ideas.	1	2	3	4	5	6
9	E3	I can describe professional or technical terms with conversational language to help communication in out team.	1	2	3	4	5	6
10	E4	I tend to use analogies when expressing abstract concepts.	1	2	3	4	5	6
11	E5	When I try to express abstract concepts, I tend to explain with examples.	1	2	3	4	5	6
12	E6	I help others clearly express what they have in mind by encouraging them to continue what they are saying.	1	2	3	4	5	6
13	C1	We tend to organize ideas and conclusions to facilitate discussions.	1	2	3	4	5	6
14	C2	We tend to use our experience to help solve problems.	1	2	3	4	5	6
15	C3	After every event, we have the habit of organizing and summarizing what happened.	1	2	3	4	5	6
16	C4	During discussions, while new ideas are formed we make sure everyone are understand collectively.	1	2	3	4	5	6
17	C5	We like to collect new information and connect it with what we know to develop new concepts.	1	2	3	4	5	6
18	C6	During discussions, we tend to organize ambiguous concepts into systemized and structured ways of thinking.	1	2	3	4	5	6
19	I1	After hearing a new idea or concept, I tend to compare it with my experience to help me comprehend the meaning.	1	2	3	4	5	6
20	I2	I understand others' thoughts better by repeating what they said and asking them "Is this what you mean?"	1	2	3	4	5	6
21	I3	I tell others what I think to make sure my understanding is the same as theirs.	1	2	3	4	5	6
22	I4	When I have finished saying something, I ask if I should repeat it to make sure others understand exactly what I mean.	1	2	3	4	5	6
23	Co1	We ask other group members questions when we are uncertain about something	1	2	3	4	5	6
24	Co2	We get other group members to help us when we need assistance.	1	2	3	4	5	6
25	Co3	We ask other group members for more information they have when we need it.	1	2	3	4	5	6

26	Ig1	We often think about how our work fits into the "bigger picture" at our organization.	1	2	3	4	5	6
27	Ig2	We try to think how the different parts of our organization fit together.	1	2	3	4	5	6
28	Ig3	We try to think how our work relates to that of others.	1	2	3	4	5	6
29	Ex1	We try out new things by applying them in practice.	1	2	3	4	5	6
30	Ex2	We test new ideas to help ourselves learn.	1	2	3	4	5	6
31	Ex3	We invite suppliers and people from outside our group to present information, seminars or have discussions with us.	1	2	3	4	5	6
32	Ex4	Our group thinks about new information and its implications for our work rather than merely concentrating on the facts given.	1	2	3	4	5	6
33	Sy1	I often think about how my work fits into the "bigger picture" at our organization.	1	2	3	4	5	6
34	Sy2	I try to think how the different parts of our organization fit together.	1	2	3	4	5	6
35	Sy3	I try to think how my work relates to that of others.	1	2	3	4	5	6

PART 3 - Questions related to your group effectiveness.
Please indicate how you personally feel about your job by indicating how much you agree with each of these statements.
Each of the statements is accompanied by a 6-point scale anchored at the ends by the labels "1 strongly disagree" (SD), "2 moderately disagree (MD)", "3 somewhat disagree (SWD)", " 4 somewhat agree (SWA)", " 5 moderately agree (MA)", "6 strongly agree" (SA).

Outcome Variables

	Coding	Questionnaire	SD	MD	SWD	SWA	MA	SA
1	Gp1	The group meets or exceeds its goals.	1	2	3	4	5	6
2	Gp2	Group members complete their tasks on time.	1	2	3	4	5	6
3	Gp3	The group responds quickly when problems come up.	1	2	3	4	5	6
4	Gp4	This group is productive.	1	2	3	4	5	6
5	Ts1	I am happy to be a member of this group.	1	2	3	4	5	6
6	Ts2	I like to be part of this group.	1	2	3	4	5	6
7	Ts3	I am **dissatisfied** with being a member of this group.	1	2	3	4	5	6
8	Gv1	This group would perform well together in the future.	1	2	3	4	5	6
9	Gv2	If I had the choice of working on this group again, I would do it.	1	2	3	4	5	6
10	Gv3	If we were assigned to another project, I am confident that this group would work well together.	1	2	3	4	5	6

APPENDIX B.2

Survey instrument for group managers

Demographics
Please indicate your responses to the following questions on your answer sheet.

What is your gender? _____Male or _____female.

What is your highest level of education?
_____High school graduate or high school equivalency.
_____Graduated form vocational school or associate degree.
_____Graduated from college or university.
_____Completed a master degree.
_____Completed a doctorate degree.

What is your age in years?
_____20-26, _____27-34, _____35-44, _____45-55, _____56 or more

Years of service in the current type of your job?
_____0-3, _____ 4-8, _____ 9-13, _____14-17, _____18 or more

How long have you worked for this organization?
_____0-3, _____4-8, _____9-13, _____14-17, _____18 or more

How many years have you been part of your present work group?
_____0-1, _____2-3, _____4-6, _____7-9, _____10 or more

PART 1 - Questions related to your group work environment.
Please indicate how you personally feel about your job by indicating how much you agree with each of these statements.
Each of the statements is accompanied by a 6-point scale anchored at the ends by the labels "1 strongly disagree" (SD), "2 moderately disagree (MD)", "3 somewhat disagree (SWD)", " 4 somewhat agree (SWA)", " 5 moderately agree (MA)", "6 strongly agree" (SA).

Input Variables

	Code	Questionnaire	SD	M D	SW D	SW A	M A	S A
1	Cp1	Goals and objectives we must achieve to fulfill our work groups' purpose are clear.	1	2	3	4	5	6
2	Cp2	My work group has a clearly defined purpose.	1	2	3	4	5	6
3	Cp3	Our purpose and goals clearly define what is expected of our work group.	1	2	3	4	5	6
4	Cp4	My entire work group understands our group's purpose.	1	2	3	4	5	6

5	Ti1	I cannot accomplish my task without information or materials from other members of my group.	1	2	3	4	5	6
6	Ti2	Other members of my work group depend on me for information or materials needed to perform tasks.	1	2	3	4	5	6
7	Ti3	Within my work group, jobs performed by group members are dependent on one another.	1	2	3	4	5	6
8	Tr1	We have a sharing relationship. Group members can freely share ideas, feelings, and hopes.	1	2	3	4	5	6
9	Tr2	We can talk freely to group members about difficulties we are having at work and know that they will want to listen.	1	2	3	4	5	6
10	Tr3	We would feed a sense of loss if a group member was transferred and we could no longer work together.	1	2	3	4	5	6
11	Tr4	If we share problems with group members, we know they will be helpful and caring.	1	2	3	4	5	6
12	Tr5	Our group has worked together to form close working relationships.	1	2	3	4	5	6
13	Fb1	The feedback our group receives compares our performance to our goals.	1	2	3	4	5	6
14	Fb2	Our group receives feedback that shows how our performance has changed over time.	1	2	3	4	5	6
15	Fb3	Our group receives feedback that helps determine the areas in which we need education and development.	1	2	3	4	5	6
16	Fb4	The feedback our group receives helps us understand how others view our performance.	1	2	3	4	5	6
17	Gs1	Our group members feel a shared sense of responsibility for our work.	1	2	3	4	5	6
18	Gs2	Our work group feels a sense of accountability for the work we do.	1	2	3	4	5	6
19	Gs3	Our group members want to do what is best for the organization.	1	2	3	4	5	6
20	Em1	This organization provides employees the opportunity to learn new skills.	1	2	3	4	5	6
21	Em2	In this organization, employees are trained on skills that prepare them for future jobs.	1	2	3	4	5	6
22	Em3	This organization provides employees with employment security.	1	2	3	4	5	6
23	Em4	This organization fills job openings by promoting capable employees within the organization.	1	2	3	4	5	6
24	It1	We have easy computer access to the information we need to do our jobs.	1	2	3	4	5	6
25	It2	We have state of the art computer tools.	1	2	3	4	5	6
26	It3	Our computer tools help people from multiple functions to work together effectively.	1	2	3	4	5	6
27	It4	We have excellent computer systems for coordinating with each other.	1	2	3	4	5	6
28	It5	Our information and computer (networking) systems are flexible.	1	2	3	4	5	6

PART 2 - Questions related to your group learning and knowledge sharing.
Please indicate how you personally feel about your job by indicating how much you agree with each of these statements.

Each of the statements is accompanied by a 6-point scale anchored at the ends by the labels "1 strongly disagree" (SD), "2 moderately disagree (MD)", "3 somewhat disagree (SWD)", " 4 somewhat agree (SWA)", " 5 moderately agree (MA)", "6 strongly agree" (SA).

Process Variables

	Code	Questionnaire	SD	MD	SWD	SWA	MA	SA
1	S1	In team discussions, we actively share our experiences with each other.	1	2	3	4	5	6
2	S2	In my work team, my teammates and I share life or work experiences with each other.	1	2	3	4	5	6
3	S3	During group discussion, we try to find out each other's opinions, thoughts and other information.	1	2	3	4	5	6
4	S4	During discussion, we bring out concepts, thoughts or ideas.	1	2	3	4	5	6
5	S5	We often encourage others to express their thoughts.	1	2	3	4	5	6
6	S6	We observe each other's expertise through practice and demonstrations.	1	2	3	4	5	6
7	E1	When others can't understand me, I am usually able to give them examples to help explain.	1	2	3	4	5	6
8	E2	Most of the time, I can transcribe unorganized thoughts into concrete ideas.	1	2	3	4	5	6
9	E3	I can describe professional or technical terms with conversational language to help communication in out team.	1	2	3	4	5	6
10	E4	I tend to use analogies when expressing abstract concepts.	1	2	3	4	5	6
11	E5	When I try to express abstract concepts, I tend to explain with examples.	1	2	3	4	5	6
12	E6	I help others clearly express what they have in mind by encouraging them to continue what they are saying.	1	2	3	4	5	6
13	C1	We tend to organize ideas and conclusions to facilitate discussions.	1	2	3	4	5	6
14	C2	We tend to use our experience to help solve problems.	1	2	3	4	5	6
15	C3	After every event, we have the habit of organizing and summarizing what happened.	1	2	3	4	5	6
16	C4	During discussions, while new ideas are formed we make sure everyone are understand collectively.	1	2	3	4	5	6
17	C5	We like to collect new information and connect it with what we know to develop new concepts.	1	2	3	4	5	6
18	C6	During discussions, we tend to organize ambiguous concepts into systemized and structured ways of thinking.	1	2	3	4	5	6
19	I1	After hearing a new idea or concept, I tend to compare it with my experience to help me comprehend the meaning.	1	2	3	4	5	6
20	I2	I understand others' thoughts better by repeating what they said and asking them "Is this what you mean?"	1	2	3	4	5	6
21	I3	I tell others what I think to make sure my understanding is the same as theirs.	1	2	3	4	5	6
22	I4	When I have finished saying something, I ask if I should repeat it to make sure others understand exactly what I mean.	1	2	3	4	5	6
23	Co1	We ask other group members questions when we are uncertain about something	1	2	3	4	5	6
24	Co2	We get other group members to help us when we need assistance.	1	2	3	4	5	6
25	Co3	We ask other group members for more information they have when we need it.	1	2	3	4	5	6

26	Ig1	We often think about how our work fits into the "bigger picture" at our organization.	1	2	3	4	5	6
27	Ig2	We try to think how the different parts of our organization fit together..	1	2	3	4	5	6
28	Ig3	We try to think how our work relates to that of others.	1	2	3	4	5	6
29	Ex1	We try out new things by applying them in practice.	1	2	3	4	5	6
30	Ex2	We test new ideas to help ourselves learn.	1	2	3	4	5	6
31	Ex3	We invite suppliers and people from outside our group to present information, seminars or have discussions with us.	1	2	3	4	5	6
32	Ex4	Our group thinks about new information and its implications for our work rather than merely concentrating on the facts given.	1	2	3	4	5	6
33	Sy1	I often think about how my work fits into the "bigger picture" at our organization.	1	2	3	4	5	6
34	Sy2	I try to think how the different parts of our organization fit together..	1	2	3	4	5	6
35	Sy3	I try to think how my work relates to that of others.	1	2	3	4	5	6

PART 3 - Questions related to your group effectiveness.
Please indicate how you personally feel about your job by indicating how much you agree with each of these statements.
Each of the statements is accompanied by a 6-point scale anchored at the ends by the labels "1 strongly disagree" (SD), "2 moderately disagree (MD)", "3 somewhat disagree (SWD)", " 4 somewhat agree (SWA)", " 5 moderately agree (MA)", "6 strongly agree" (SA).

Outcome Variables

	Code	Questionnaire	SD	MD	SWD	SWA	MA	SA
1	Gp1	The group meets or exceeds its goals.	1	2	3	4	5	6
2	Gp2	Group members complete their tasks on time.	1	2	3	4	5	6
3	Gp3	The group responds quickly when problems come up.	1	2	3	4	5	6
4	Gp4	This group is productive.	1	2	3	4	5	6
5	Ts1	I am happy to be the supervisor of this group.	1	2	3	4	5	6
6	Ts2	I like to be the supervisor of this group.	1	2	3	4	5	6
7	Ts3	I am **dissatisfied** with being the supervisor of this group.	1	2	3	4	5	6
8	Gv1	This group would perform well together in the future.	1	2	3	4	5	6
9	Gv2	If I had the choice of working on this group again, I would do it.	1	2	3	4	5	6
10	Gv3	If we were assigned to another project, I am confident that this group would work well together.	1	2	3	4	5	6

APPENDIX B.3

Survey instrument for senior managers

PART 1 - Questions related to group effectiveness.
Please indicate how you personally feel about the group effectiveness by indicating how much you agree with each of these statements.
Each of the statements is accompanied by a 6-point scale anchored at the ends by the labels "1 strongly disagree" (SD), "2 moderately disagree (MD)", "3 somewhat disagree (SWD)", " 4 somewhat agree (SWA)", " 5 moderately agree (MA)", "6 strongly agree" (SA).

Workgroup Number/Name _____

Outcome Variables

	Code	Questionnaire	SD	MD	SWD	SWA	MA	SA
1	Gp1	The group produces high quality products/services.	1	2	3	4	5	6
2	Gp2	The group works out internal or external customer problems in a timely manner.	1	2	3	4	5	6
3	Gp3	This group follows through on complaints and requests.	1	2	3	4	5	6
4	Gp4	The group provides a satisfactory level of service to internal and external customers.	1	2	3	4	5	6
5	Gv1	This group would perform well together in the future.	1	2	3	4	5	6
6	Gv2	If I had the choice of assigning these same members to a group together again, I would do it.	1	2	3	4	5	6
7	Gv3	If this group was assigned to another project, I am confident that they will work well together.	1	2	3	4	5	6

APPENDIX C.1

Analysis of Participated Workgroups

Table 35 – Participated and Respondent Workgroups

Group Number	Function	Size	Responses	Response rate
101	Product Development	14	12	85.71%
102	Product Development	15	14	93.33%
103	Manufacturing	8	5	62.50%
104	Manufacturing	12	12	100.00%
105	Manufacturing	10	9	90.00%
106	Manufacturing	8	6	75.00%
107	Product Development	8	7	87.50%
108	Product Development	13	10	76.92%
109	Product Development	15	13	86.67%
110	Product Development	10	8	80.00%
111	Product Development	12	10	83.33%
112	Product Development	14	**11**	78.57%
113	Manufacturing	11	9	81.82%
114	Manufacturing	9	7	77.78%
115	Quality & Operation	11	9	81.82%
116	Quality & Operation	7	0	**0.00%**
117	Quality & Operation	13	13	100.00%
118	Quality & Operation	9	8	88.89%
119	Product Development	9	7	77.78%
120	Product Development	8	8	100.00%
121	Product Development	14	**13**	92.86%
122	IT and Administration	10	8	80.00%
123	IT and Administration	9	7	77.78%
124	IT and Administration	9	8	88.89%
125	IT and Administration	10	6	60.00%
126	IT and Administration	8	7	87.50%
127	Quality & Operation	10	9	90.00%
128	Quality & Operation	8	7	87.50%
129	Quality & Operation	11	**7**	63.64%
130	Sales & Marketing	11	8	72.73%
131	Sales & Marketing	12	9	75.00%
132	Sales & Marketing	10	8	80.00%
133	Sales & Marketing	15	12	80.00%
134	Quality & Operation	8	7	87.50%
135	Quality & Operation	12	8	66.67%

136	Quality & Operation	6	5	83.33%
137	IT and Administration	10	8	80.00%
138	IT and Administration	8	7	87.50%
139	Product Development	9	8	88.89%
140	Product Development	12	11	91.67%
141	Product Development	7	6	85.71%
142	Product Development	10	9	90.00%
143	Product Development	15	**12**	80.00%
144	Product Development	10	8	80.00%
145	Product Development	9	9	100.00%
146	Product Development	6	0	**0.00%**
147	Product Development	15	14	93.33%
148	Manufacturing	8	6	75.00%
149	Manufacturing	10	9	90.00%
150	Manufacturing	12	10	83.33%
151	Manufacturing	9	6	66.67%
152	Manufacturing	8	7	87.50%
153	Manufacturing	13	11	84.62%
154	Manufacturing	9	8	88.89%
155	Manufacturing	8	8	100.00%
156	Manufacturing	12	**9**	75.00%
157	Quality & Operation	10	9	90.00%
158	Quality & Operation	12	10	83.33%
159	Quality & Operation	8	6	75.00%
160	Quality & Operation	9	6	66.67%
161	Quality & Operation	11	10	90.91%
162	Quality & Operation	15	13	86.67%
163	Quality & Operation	12	11	91.67%
164	Sales & Marketing	13	**12**	92.31%
165	Sales & Marketing	12	9	75.00%
166	Sales & Marketing	14	11	78.57%
167	Sales & Marketing	8	6	75.00%
168	Sales & Marketing	7	6	85.71%
169	Sales & Marketing	13	11	84.62%
170	Sales & Marketing	9	9	100.00%
171	Product Development	10	8	80.00%
172	Product Development	9	7	77.78%
173	Product Development	10	8	80.00%
174	Product Development	8	5	62.50%
175	Product Development	14	11	78.57%
	Total	783	641	81.86%

APPENDIX C.2

Path Analysis of Antecedent Variables

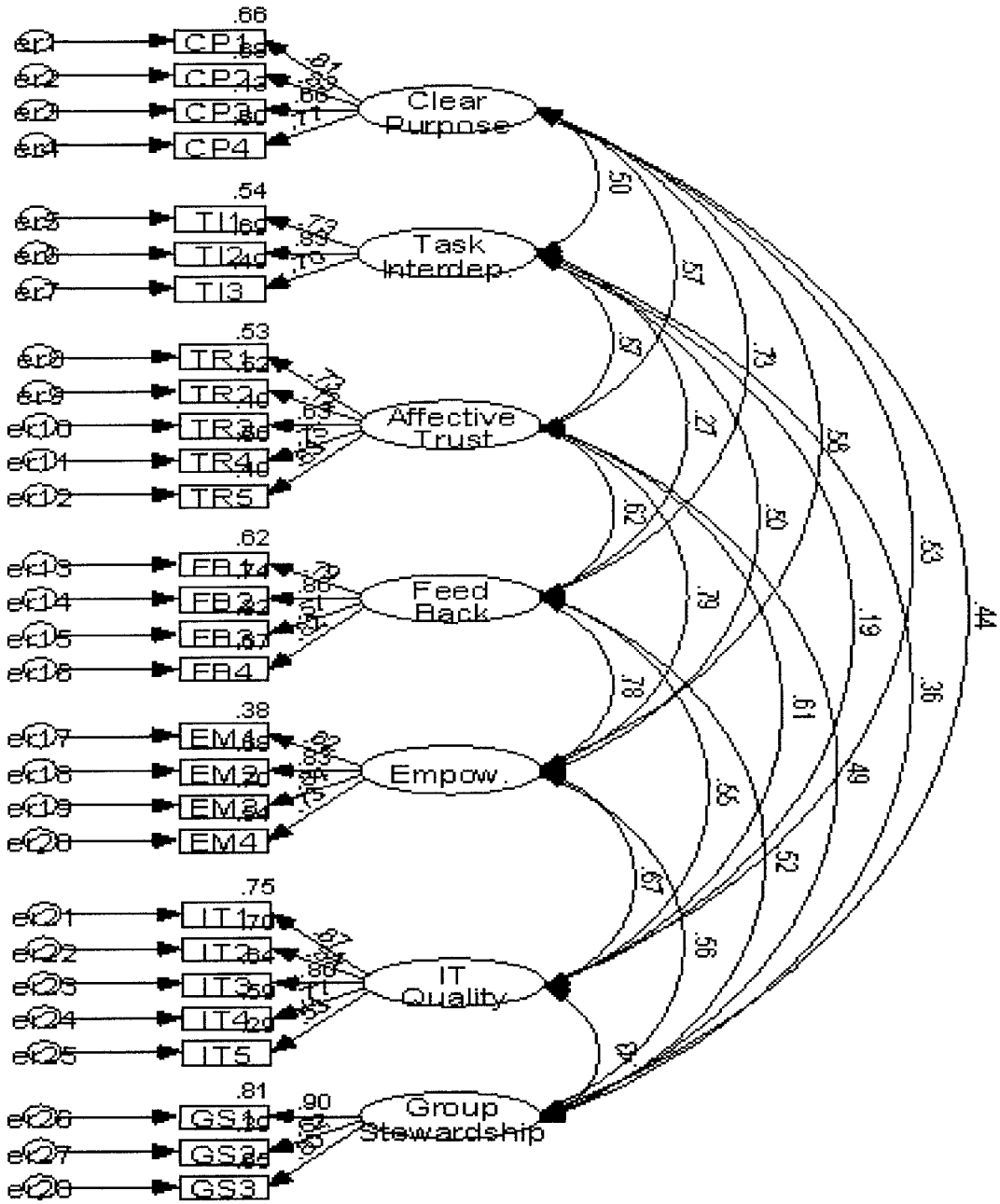

Figure 5 – Path Analysis of Antecedent Variables

APPENDIX C.3

Path Analysis of Group Learning

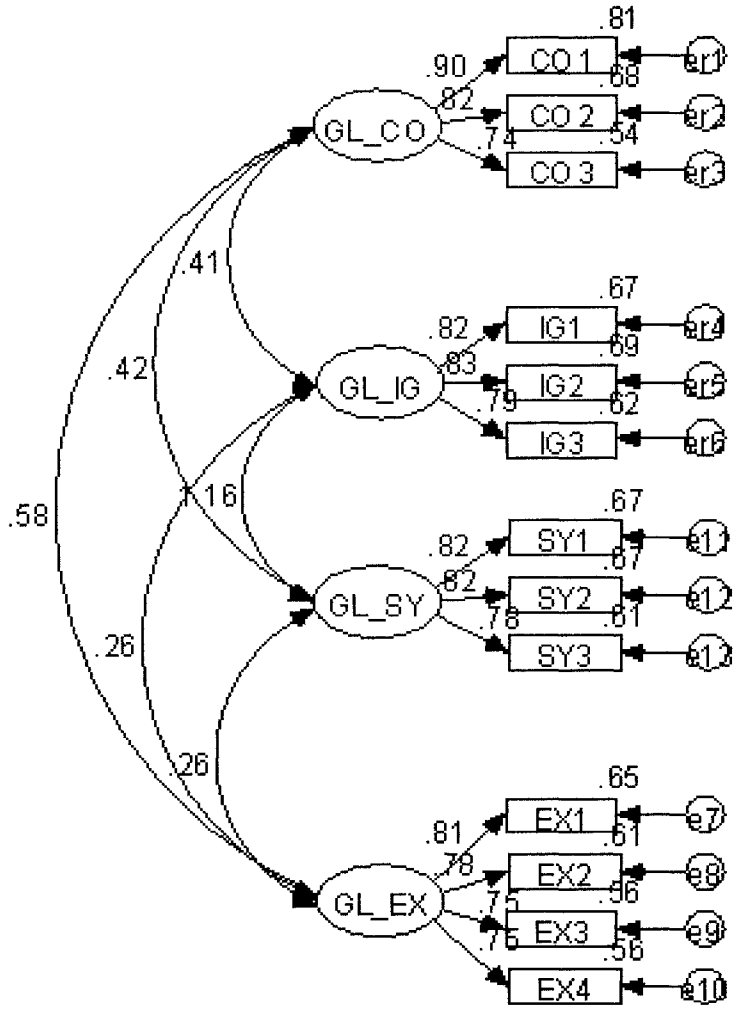

Figure 6 – Path Analysis of Group Learning

APPENDIX C.4

Path Analysis of Knowledge Conversion

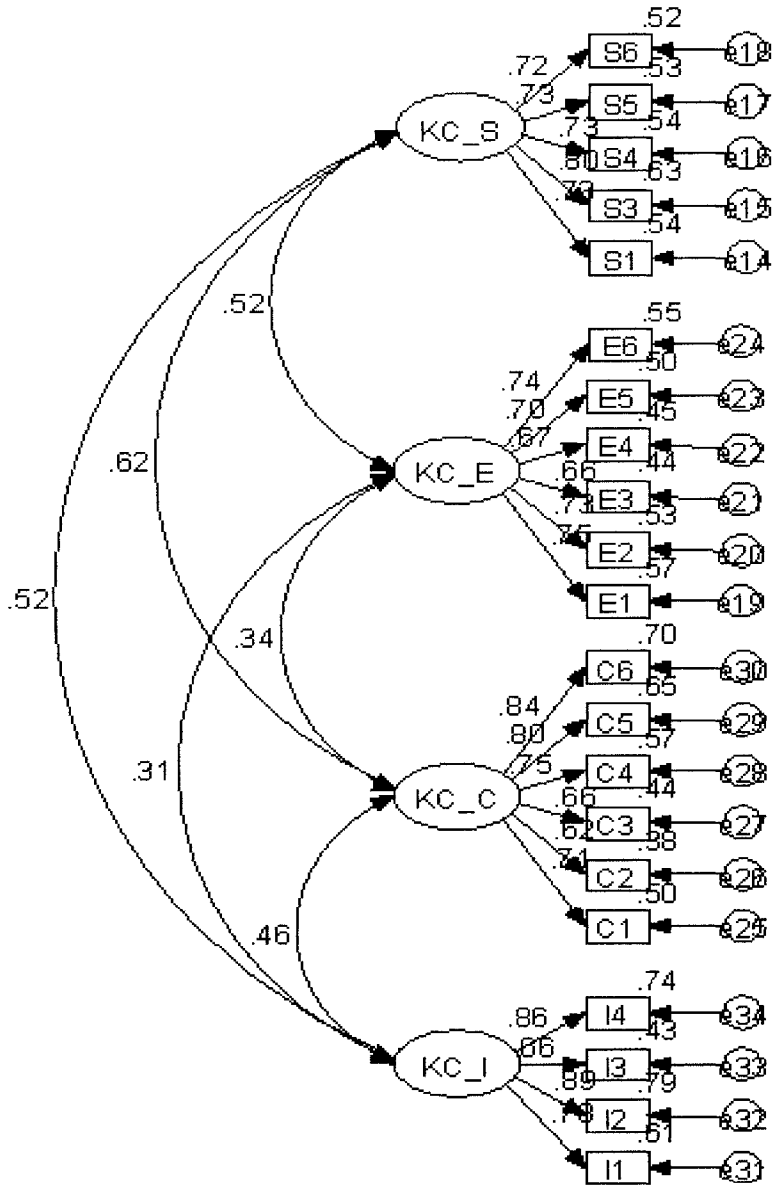

Figure 7 – Paths Analysis of Knowledge Conversion

APPENDIX C.5

Path Analysis of Outcome Variables

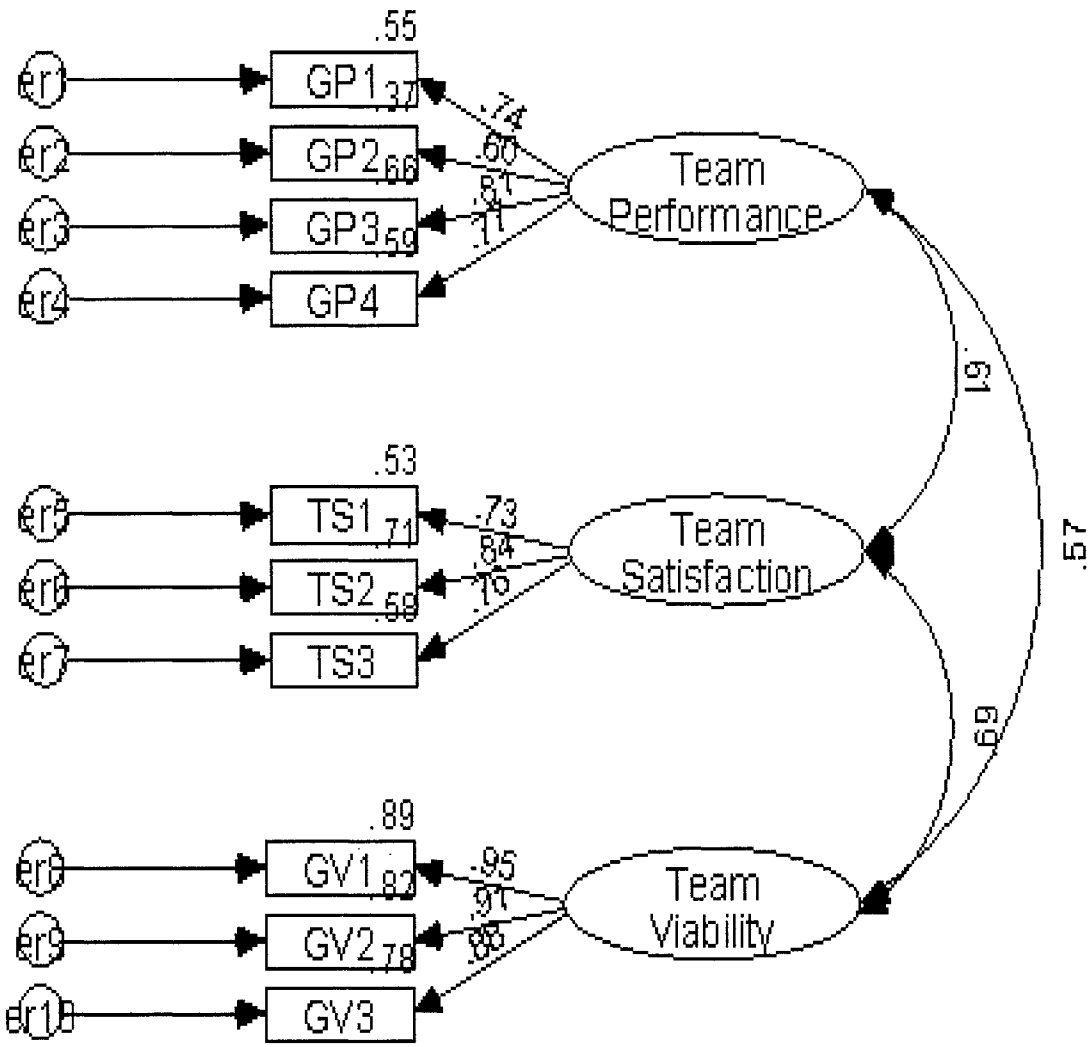

Figure 8 – Path Analysis of Team Effectiveness

APPENDIX D

Test Results of Preliminary Model

Table 36 - Standardized Regression Weights

			Estimate
Knowledge Conversion	<--	Task Factors	0.093
Knowledge Conversion	<--	Team Factors	0.044
Knowledge Conversion	<--	Organization Factors	0.005
Knowledge Conversion	<--	Group Stewardship Factor	0.861
Team Learning	<--	Task Factors	-0.014
Team Learning	<--	Team Factors	0.026
Team Learning	<--	Organization Factors	-0.006
Team Learning	<--	Group Stewardship Factor	-0.045
Team Learning	<--	Knowledge Conversion	1.038
I	<--	Knowledge Conversion	0.964
C	<--	Knowledge Conversion	0.91
E	<--	Knowledge Conversion	0.879
S	<--	Knowledge Conversion	0.862
CO	<--	Team Learning	0.789
IG	<--	Team Learning	0.907
EX	<--	Team Learning	0.887
SY	<--	Team Learning	0.908
TI	<--	Task Factors	0.691
CP	<--	Task Factors	0.66
GS	<--	Group Stewardship Factor	0.961
IT	<--	Organization Factor	0.76
EM	<--	Organization Factor	0.832
FB	<--	Team Factor	0.558
TR	<--	Team Factor	0.957
GV	<--	Team Learning	-19.412
TS	<--	Team Learning	-17.258

GP	<--	Team Learning	13.678
GP	<--	Knowledge Conversion	-12.8
TS	<--	Knowledge Conversion	18.065
GV	<--	Knowledge Conversion	20.148