CHAPTER 1

INTRODUCTION

1.1 Background

Knowledge management is related to capturing, organizing, and storing knowledge and experiences of individual workers and groups within an organization, and making this information available to others in the organization while respecting and compensating value to the concerned owners of the intellectual property rights. Literatures on KM indicate the necessity to define knowledge as a primary task since how one defines knowledge also determines how one uses and manages knowledge (Allen, 1998). In addition, it is argued that those who fail to define and make clear distinctions of knowledge, data and information make very serious error in knowledge management (Fahey & Prusak, 1998).

Although information on how knowledge might be managed are scattered in different disciplines such as economics, philosophy and epistemology, computer science, and sociology, it is still difficult to define them. (Earl, 2001) So far, there are no universal definitions of knowledge and knowledge management. Knowledge can be viewed from various perspectives such as it being distinct from data and information, a state of mind, an object to be stored and manipulated, a process of applying expertise, a condition of having access to information, and the capability to influence our actions (Alavi & Leidner, 2001).

Extending the earlier works of others (Huber, 1991) (Nonaka, 1994), Alavi and Leidner, (1999) define knowledge as a justified belief, which increases an individual’s capability to take effective action. The term ‘action’ in the above definition may apply to physical skills, cognitive/intellectual capability or both. Sveiby (1997) also consents that knowledge is the capacity to act.

1.2 Classification of Knowledge

There are different scales of classifications of knowledge in KM literature. Some have noted up to ten types, while others have noted lesser in number (Alavi &

Leiner, 2001). They are (1) tacit, (2) explicit, (3) individual, (4) social, (5) declarative, (6) procedural, (7) causal, (8) conditional, (9) relational, and (10) pragmatic. Another classification (Blumentritt & Johnston, 1999) mentions only four types: (1) codified, (2) common, (3) social, and (4) embodied. Some also argue the need to reconstitute KM (Faucher, Everett & Lawson, 2008). Their study concludes that data information, knowledge and wisdom should be redefined from a new perspective for further improvement in KM deliveries. They have clearly pointed to 'meta-data, meta-information and meta-knowledge'.

Among the different classifications of knowledge, the distinction between tacit and explicit types seems to be well-known and widely accepted by many authors and researchers (Xu & Quaddus, 2005). Davenport and Prusak, (1998) further explains these explicit and tacit forms of knowledge stating that they exist in organization's experience, values, norms, repository systems, practices, documentations etc. It needs substantial time to convert tacit knowledge into explicit knowledge, which can be absorbed and applied for technological innovation. This is the result of human effort to adopt a habit of 'learn to learn' (Heffner & Sharif, 2008). This habit may lead to increased organizational competiveness. Heffner and Sharif (2008), note that tools such as 'skills, facts and methods' are applied knowledge within organizations.

1.3 Difference between Data, Information, Knowledge and Wisdom

In addition, a few distinctions between data, information, knowledge and wisdom are made to avoid serious errors in KM (Fahey & Prusak, 1998). Having clear conceptualization of critical success factors is relevant in the context of interdisciplinary practice of knowledge which is the subject covered in the present study. There appears a general agreement that data, information, and knowledge are not interchangeable concepts. Data are raw numbers, pictures, facts, symbols, bits observations; information is processed and organized data that gives some meaning to those who receive it. Knowledge is a combination of more information that is applicable or that which can be practiced in the present context. Having an idea of how to apply gained information to perform in single or multiple tasks is also referred to as knowledge. Wisdom is rationality about how, where and when to apply a particular knowledge (Brooking, 1999) (Zack, 1999) (Alavi & Leidner, 2001) (Callaghan, 2002). Xu & Quaddus, (2005) in their article referred to knowledge as representing many peculiarities - it relates to human actions, it is the residue of thinking, it can be applied, society is the owner of knowledge, and it circulates through communities in many ways.

1.4 Knowledge Management Generations

By the early nineties, the first and the second-generation knowledge management emerged in the knowledge management literature (Xu & Quaddus, 2005), and the third generation appeared in 1999.

1.4.1 The First Generation

Literature reveals that this generation was proposed by Koenig (Vorakulpipat & Rezgui, 2008), which primarily focuses knowledge sharing, using best practice and lessons learned. This involves the capturing or harvesting of information and experience so that they are easily accessible in a corporate environment. Management of captured experiences and information leads a system to grow into a powerful information asset and organizational memory. This has led to organizations investing heavily in technological fixes that had either little impact or a negative impact on the way in which knowledge was used.

Exhibiting the first generation KM scenario, an organization installed a sophisticated intranet in order to categorize and disseminate information, but found that only few people within the organization actually used the intranet. This led the management to make the use of the intranet compulsory, but this resulted in disappointment among the staff, and decreased their trust in the organization. Thus, the first generation solutions were often counterproductive (Xu & Quaddus, 2005). It is criticized for its failure to indicate theoretical base to explain the process of how new knowledge is learned in organizations to boost their competitive strengths. Thus, the first generation knowledge management is blamed for being incapable of managing knowledge creation since it focuses on the supply side, i.e. sharing knowledge.

1.4.2 The Second Generation

The second generation KM proposed by Snowden (Snowden, 2002) (Vorakulpipat & Rezgui, 2008), is an update of the first generation KM in that it uses metaphors to explain how knowledge grows. It focuses on knowledge creation activities based on SECI models (Nonaka & Takeuchi, 1995). Alternatively, this generation of KM emphasizes on the demand side, i.e. knowledge creation. In comparison, these metaphors are closely linked to the concept of organizational learning in order to adopt a practice as new piece of knowledge.

It is believed that organizational learning and cooperative learning are very important for organizational and individual success in practicing transformation of tacit knowledge to explicit knowledge. This views knowledge as commodity. The motive of commercialization of knowledge by individuals and organizations in the form of intellectual property rather than property of the society may appear as a challenge in the third KM generation.

From the social view, there are some degrees of knowledge, material, and context as social input to create new knowledge, and thus, there seems no rationality in granting intellectual property rights to individuals or institutions. Instead, it would be better to provide some form of honor and special support to the knowledge creators by the society for their contribution to the civilization to grow to further heights where they learn and live. There is the need to establish a balance between IPR and assurance of social access to new inventions.

It is not clear whether this second generation KM has the capacity to explain the unsolved problems cited in the first generation KM literature, but one thing has certainly happened – it has changed the focus of KM from knowledge sharing to knowledge creation.

1.4.3 The Third Generation

Literature cites the third generation KM being proposed by McElroy (McElroy, 1999). Although there appears to be no clarity in direction and focus of this KM generation, some literatures have shown attempts being made to focus on value creation (Vorakulpipat & Rezgui, 2008). Value creation by KM is possible through a number of different alternative methods – in particular, by the application or practice of knowledge in production, experimentation in economies, creation and transfer of knowledge in the local-global context. These values may account in various forms such as material, psychological, monetary and non-monetary.

This dissertation construes the knowledge application construct in the structural model to denote creative use of knowledge for value. It is more convenient to transform the new concept based on conventional understanding of the subject matter given in literatures. To some extent, this also contributes to further promote literature in value creation (Vorakulpipat & Rezgui, 2008) aspects of the third generation KM.

1.5 Essential Skills of Knowledge Workers

There appears to be a general agreement that a knowledge worker or a knowledge advisor should be familiar with actions and benchmarked strategic skills for effective knowledge utilization and transfer process. Others add that for efficient knowledge transfer in virtual communities, some degree of personification is required even if there are problems of regular face-to-face contacts (Gammelgaard & Ritter, 2005). KM literature reveals a list of skills of a knowledge worker, i.e., codification, personalization, exploration, exploitation, best practice, after action reviews (AARs), peer reviews, knowledge mapping, lesson learned, *Ba*-skills, induction (data mining), web standard and protocol.

1.6 Allocation of Knowledge Workers' Time

Jacobson & Prusak, (2006) unveil that the largest share (45.9%) of knowledge workers' time is consumed in adapting knowledge gained from different sources to accelerate achievement of meaningful purpose of knowledge organization. This is followed by time spent on eliciting knowledge from experts (37.7%), searching for knowledge (10.2%) and scheduling meetings with experts (6.2%) respectively. These figures indicate that application of knowledge requires the highest amount of knowledge workers' time compared to allocation in other works.

1.7 Levels of Knowledge

According to Brooking (1999), data are factors, pictures and numbers presented without a context, whereas information represents organized data with context. Knowledge is information presented in context with further detail understanding of how to use the same. The proposition of Zack (1999) is that data is fact that comes out of context. Information results from arranging data in a way that gives some meaningful context. Knowledge is information organized meaningfully by using experience. Wang and Plaskoff (2002) also concur with Zack (1999) in that knowledge is injected with experience and that information has context and meaning, while data has no context and meaning at all.

Literature on KM shows that data is meaningless output of any operation and is a symbolic representation of numbers, letters and facts, and that it is the means of storing and transferring information and knowledge (Ahmed, Lim & Loh, 2002). Information is the group of these data arranged in a context that makes a valuable meaning. Knowledge involves sophisticated work of combining various elements like experience, skills, intuition, ideas, judgments, context, motivations and interpretation. It appears that knowledge involves integration of both thinking and feeling**.** A recent study proposes an E2E model to reconstitute KM, and concludes the existence of non-linear relationships among existence, data, information, knowledge, wisdom and enlightenment (Faucher et al., 2008).

Knowledge is the cumulative stock of skills and information that is produced from the use of information by human resources. The use of information by people undergoes a cognitive process whereas data represents any kind of signal (Burton-Jones, 1999). There is a lot of similarity among scholar community regarding the concept of data, information and knowledge. For example, knowledge contains truths and beliefs, perspectives and concepts, judgments and expectations, methodologies and knowhow, all of which are possessed by individuals or organizations. Knowledge may be rigorously applied to recognize, receive, analyze and interpret etc. information intelligently (Wiig, 1999).

Researchers and scholars have differentiated data, information and knowledge on context, usefulness or interpretability. The main basis for differentiating knowledge from information and data is the belief that knowledge is the result of processing information mentally. It is, therefore, not isolated from knowledge possessing bodies and units that may or may not be unique (Alavi & Leidner, 2001).

1.8 Contemporary Knowledge Management

The contemporary KM has regressed to ever-increasing capacity of electronic storage and transfer of knowledge and information through internet, intranet and other unique modes to satisfy diverse needs of the society. The dot com generation has become old story due to enhancements through faster and efficient hardware improvements. Yet, the basics of capturing, possessing, and arranging tacit and explicit knowledge to apply this for productive purpose have not changed (Alavi & Leidner, 1999) (Davenport, Long & Beers, 1998). Similarly, the trend of brain drain from one place to other attractions, and competition among buyers in harnessing knowledge resources have become universally important and inseparable items as reflected by the magnificent volumes of contemporary world trade. Organizations on the other hand use knowledge to increase organizational memory by rightful and logical value in acquiring the content of knowledge in their own system. KM includes four knowledge processes, namely, knowledge creation, knowledge storage, knowledge distribution and knowledge application (Wiig, 1993) (Myers, 1996) (Alavi & Leider, 1999).

People have understood KM in various dimensions at different times and in different contexts (Cortada & Woods, 1999, 2000) (Bonner, 2000) (Malhotra, 2000). KM is a social-technical system of both tacit and explicit business policies and practices (Carayannis, 1999). Wiig (1993) defines KM as the fields of analysis, synthesize, assess and implement goal-oriented changes relating to knowledge. Sveiby (1998) describes KM as the value creating art by applying organizational intangible assets. Duffy (1999) views KM as a process that causes creation by taking advantages of organizational experience and intellectual resources. Saffady (1998) views KM utilizes knowledge resources of an organization systematically and effectively. Malhotra (1998) states that knowledge management deal with the issues of organizational adaptation, survival and competence during unstable environment changes. The American Productivity and Quality Center (1999) views KM relates to strategies and processes that assist a firm to compete by identifying, capturing and leveraging knowledge.

The above ideas indicate that contemporarily KM is enabled by the strategic integration of information technology tools, business processes, and intellect, human and social capital, which is the driver of innovation and value creation works.

1.9 Statement of the Problem

There is an acute lack of a structural model in KM literature that can facilitate one to explore and describe the aspect of knowledge application in organizations by linking critical success factors and group process. In the organizations under study, knowledge application often appeared to be antecedent of knowledge outcome or value creation. For example, robot making, treating patients, and introduction of new varieties of animals, rice, maize, and vegetables have been accomplished by application of knowledge. These outputs create value for individuals and the society. The study of the structural model has been necessary to examine unproven queries (Wong, 2005) in KM literature – such as the link of critical success factors explored by previous work (Davenport , Long & Beers (1998) with knowledge application and, thereby, with value creation. According to Wong (2005), that perceived link of critical success factors and knowledge management output they (Davenport et al., 1998) mentioned has remained unverified in subsequent studies. This indication in knowledge management literature is the research gap and the statement of problem. This has inspired the study in Nepalese organizations.

Pieces and bits of knowledge emanating from previous studies provided some indications to form logics in designing a structural model that could serve the purpose for exploration in Nepalese organizations. The different pieces of variables were not taken solely from model studies but were also taken from different studies done with various approaches and purposes in different parts of the world. The group process is the only variable utilized in previous model study linking to growth satisfaction and job satisfaction (Janz & Prasarnphanich, 2003). Group process which could be a mediator variable to channelize information communication technology and budgetary resources has remained unexamined in previous studies. Similarly, the link of group process with knowledge application is still unknown, and that again stands as an unsolved problem in the literature.

Another problem is that contemporary literature on knowledge management is overwhelmed with studies undertaken in the developed countries. Very few materials pertaining to least developed countries are available. This study in the Nepalese context serves to fill the gap in KM literature. This is an academic research that explores common critical success factors and their paths to knowledge application in engineering, agriculture research and hospital sectors.

Literature reveals that the critical factors proposed by Liebowitz (1999) have contextual implications on organizations. Organizational memory is one such variable that is referred to champion organizations in the field of KM practices (Wong, 2005). The status of contextual effect on HRD, work process, ICT, and budget remains unknown in KM literature. These mysterious aspects of critical success factors needed to be examined from general and situational perspectives so as to expand the understanding of their behavior when organizational sector and year of involvement/job tenure of concerned participants are changed. The problem for this model study lies in the analysis and exploration of the contextual effects of these factors, which were perceived to be general for all organizations because no such descriptions were found in literature.

Another crucial problem is to design a model, which enables researchers to study the value creation aspect of the third generation KM, which is also lacking in the contemporary literature.

1.10 Scope of Research

Since a number of convincing evidences were found in the selected organizations that showed that knowledge application is antecedent of value creation, the heart of the third generation KM, this model may be utilized to examine the structure of critical success factors to knowledge application. Knowledge application can further be linked to value creation in the future provided there is adequate number of participants or possibility of observations in the concerned sectors. Besides, as a base design, this model has wider scope of structural customization and multidisciplinary adaptation for a number of projects in areas such as climate change, biodiversity conservation, tourism, public health, transportation, communication, agriculture, trade, education etc.

This work may open doors for further studies for refining theories of KM by assessing, among others, the degree of link of critical success factors to knowledge application and finally their link to quantitative indicators of value creation in organizations such as productivity, number of operations conducted on kidney patients, quantitative values created for industries by robot deployment, changes in food security and life standards of farmers by absorption of prescribed farming technology, and Tobin's-Q change of agricultural firms, i.e., ratio of market value to replacement cost (Tobin, 1969) (Smirlock, Gilligan & Marshall, 1984).

The structural model being considered in the current thesis originates from critical success factor, the group process, and knowledge application. The whole purpose of knowledge application in organizations is aimed at creating certain value, either qualitative or non-qualitative. Attempt at value creation is the primary focus of the third generation KM (Vorakulpipat & Rezgui, 2008). The representing factors namely work process, ICT, HRD, supportive culture, organizational memory, and budget included in this dissertation may serve as indications for future researches particularly in developing scales of variables that can be used for one sector rather than three sectors. They may thus serve as the pointing model path linking to knowledge application and then to value creation construct.

The stability of the estimated model results has been tested in Monte Carlo simulation, which further enhances the precision of parameter, standard error and other fit evaluation criteria. This simulation experiment work has explored new pieces of empirical evidence relating to the Chi-Square use in large samples and the Steiger-Lind RMSEA feature, which are found in structural equation modeling literature.

1.11 Rationale of Study

Critical success factors have been treated equally for IOE, NARC and IOM/TUTH in the face of their knowledge application, outputs and value creation diversity. A list of critical success factors of KM provided in literatures has been utilized in filtering most relevant factors that are based on principal component analysis of the pretest ratings by 46 experts. They provided ratings to describe the roles of those factors in achieving an organization's outcomes. The rationale of treating factors commonly is also to examine previous literatures (Liebowitz, 1999) that have suggested culture and knowledge repository (i.e., organizational memory) being applicable to KM-champion organizations (Wong, 2005), while other variables had no special remarks. The receiving of international awards in their fields by the organizations under study was a major consideration for perceiving that one of the three organizations may be the champion.

Another rationale for analyzing single structural model for treating indifferent factors is to retain the reliability of scales in the parameters of the estimated paths. If three models for each sector were analyzed, there would be high chances of sudden drop in reliability (Cronbach's alpha) of the variables, particularly those which were slightly above the minimum recommended 0.60, (Nunnally, 1978) (Bagozzi & Yi, 1988) (Baker, Parasuraman, Grewal, & Voss, 2002) due to split in sample size. In addition, the PCA of surveyed data revealed that common treatment of success factors explains 61.63% of sum of squares by this structural model.

Finally, in the backdrop of most literatures on KM dwelling on the perspectives and contexts of developed countries, this study represents a model from a least developed country. In Nepalese context, six variable constructs have been developed originally, and a mediating variable, the 'group process', has been borrowed directly from the western literature (Campbell & Hallam, 1994) to extend our understanding of combined linkage of group process, information communication technology and budget in knowledge application.

1.12 Objectives of Study

The main goal of this research is to explore whether the strength of critical success factors rated by participant knowledge workers demonstrates a linkage with the knowledge application in the organization. This thesis attempts to achieve the following objectives by using the maximum likelihood estimation technique:

1. To examine the normal convergence of the selected variables in confirmatory factor analysis and to obtain their input matrix.
2. To examine the significance of the six hypothesized model paths and to estimate their parameters, standard error, t-statistics and fit indices.
3. To test fulfillment of the centrality and the non-centrality based assumptions by the model.
4. To evaluate the stability of reported fit indices, standard errors and parameters by the use of Monte Carlo simulation technique.
5. To examine the existence of contextual effects, if any, reflected in sample data by establishing direct linear link of all variables of the model to knowledge application scale.

1.13 Hypothesis

Relationships between the exogenous manifest variables and the endogenous manifest variables are established for the design of the structural model path presented in Figure-1 by using references available in the theories of KM. This figure accounts for hypotheses one to six respectively. The hypothesized structural paths are highly supported by rigorous literature reviews for the construction of the following hypothesis in this confirmatory research design.

H_1: Structural path originating from ‘work process’ to ‘knowledge application’ is significant.

H_2: Structural path originating from ‘information communication technology’ to ‘group processes’ is significant.

H_3: Structural path originating from ‘organizational memory’ to ‘knowledge application’ is significant.

H_4: Structural path originating from ‘HRD’ to ‘knowledge application’ is significant.

H_5: Structural path originating from ‘budget’ to ‘group process’ is significant.

H_6: Structural path originating from ‘group process’ to ‘knowledge application’ is significant.

Level of significance: 0.05

1.14 Limitations of Study

Since there are numerous critical success factors in KM, only five are included in the current model. This thesis is unable to take into account the surveyed six critical success factors and observes their structural paths to knowledge application. The supportive culture produced scale reliability below acceptable level. Thus, it has been removed from the current structural model due to decrease in degree of freedom that further constrained the analysis.

In structural equation model's result, all predictor and dependent variable's reliability were measured above the minimum recommended limits of 0.60 (Nunnally, 1978) (Bagozzi & Yi, 1988) (Baker et al., 2002), but the same could not be established in regression analysis for all variables by split of samples as per selection criteria employed. Therefore, it would be wise to trust the structural equation model result considering this fact that the disturbance (ZETA) is significant on the model path headed to group process only.

Due to the limitation of time, cost, and researcher's knowledge, the presence of diversity in knowledge application and the perception of value by the participants' quantitative assessment could not be established as intended. The work process, ICT, HRD, organizational memory, supportive culture, budget and knowledge application variables have been originally developed for this study. Nevertheless, repeated interactions carried out while developing the questionnaire tool and subsequent pretest survey in the selected organizations may have caused discomfort to participants as reflected by low participation in the final survey. No incentives could be provided to the participants neither at the individual level nor at the organizational level during the survey period to ensure greater participation.

This thesis does not intend to dwell on tedious equations since alternative computer-based methods that give greater precision are used for defining equation variable links and measuring parameters. The path diagram written by the use of AMOS package is only to show how links of independent critical success factors to the dependent variables have been designed in the total framework of the model for quick reference. The path diagram is considered an alternative to long equations to describe structural links of variables (McArdle & Roderick, 1984).

Econometricians still favor writing a series of tedious equations, but it is not the purpose of this thesis. Its purpose is to predict parameters, standard errors and t-values of concerned variables modeled in the structural paths. No analysis has been performed in AMOS package except for determining the degree of freedom, sample movement and number of parameters without constraining any of the exogenous variables. The exact constrained model analysis and simultaneous equation system analysis is administered respectively in SEPATH and STATA procedures. Therefore, its design shown in Box1 exhibits fixed exogenous variables in the solved model path.

More response items could have been collected for ‘human resource development’ and ‘organizational memory’, the realization of which came only after the completion of survey. It may be pertinent to mention here that this study may have encountered numerous errors such as human error, machine error, software error and conceptualization errors in the literatures and the structural modeling technique, assumption errors and response error of the participants.

1.15 Methodology

The methodology adapted for this study is described below.

1.15.1 Selection of Organizations for Survey

The three organizations Nepal Agricultural Research Council, Khumaltar, Institute of Engineering, Pulchok Campus and Institute of Medicine/Tribhuvan University Teaching Hospital, Maharajgunj have been selected for this study considering their diverse knowledge application practices. Interaction with research scientists, mechanical engineers and electrical engineers and doctors respectively from NARC, IOE and IOM/TUTH provided advantages in streamlining the relevant six critical success factors out of a long list extracted from literature. In addition to principal component analysis, a workshop organized in NARC further accelerated the work of finalizing the common variables and context items for knowledge application scale. This eased the difficulty arising out of diversity of input, time, cost, process in applying common scale to measure varied perceptions on value creation by these organizations and pretesting surveys in those organizations made it possible to derive a modified common multi-item scale for the design of structural model.

1.15.2 Selection of Variables for Structural Model

The questionnaire contains more than three representative items per critical success factor. If one or two items were merged to form one variable, it could produce an unstable parameter estimate of model even if the reliability measures were satisfactory. The structural equation modeling literature recommends measurement of three or more items per variable (Hatcher, 1994), which appears reasonably comfortable. From reliability point of view, the smaller the sample sizes the more items per variable is demanded. This indicates that more the number of items per variable the better, however, there is a fear of agitating participants if too many items were included in the questionnaire. The exogenous and endogenous variables demonstrating values of Cronbach's alpha above the recommended minimum threshold of 0.60 (Nunnally, 1978) (Bagozzi & Yi, 1988) (Baker et al., 2002) are only considered for structural model analysis.

1.15.3 Instrument Design to Measure the Variables

Interaction programs were organized in the selected organizations to acquaint with the general concept, procedures and issues of organizational work procedure, critical success factors and knowledge application in selected organizations. The key faculty involved in robot making project, researcher scientists, and doctors were encouraged to describe critical success factors for best utilization of their knowledge.

In the initiation phase of the survey, the multi item questionnaire containing seven critical success factors (produced from literature review) indicated unstable reliability. Utilizing the experience gained through successive surveys, the variables that indicated unstable reliability were modified in the questionnaire with items matching with the working context items rather than the quantitative content items of participant's jobs.

The mediating variable, i.e., the group process taken from Campbell and Hallam's team development survey of 1994, is also an endogenous variable of critical success factors but exogenous for knowledge application. Although the instruments of measurement of scale for the mediating variable in the model are adopted from previous studies conducted by others, the rest of the scales are developed as original work for this study through frequent informal interactions and discussions with champion knowledge workers of the respected work areas.

In the beginning, the focus was to attempt quantitative outcome measures of knowledge application, but analysis of pretest survey data produced challenging number of items and size of participants needed to achieve acceptable reliability by the scale. This problem was subsequently solved by changing the focus of a few question items of the knowledge application scale measuring quantity to context because the response to context items were found to be quite high in the pretest surveys as they were compared with the response for the quantitative items of the variable of questionnaire.

1.16 Methods of Data Analysis

Statistical and algebra computations are performed using SEPATH, STATA, AMOS, and SPSS packages. The data from the three organizations are combined for a representative outcome because the responses were insufficient to meet the scale reliabilities when the hypothesized model was analyzed separately for each organization. The following steps have been adopted in analyzing the surveyed data.

1.16.1 Removal of Outlier

The collected questionnaire has been verified for usability and responses recorded in the computer. At first, the outlier responses at 95% confidence interval were identified and removed from the data file.

1.16.2 Reliability Analysis

The constructs, dependent and independent variables are measured in a seven-point Likert scale, have been tested for their reliability. The cutoff point of Cronbach's alpha applied to select a variable in the model is 0.65 in value, which is slightly above the recommended minimum level (Nunnally, 1978) (Bagozzi & Yi, 1988) (Baker et al., 2002).

1.16.3 Power Transformation of Data

The sum of the selected scales including the mediating variable group process has been transformed with Box-Cox method taking precaution for avoiding the adverse cases of a singular covariance matrix during its iteration. Box and Cox suggested this process to change non-normal data into approximately normal after observing that there were no obvious methods (Box, Jenkins, & Reinsel, 1994).

1.16.4 Confirmatory Factor Analysis

The exogenous and endogenous manifest variables of the hypothesized structural equation model were tested for normal convergence in CFA procedure before advancing towards the structural modeling. The normal convergence of selected model variables was achieved in five iterations.

1.16.5 Structural Equation Modeling

The input correlation matrix produced by CFA has been used for structural equation model analysis. The constrained solution achieved normal convergence in 29 iterations (Annex 3) producing various fit indices, parameters, and standard errors of the estimated model. This analysis also tested the causal link of exogenous critical success factors with knowledge application and fulfillment of multivariate assumptions by the model at five percent level of significant.

1.16.6 Monte Carlo Simulation

Next, the solution has been tested for presence of Heywood effect in estimated model checking the model's consistent stability in Monte Carlo simulation technique. The simulation is a form of experimental design to confirm many different dimensions of predictions based on data from single research. Researchers use this technique, despite its implicit limitations to save cost, time and effort needed to conduct similar researches repeatedly in the same population to confirm their initial results.

1.16.7 Simultaneous Equation System

The Eigenvalue Stability Index produced by simultaneous equation system analysis is useful in crosschecking the status of a structural equation model based on simulation reports. This index also help the researcher ensure whether the Software deployed for simulation and vice-versa performed according to inputs provided by a model's path diagram.

1.16.8 Multiple Regression Analysis

Initially, the use of regression analysis for the validation of structural model's result (Sabeherwal & Fernandez, 2003) was not planned. It was, however, necessitated after two independent variables link indicated by the structural model analysis were found to be antagonistic to the conclusion repeatedly established by earlier studies conducted in different organizations and places. Lastly, an obvious contextual effect has been previewed in regression analysis to convince the prismatic character of independent variables link with knowledge application construct empirically by changing the conditions of selection variable like organization and participants' involvement years/job tenure by applying the following model:

$$\hat{Y}= \beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\varepsilon$$

Where, $\hat{Y}$= regression model applied β_0= constant value in regression, β_1X_1= coefficient of work process, β_2X_2 = coefficient of HRD, β_3X_3 = coefficient of organizational memory, β_4X_4 = coefficient of budget, β_5X_5 = coefficient of ICT, β_6X_6 = coefficient of group process and ε = errors in estimating coefficients

1.16.9 Principal Component Analysis

PCA is useful in arranging variables or problems captured by surveyed data in the order of their power and importance. Their results usually provide the basis to explain more logically, why some variables in the model exhibit different characters.

The summary of purposes and methods deployed for data analysis is given in Table 1.

Table 1: Methods Deployed for Data Analysis

Analysis method	Reason for use
Removal of Outliers	Redundant flow of data received in questionnaire survey contaminates analytical procedure and produces undesired directions of the model parameters and statistics. An extreme low or high value in rating questionnaire items of variable is a universal problem resulting out of various influences. Detection and removal of such extreme data, with statistical software at 95% confident interval, may improve the quality and stability of the result rather than retaining the outlier data sets.
Reliability Analysis	Reliability analysis of scale is useful to researchers in making decisions on selection of variables for the successive steps of structural equation modeling. Prediction made by variables with strong reliability may have more stable parameter estimates than low reliable measures obtained for the same purpose.
Box-Cox Transformation	Box-Cox is a power transformation system, which converts non-normal data into approximately normal. The aim of such transformation is to reduce the potential problem of singular covariance matrix during confirmatory factor analysis (CFA) and structural equation model (SEM) iterations. Prior normalization of variables is a universally acceptable practice for streamlining the data structure for analysis provided the procedure demands normal input data. In addition, transformation is one of the data preparation process widely adopted in multivariate analysis.

Confirmatory Factor Analysis	CFA is mandatory to confirm convergence test of manifest variables (predictor and dependents) and to know the nature of measurement model employed before proceeding for the structural modeling.
Structural Equation Modeling	SEM is used to transform variable links as per theory showing correlational relationships into structural model path and to estimate model parameters and model fit indices. It is also used to evaluate whether the fitted model fulfills assumptions of structural equation modeling.
Monte Carlo Simulation	This is used to review fit indices of forecasted model in simulated sample size and numbers without extended series of field survey and to check whether the model has been influenced by Heywood cases.
Simultaneous Equation System	Analysis of simultaneous equation system of entire structural model paths produces an Eigenvalue Stability Index, which is used to crosscheck and legitimatize the Monte Carlo simulation reports and their resultant conclusions drawn on a tested structural equation model.
Regression Analysis	Multiple regressions are used to exhibit the change in the pattern of link of the independent variables to knowledge application when variation in selection criterion, i.e., year of involvement and organization are applied.
Principal Component Analysis	PCA assisted in organization based arrangements of variables captured by surveyed data in order of their power and importance. By reviewing its result, it is possible to find a logical explanation of why some variables exhibit heterogeneous characters in model link.

1.17 Structural Equation Modeling Technique Adopted

A few popular methods of structural equation modeling are the LISREL model, the COSAN, Benter-Weeks model, McArdle's RAM model and the SEPATH model respectively. The SEPATH program revolutionized structural equation modeling from its earliest editions featured with centrality fit measures to introduce the Steiger-Lind based RMSEA index in structural equation modeling. This has filled the vacuum in earlier LISRELIAN measures like Joreskog GFI and Joreskog AGFI.

Thus, this structural equation modeling analysis is confirmatory of SEPATH procedure. The solutions of the structural equation model have been achieved in these conditions: exogenous variable- fixed, standardized- new, analysis- correlation, initial value- automatic. Monte Carlo simulation uses all the conditions mentioned before, but default 0.5 was applied as initial value to run the program.

1.18 Model Design

Model design is a key process in reviewing the method of measuring parameters in structures as per preconceived theoretical concepts about relationship of variables found in the KM literature. The foundation of theoretical concept, whether or not it is established in earlier studies, needs to be translated in the model structure path for evaluations. One needs to explore how exogenous variables cause changes in endogenous variables, or how the researcher evaluates the degree of fit of observed data to hypothesized model path directions.

The critical success factors namely, work process, ICT, HRD, supportive culture organization memory, and budget have been indicated repeatedly in knowledge management literature. This dissertation analyzes a structural model containing five critical success factors, one mediating variable and one dependent variable all fulfilling the acceptable scale reliability.

The structural model does not deal with selection variables that are merely used to illustrate empirically how they react in the changed contexts. The selection variables, i.e., year of involvement and organization, therefore, deals extensively with the analysis results generated in multiple regression analysis. The multiple regressions has used no mediating variable as such, but a direct link of the six variables to knowledge application scale is established and assessed for further exploration and discussion purpose.

1.19 Simulated Experiment with Monte Carlo

Structural modeling researchers who are not familiar with the logic of experimental design are often unaware that the design of the research can yield additional specifications. Likewise, longitudinal designs may bring with them certain parameters that do not change over time. Successful structural modelers exploit all three types of specifications – substantive theory, measurement theory, and experimental design respectively. Traditionally, psychologists focus on experimental design, the psycho-metricians on measurement theory, and econometricians on substantive theory. Rather than choosing one specification by one discipline, specifications should be chosen to fit the problem that has been unanimously accepted during the design of the structural model in the preparation of this thesis**.**

A causal modeler dreads most is the fear of model misspecification. Misspecification of model is a universal case, i.e., one of the assumptions of the model is incorrect. It is not wise to criticize a model simply because it is misspecified. It is rational to present the evidence to prove that it seriously estimates biased parameters, because sometimes a complete or a part of the model may be robust. The designs of structural equation path for this thesis are motivated by such major influences of the literatures in KM, organization behavior and, finally, the literatures of SEM.

There are possibilities that a fit index, which rejects a model at first attempt, may not reject it again in other replications. The single-sample based result needs to be reevaluated through simulation to confirm its stability. It is true that one cannot work with the real data of population covariance/correlation matrix of the estimated structural model, but can evaluate simulated data. Evaluation of stability of estimated model parameters, standard errors and fit indices assures that the estimated model is free from Heywood effect. It also tests whether a particular method of estimation is capable of maintaining specified limits of error while a model is being evaluated.

There are few empirical studies that refer to limitations of different estimation methods and tools used in structural modeling. Simulation study is one of the desired procedures available for the researchers. It not only fills the gap in contemporary SEM literature but also helps in interpreting the model itself.

A previous study (Davenport et al., 1998) indicated that critical success factors may have link in organizational effectiveness. However, no substantial studies have attempted to validate this with empirical tests. This act, therefore, provides support for the creation of a base model to add another block in the development of theories in the dynamic realities of the KM discipline. For this, the estimated model is retested in 50 simulated samples to ensure that its parameters, standard error and fit indices are stable in population. In addition, it needs to be examined for fit of assumptions of multivariate normality to draw conclusive inference of credibility of the estimated model.

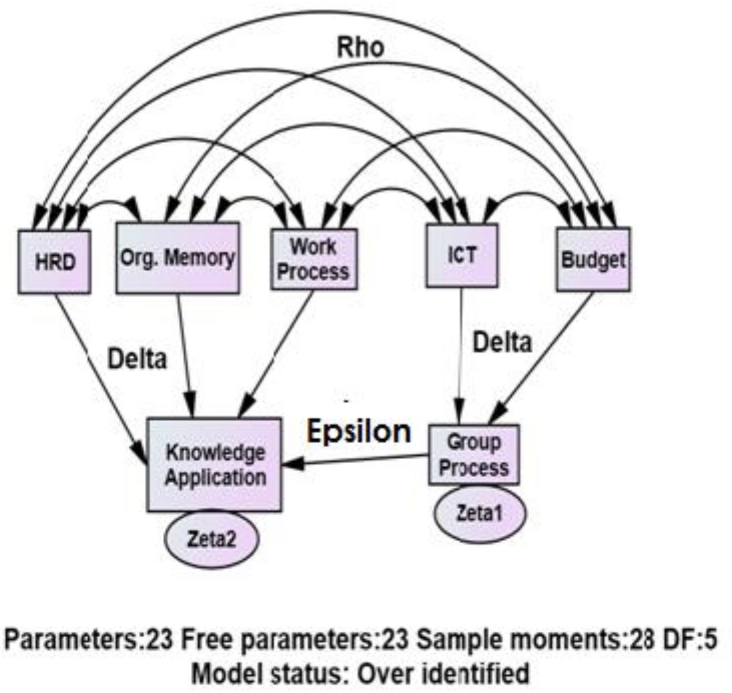
1.20 Path Diagram of the Hypothesized Structural Equation Model

The path of structural equation model related to hypotheses 1 to 6 is given in Box 1 showing variables that are correlated (rho) and variables with causal relations in the equation path (indicated by → sign). The programming skills in PATH1 or Microsoft's Visual Basic provide the benefit in understanding structural definition of this model.

The path diagram uses fundamentals of Reticular Action Model (RAM), which can directly incorporate different types of common structural models including the models based on structure of means (McArdle & Roderick, 1984). An easy to understand path diagram of the model created in AMOS, given for reference (Figure 1), may provide a crude framework of the hypothesized model. The degree of freedom (D.F.=5) mentioned in the path diagram refers to the condition of model identification where all exogenous variables are free.

In a comprehensive term, since supportive culture is discarded for poor reliability of scale, there is one degree of freedom in the structural equation model when estimated with constrained exogenous manifest variables and new standardized method used in SEPATH module (Box1). Box 1 includes detail of relationships of variables shown in Figure 1, and it also represents the actual status of model identification after exogenous variables were constrained. The parameters, fit indices, and standard errors, reflector matrix etcetera have been described in this thesis.

Figure 1: Path Diagram of the Hypothesized Structural Model



Note:

Rho: Correlation between independent variables, Delta: Base name for residual variables, Epsilon: Base name for residual variables, and Zeta: Base name for disturbances.

Box1: SEPATH Syntax of the Hypothesized Structural Model

```
(Work Process)-1->[wpro]
(ICT)-2->[ict]
(HRD)-3->[hrd ]
(Organizational Memory)-4->[memory]
(Budget)-5->[budget]

(DELTA1)-->[wpro]
(DELTA2)-->[ict]
(DELTA3)-->[hrd]
(DELTA4)-->[memory]
(DELTA5)-->[budget]

(DELTA1)-6-(DELTA1)
(DELTA2)-7-(DELTA2)
(DELTA3)-8-(DELTA3)
(DELTA4)-9-(DELTA4)
(DELTA5)-10-(DELTA5)
(ICT)-11-(Work Process)
(HRD)-12-(Work Process)
(Organizational Memory)-13-(Work Process)
(Budget)-14-(Work Process)
(HRD)-15-(ICT)
(Organizational Memory)-16-(ICT)
(Budget)-17-(ICT)
(Organizational Memory)-18-(HRD)
(Budget)-19-(HRD)
(Budget)-20-(Organizational Memory)

(Group Process)-21->[gpro]
(Knowledge Application)-22->[kapply]

(EPSILON1)-->[gpro]
(EPSILON2)-->[kapply]
(EPSILON1)-23-(EPSILON1)
(EPSILON2)-24-(EPSILON2)

(ZETA1)-->(Group Process)
(ZETA2)-->(Knowledge Application)

(ZETA1)-25-(ZETA1)
(ZETA2)-26-(ZETA2)

(ICT)-27->(Group Process)
(Budget)-28->(Group Process)
(Group Process)-29->(Knowledge Application)
(Work Process)-30->(Knowledge Application)
(HRD)-31->(Knowledge Application)
(Organizational Memory)-32->(Knowledge Application)
```

1.21 Sample Size

Although there are many rules of thumb in prescribing the sample size (Loehlin, 1992), it is generally suggested that the sample size should be greater than 100 cases because structural modeling relies on tests that are sensitive to sample size. Literatures (Bentler & Chou, 1987) recommend that there should be at least five cases per parameter estimate (including the error terms as well as the path coefficients). Likewise, to calculate asymptotic covariance matrix, it is suggested to have $k(k+1)/2$ observations, where k is the number of variables. This indicates that to incorporate seven variables in the present structural model analysis, it is required to have a minimum of 28 samples provided there are no missing responses.

From the various recommendations related to sample size determination, it has been deduced that a large sample could mean at least 100, which is an acceptable default size in SEPATH module developed for commercial purpose by StatSoft Corporation, USA. Therefore, this model study utilizes 167 responses collected from questionnaire survey.

1.22 Data Collection

Two pretest surveys were conducted to streamline common items of variables during development and validation of the scales used for final survey. The structured questionnaire given in Annex 6 was distributed to students and faculties of mechanical and electronics departments of IOE that were involved in robotics project in the past, and research scientists of NARC involved in various knowledge application and creation projects. Similarly, the questionnaire was distributed to faculty doctors, MBBS and MD students involved in different departments of IOM/TUTH. Altogether, 167 usable responses (22.27%) out of 750 vibrant knowledge user population working in 23 different units of the three organizations represent in the final questionnaire survey. The detail is provided in the following section.

1.23 Participants of the Sample

A total of 750 questionnaires were distributed, but only 270 were returned. Out of these, 103 questionnaires lacked complete responses in multiple variables.

Therefore, the responses of only 167 questionnaires have been used for this model study. The removal of outliers further decreased the range of sample size available for reliability analysis and input correlation matrix. Table 2 depicts the total picture of sample participants from different sectors contributing to shape the direction of the estimated model described in this thesis.

Table 2: Population and Sample Participants

Professional Area	Organization	Population[123]	Sample	Percent
Medical science	IOM/TUTH	405	58	14.32
Engineering	IOE	102	54	52.94
Researcher scientists	NARC	243	55	22.63
	Total	750	167	22.27

[1] Faculty doctors, M.B.B.S. and M.D. students from anesthesiology, anatomy, biochemistry, clinical pharmacology, dental, dermatology, ENT, forensic medicine, general surgery, internal medicine, microbiology, ophthalmology, and orthopedic departments are included.

[2] Only faculty engineers and students of who once involved in robot making projects from electrical and mechanical departments are included because robot making is an irregular and extracurricular activity.

[3] Crop, horticulture, livestock, fisheries, crosscutting (soil and insect) outreach, and seed production units are included.

CHAPTER 2

LITERATURE REVIEW

2.1 Chapter Theme

This chapter covers the basic concepts and information found commonly in knowledge management literature and model variables, which are the core parts of this model study. The topics covered under this section are knowledge types, nature of organizational knowledge, KM need, modes of knowledge creation, concept of knowledge transfer, problems of knowledge transfer in SECI model, the core themes for KM, use of scorecard, and KM diversity. Besides, it also covers model variables, namely ICT, budget, organizational memory, HRD, work process, group process, knowledge application constructs and methodological basics of structural modeling techniques.

2.2 Knowledge Types

KM literature divides knowledge into tacit and explicit forms (Polanyi, 1962, 1967) (Nonaka & Takeuchi, 1995) (Spender, 1996) (Alavi & Leinder, 2001) (Leonard & Sensiper, 1998). The tacit knowledge can be applied in multiple works like problem solving, exploring hidden problems, and forecasting consequences of given situation and its potential results (Leonard & Sensiper, 1998).

This tacit knowledge also exists in technical and cognitive forms. The cognitive part of tacit knowledge is perceived to be a mental model, which helps human resources in the process of understanding and interpreting the real world situation or the events and things around them. An individual’s perspectives, beliefs and opinions are few examples of tacit knowledge, whereas the technical part of tacit knowledge comprises of things such as knowhow, crafts and various skills and abilities an individual possesses (Nonaka & Takeuchi, 1995). In other words, the explicit knowledge is to know ‘what’ and tacit knowledge is to know ‘how’ and ‘when’ dimensions of knowledge application. The noesis of ‘when to apply’ a particular knowledge appears to be strategic in nature than to know ‘how to apply’ it. Knowing when to apply knowledge tests one’s level of rationality, wisdom and philosophical soundness to view the world and its peripheries for the welfare or destruction of universe. In addition to that, the combination of three elements – 'what to apply', 'how to apply' and 'when to apply' knowledge gives the direction of competitive strength, innovation and growth to individuals and organizations.

Literature reveals that tacit knowledge tends to be highly personalized and context-specific as well as subjective in nature; therefore, it is more difficult to formalize and communicate to others (Nonaka & Takeuchi, 1995). In contrast, explicit knowledge is more objective and generally can be codified or documented in a formal or systematic format for wider circulation – like information in database, journals, libraries, and internet. Tacit knowledge has much higher value than explicit knowledge since people always know more than what they can tell to others (Sveiby, 1997) (Moody & Shanks, 1999). Application of explicit knowledge appearing in expressible status such as data, texts, codes and so on are possible if they were already converted into tacit. This is the reason for tacit knowledge being extensively expensive. It provides more value to organization's service delivery mechanism (Moody & Shanks, 1999).

2.3 Nature of Organizational Knowledge

Knowledge in an organization appears to be in the hierarchical structure ascending from data, information, knowledge and wisdom as one views this concept from the bottom-up. Data is the basic element of information coding, a perception, a signal, a sign or quanta of interaction. For example, '13' or 'X' are data. Thus, data is symbolic representation of numbers, facts and quantities. Fukuda (1995) also mentioned that data are made up of symbols and figures, which reflect a perception of the experiential world.

Information is data structured according to a convention, such as 'yesterday, it rained 125 mm in Pokhara'. Information is the result of comparison of data that are structured according to situations in order to arrive at a message that is significant in a given context. Information is obtained from data, which have been given significance and selected as useful. Therefore, information is to be understood as the selected sets or combined form of one and other types of data that serves a purposive meaning.

Information can be defined as knowledge expressed according to a convention or knowledge in transit. Nonaka (1994) explained that information is a flow of messages, and knowledge is a stock created by accumulating information. Thus, information is a necessary medium or material for eliciting and constructing new forms of knowledge. The second difference highlights that information is something passive while knowledge comes from belief, which makes it more proactive.

Knowledge is information with a context and value that makes it usable to strengthen or weaken organizational performance. Knowledge places someone in the position to perform a particular task by selecting, interpreting and evaluating information as the context appears factually relevant (van Dijk, Berends, Jelinek, Romme & Weggeman, 2011). This is how knowledge empowers people, and thus the adage 'knowledge is power'. Knowledge is systematized information arranged in accordance to definite plans or projects. According to Fukuda (1995), knowledge is an information which is interpreted (i.e., the intended meaning of which was decided) in context, and the meaning is articulated with already acquired knowledge.

Wisdom can be defined as 'timeless knowledge', and adds an intermediary step for theory, which Fukuda (1995) defines as generalised knowledge. Knowledge understands a subject, which has been obtained by experience or study. Recent E2E model study has concluded that there is existence of nonlinear relationships among data, information, knowledge and wisdom (Faucher, Everett & Lawson, 2008). The above explanation may provide some indication of the fundamental nature of knowledge that exists in modern organizations.

2.4 Need of Knowledge Management

KM is needed for people from all walks life to maintain a better survival status. The globalization widened the intensity of status prospect at a new global-scale at each value added series of utilization. This has created interest in the invention and modification of prototype utilities in the target market and transversal resource. Such a need has arisen due to information heterogeneity and information overload. There is a need for awareness among targeted objects (human resources) for upgrading and transforming into organizational or individual tacit form so that copying by others becomes difficult. Knowledge workers are also familiar about new knowledge deposit, location, means, and strategies to apply for their own benefit. Timely availability of relevant information from resources accessible to an organization can lead to more informed decisions on the part of individuals, thereby promoting the effectiveness and viability of decentralised decision making.

Sharing an activity in a group also implies sharing of the knowledge involved in it. To survive, the organization needs to share knowledge among its members and create and collect new knowledge to anticipate the future (Abecker, Bernardi, Hinkelmann, Ku, & Sintek, 1998). The above idea is good from organizational perspective, but appears to be a unilateral view that does not include the knowledge from champions in the organizational memory system. Sharing knowledge from the existing orgnizational memory may lack benchmarks, and sharing work may not seem to be productive in critical contexts where the level of innovation is high.

From the perspective of organizational survival , one could argue that human resources should not share knowledge in organization; rather, they should provide output of knowledge only. In the highly competitive globalized employment market, it is seemingly impractical to expect one to develop his/her own rivals and ease management in future human resource supply. Organizations develop and use patent or trademark rights by encouraging free sharing of knowledge of their human resources because the secret of knowledge is already scattered around people of the organizations. But the question arises - when organizations enjoy intellectural property right, why not human resources too?

The organization that fails to value knowledge of its own human resources would not affect the society by its extinction. Thus, it seems rational to provide incentive for exchange of explicit or tacit skills of an individual or a team. It is also a fundamental prerequisite for stimulating the sharing of personified knowledge within the organization. This pertinent factor (Shane, 1995) (Ang & Massingham, 2007) is considered as the independent variable for knowledge application. To sum up, the need for knowledge management arises simply because knowledge is still the core business resource of an organization. The difference in facets are in context, level and usefulness to society and communities.

2.5 Modes of Knowledge Creation

The four modes of tacit and explicit knowledge creation processes – the socialization, externalization, combination and internalization are proposed in SECI model (Pentland, 1995) (Nonaka & Konno, 1998). Knowledge creation is the focus of the first generation knowledge management.

The SECI model identifies four '*ba*', which are spaces, or places an organization needs to create for human interaction so that knowledge creation, distribution, collection and application takes place. These places are originating *ba,* dialoguing *ba,* systemizing *ba* and exercising *ba*, which are related to socialization, externalization, combination and internalization modes of creating knowledge respectively. This model is extended by adding two more *ba*'s (Uotila, Melkas & Harmaakorpi, 2005) - the visualization and potentialization, which respectively require imagination *ba* and futurizing *ba*. The additional *ba*'s are called transcending mode.

Socialization refers to the process of exchanging and absorbing tacit knowledge from people through different media like face-to-face contact, master-fellow relationships, focus on-the-job training, brainstorming, and informal meetings. This process links to personalization (Moody & Shanks, 1999). In this knowledge creation process, information technology can be useful in creating and sustaining knowledge communities through teleconferencing, desktop video-conferencing, video calls, chat and emails. Overall, literature review suggests that socialization is useful in developing organization's tacit knowledge accumulation and enhancement capacity that are possibly utilized in practicing and creating things. Organizational culture is reported to have significant interaction effect on knowledge accumulation capacity (Chang & Lee, 2008). The successful innovators are those organizations that learn to learn (Heffner & Sharif, 2008) besides creating new knowledge.

Externalization is the process of converting tacit knowledge to explicit knowledge in many different forms like hypotheses or articles by converting ones experience, insight, judgment, knowledge obtained through observation, and practice into a format that can be used in the future by those who may need it. Large amount of learning in technologically embodied organizations involves changing tacit knowledge to explicit knowledge (Heffner & Sharif, 2008). There is sufficient evidence in the study that indicates externalization has a great role in knowledge application of NARC, IOE and IOM/TUTH as well.

Externalization, in more specific terms, is the set of activities involved in articulating tacit knowledge in appropriate patterns for mass circulation. Thus, this process is related to the codification strategy. The creation of explicit knowledge can be enhanced by introducing and extending employee access to information technologies (Junnarkar & Brown, 1997). In emerging techno-communities, the internet and computer support facilities available in organizations may be used in different modes of knowledge application and creation system because the internalization, externalization and combination modes of knowledge creation tend to switch to convenient electronic versions, from manual interaction and cooptation, at increasing rate. A study report has indicated that creating knowledge in a Japanese research university was impaired by aspects of technological support, human resources engaged in innovative projects, laboratory and culture, in particular (Tian, Nakamori, & Wierzbicki, 2009).

Combination is the addition of explicit knowledge to create newer and more advanced explicit knowledge (Vorakulpipat & Rezgui, 2008) from different sources by individuals through various activities like sharing archived data, combining and comparing sets of information from journals, and organizing and processing pieces of knowledge and information. Internet, intranets and electronic mails have speeded up the volume and frequency of knowledge transfer within and outside organizations. These technologies have extended the scope of the paperless explicit to explicit knowledge transfer (Junnarkar & Brown, 1997). Technology has saved time and cost, it has also increased unprecedented risk of information phishing, misuse and leakage by unauthorized people and agencies. Some empirical studies indicate the existence of knowledge network have different rates of codified knowledge transfer in organizations in Europe, Japan, Korea and Taiwan (Appleyard & Kalsow, 1999)

Internalization is the process that relates to the absorption of explicit knowledge and converts this to tacit format through practice. In other words, internalization is the whole process within the organization that is concerned with conversion of facts and figures obtained through many published and unpublished sources into practice in day to day activities by human resources. Documented knowledge can be helpful in this process, such as learning from best-practice databases. Computer-based data mining tools enhance decision-makers' ability to make sense of explicit information, especially in the presence of complex sets of data (Junnarkar & Brown, 1997).

2.6 Concept of Knowledge Transfer

One of the dreamed traditions of cooperative learning in the organizational work life is to share work materials and ideas between individuals or among members of the organization for better performance outcomes. However, viewed from individual growth perspective, the tendency to protect ones broad competency in the global knowledge market is paradoxical to the expectation of making other people competent in work through sharing of mental models, beliefs and perceptions. Valuable tacit knowledge requires many years to develop from work experience. When this form of knowledge is shared with other people and employees in the organization, it is tantamount to giving away ones special skills forever to other bodies (Tranfield, Denyer, Marcos, & Burr, 2004).

Perhaps, some forms of attractive compensation packages and incentive systems within the organizational framework will maintain a reasonable scope of this knowledge sharing culture in the competitive knowledge market for the long run. Externalization and socialization modes are highly encouraged to speed up knowledge transfer to other people. The 7C model proposed by Oinas-Kukkonen (2004) considers communication as one variable in which the use of internet or ICT is said to speed up explicit knowledge transfer. Study has indicated that acquisition and responsiveness to knowledge is more important for knowledge creation than dissemination of knowledge in organization (Darroch & McNaughton, 2002).

2.7 Problems of Knowledge Application in SECI Model

Nonaka's (1994) SECI model, useful for recognizing the mode of knowledge creation, has further facilitated knowledge professionals in identifying the problem of knowledge transfer. SECI includes the focus of three-generation KM because knowledge creation, knowledge distribution and knowledge application presumably produces goods and services that have some material or immaterial values. There are, however, problems in socialization, combination, externalization and internalization. Transfer problems prevail universally in the processes of creation of knowledge, knowledge application, knowledge storing and knowledge benchmarking etc. The main problem in KM arises within the knowledge transfer cycle of knowledge creation to knowledge diffusion and knowledge adoption to utilization (Bolloju & Turban, 2002).

2.8 The Core Themes for Knowledge Management

They (Devenport et al., 1998) studied a number of KM projects and have offered some insight into the range and nature of such projects that are currently being implemented. Organizations like Dow Chemical have sought to demonstrate that KM can affect the bottom-line by starting with quick fix solutions rather than attempting to embed KM in a holistic manner throughout the organization. Dow Chemical started with a project that involved the systematization of information on the company's 30,000 patents. (Devenport et al., 1998) were able to categorize these projects based on their objectives. They identified four broad project objectives: (1) Creation of knowledge repositories to store knowledge and information, (2) Improvement of knowledge access, (3) Creation of conductive environment for more effective knowledge creation, transfer and utilization, and (4) Recognition of the value of knowledge to start KM efforts.

2.9 Use of Scorecard in Knowledge Management

Scorecards have become a fad in the 21st century management literature. The use of scorecard justifies inter-group stake sharing relationships. (Skyrme & Amidon, 1998) proposed measurement of knowledge by using scorecard that was forwarded by Kaplan and Norton (Kaplan & Norton 1992). The scorecard evaluates organization's value in four dimensions – the customer, internal process, innovation and learning, and financial aspects, respectively (Knotts, Jones, & Udell, 2006). Although there is a continuing debate about the appropriate metrics in this quadrant, they have the potential to measure knowledge as an asset and to support organizations as they seek to value their intellectual capital.

2.10 Knowledge Management Diversity

The different objective categories have identified four types of perspectives on KM, and emphasize the diversity of the concept. There are many who have suggested KM from project view. According to (Davenport & Prusak, 1998) “Knowledge management is concerned with the exploitation and development of the knowledge assets of an organization with a view to furthering the organization's objectives. The knowledge to be managed includes both explicit, documented knowledge, and tacit, subjective knowledge” (p.62).

Their definition identifies KM from the assets view to forward organizational goal. For example in NARC, it is the prescription of new variety of seeds, techniques of farming and fisheries by conducting observation-based research in Nepalese topography and climate. For IOM/TUTH, it is to cure patients by practicing medicines, equipment use, and medical research. For IOE, it is to try out models of machine operation and electrical works including some interesting projects like robot making and exhibition of engineering works and products.

KM includes ensuring organizational repository and memory access to human resources and manage IT infrastructure for efficient communication need. The above proposal also indicates the fact that IT use and organizational memory are independent variables for continuing the objectives of KM, which is knowledge application of the current model.

There are also people who opine KM from the process perspective rather than a project. They provide a list of processes like generating knowledge, seeking knowledge from external sources, keeping document, databases, software etc. in organizational memory, blending knowledge in products and services, penetrating knowledge in whole departments, application of knowledge in making decision, foster incentive and supportive culture to expand knowledge and measurement of the result of knowledge (Galagan, 1997).

2.11 Critical Success Factors

According to (Rockart, 1979), the critical success factors are those few performance measures, which ensure successful and competitive results. Wong (2005), viewed critical success factors as activities and practices that should be considered for a successful implementation.

Therefore, critical success factors are those selective elements of organization, which help in creating perceived qualitative and quantitative value of KM by contextual interactions including with other low profiled factors.

Studying the practices and experiences of the knowledge leader companies, Skyrme and Amidon (1997) present seven critical success factors respectively closely linked to business goal, brilliant vision, leadership, knowledge creation and sharing culture, restless learning, strong technology infrastructure and systematic process. They were recommended for considering critical success factors by those organizations that were planning to transform themselves into a knowledge-based entity.

Holsapple and Joshi (2000) carried out a Delphi study to investigate the factors that could influence management of knowledge in organizations, which they categorized as managerial, resource, and environmental with different factors included in each. For example, leadership, control, measurement, coordination as managerial factor; human, material, knowledge, finance as resource factor; and, economic, government, time pressure, market, competition etc. as environmental factor.

Davenport et al. (1998), conducted an exploratory study with a view to determine critical success factors relating to effectiveness of 31 KM projects run by 24 companies. They found eight common factors associated to 18 successful projects in terms of performance, namely support from top management, dynamic motivational practice, knowledge–friendly culture, structure, clear purpose, economic performance and existence of multiple channels to transfer knowledge in the projects. Wong (2005), states that the study by Devenport and others "… was an exploratory study, it was agreed that linking of identified factors with the success of knowledge management should be viewed as being hypothesized, not proven" (p.270). This gesture found in knowledge management literature became the first theoretical base to establish direct causal linkage of critical success factor to knowledge application, and one of the organization's success measurement criteria or variable used in the current model.

Chourides, Longbottom and Murphy (2003), found critical factors in five functional areas after they conducted longitudinal study, literature review and interviews with key staff and administered questionnaire survey. They identified critical success factors in organizations as 'strategy, HRM, IT, quality' and 'marketing' respectively. Their listed factors like 'improve time to market skills, improve organization velocity to respond to customer needs, monitoring knowledge management portfolio matrix' are criticized for being too specific and unrealistic by Wong (2005). One of the listed factors by Chourides et al.(2003), the 'innovation through research' was found to be relevant, but could not be brought to use as there were no agreeable and continuous bases to record innovation in the surveyed sectors.

There is another reference of Liebowitz (1999), who indicates six key factors that contribute to a successful KM. These critical success factors proposed by him are 'senior management supported strategy', 'arrangement of chief knowledge officer and KM infrastructure', 'knowledge repository' or organizational memory, 'KM system and tools', 'incentives' to encourage knowledge sharing, and supportive organizational 'culture'. This obviously reflects a focus towards those organizations that have the necessary expertise, human and financial resources. Wong (2005), opined that the critical success factors proposed by Libowitz are more suitable to champion organizations in the field of KM practices.

Hasanali (2002) highlighted a list of critical success factors containing 'leadership, culture, structure, roles and responsibilities, IT infrastructures, and measurement.' Attempt made to include supportive culture and ICT use by participant knowledge workers, as exogenous variables in the current model are the influences of Hasanali's work. However, the supportive culture is discarded from the current model study due to poor reliability of scale.

Likewise, the APQC (1999) includes strategy and leadership, culture, technology and measurement as enablers that can support the operation of KM. Although these factors are eminently sensible, it is believed that the success of KM is also dependent on other additional aspects.

To sum up, the critical success factors most frequently found in literatures are management leadership and support, culture, information technology, strategy and purpose, measurement, organizational infrastructure, processes and activities, motivational aids, resources, training and education, and human resource management.

2.11.1 Supportive Culture

This variable is derived from the references made available in earlier KM literature (Skyrme & Amidon, 1997) (Devenport et al., 1998) (APQC, 1999) (Liebowitz, 1999) (McDermott & O'Dell, 2001) (Hasanali, 2002) (Wong & Aspinwall, 2005). This factor is not included in the present model for exhibiting the lowest reliability of scale among the variables captured from questionnaire survey.

2.11.2 Information Communication Technology

ICT, which is close to IT factors, is derived from the references made available in earlier KM literature (Skyrme & Amidon, 1997) (Devenport et al., 1998) (Liebowitz, 1999) (APQC, 1999) (Hasanali, 2002) (Alavi & Leidner, 2001) (Wong & Aspinwall, 2005) (Shankar, Acharia, & Baveja, 2009) (Hsiu-Fen, 2011). This factor has been included in the model for producing acceptable reliability of scale.

2.11.3 Organizational Memory

Having organizational memory is similar to having access and use of knowledge repository and documentation system that is considered an important part of organizational infrastructure. It is also derived from the references made available in earlier KM literature (Devenport et al., 1998) (Liebowitz, 1999) (Herschel & Nemati, 2000) (Hasanali, 2002) (Wong & Aspinwall, 2005) (Shankar et al., 2009). This factor has been included in the model for producing acceptable reliability of scale.

2.11.4 Work Process

The work process as a model factor for this study is derived from the references made available in earlier KM literature (Skyrme & Amidon, 1997) (Devenport et. al., 1998) (Holsapple & Joshi, 2000) (Bhatt, 2000) (Dvir & Pasher, 2004) (Wong & Aspinwall, 2005). This factor has been included in the model for producing acceptable reliability of scale.

2.11.5 Budget

The budget factor is derived from the references made available in earlier KM literature (Holsapple & Joshi, 2000) (Davenport & Volpel, 2001) (Dvir & Pasher, 2004) (Wong & Aspinwall, 2004) (Wong & Aspinwall, 2005). This factor has been included in the model for producing acceptable reliability of scale**.**

2.11.6 Human Resource Development

HRD is related to competency of human resources, which is derived from the references made available in earlier KM (Horak, 2001) (Yahya & Goh, 2002) (Mentzas, 2001) (Wong & Aspinwall, 2005) (Shankar, Acharia, & Baveja, 2009). This factor has been included in the model for producing acceptable reliability of scale.

2.12 Group Process

Group process is borrowed from the team development survey originally used by Campbell and Hallam (1994). There are structural model studies where group process is combined with two other constructs like positive interdependence and promotive interaction to form a mega construct termed as cooperative learning. Janz and Prasarnphanich (2003), modeled these three constructs into one single construct indicating causal link to growth satisfaction as a non-Tobin-Q variable of job characteristics model of Oldham and Hackman (1980). Cooperative learning is the process of improving action through better knowledge and understanding (Fiol & Lyles, 1985). According to others (Hult, Ketchen, & Earnest, 2003), it relies on two concepts – the process of learning and the structure of the learning organization respectively.

Group process is the feeling of a team reflecting on its performance and thinking together how to achieve further improvement possibilities. Group process refers to the effort to evaluate a group's performance periodically and represents the behavior of transition from simply having information to possessing the knowledge when it is to be used. Group process is a part of cooperative learning and is referred to as a collective mind (Weick & Roberts, 1993). It is one of the important features possessed by effective workgroups. This includes socialization mode of tacit-to-tacit knowledge creation and personalization mode of knowledge transfer (Nonaka, 1991). The references in previous studies encouraged to link group process with ICT and budget. Cooperative learning occurs when members of the team work together to share and develop tacit knowledge while doing their job. Positive interdependence, promotive interaction, and group process are necessary conditions for cooperative learning (Janz & Prasarnphanich, 2003). Theoretically, a high degree of group process implies corresponding high degree of social knowledge in the group.

Job performance within the boundary of time, volume, direction and strategic moves may also be affected by complex integration of resources of organizations. The capacity to arrange required resources according to the nature of job sequence and the intensity of process and interdependence of other processes involved in a project affect ones performance. In other words, it is to intensify creative use of knowledge by the knowledge workers.

2.13 Knowledge Application

There should be a creation and transfer cycle of knowledge, and the transferred content of knowledge needs to be adopted by other people in organizations prior to its application and practice at work. Application of knowledge results into either positive or negative value creation of teams and organizations. The capability to acquire knowledge is far more important to organizations than their knowledge diffusion capacity across user groups for innovation purposes (Darroch & McNaughton, 2002). Creation and innovation is normally achieved by knowledge application in a given work context. A knowledge or practice is adopted if new idea or material is meaningful or makes sense to people (Weick, 1995). The adoption of new practice is to discard old knowledge, findings or ideas by forming a perception (Gear, Liendo & Scott, 1989). In KM literature (Brachos, Kostopoulos, Soderquist & Prastacoos, 2007), Gear's "perception" (Gear et al., 1989) and Weick's "sense making" (Weick, 1995) are concepts that are very similar to Brachos's "perceived usefulness of knowledge" (Brachos et al., 2007). New methods are needed for acquiring and synthesizing the lessons learned from the existing research and presenting it to people in clear, logical, comprehensible and actionable forms.

The knowledge application is related to the practice of findings, ideas, models and propositions. Three predominant types of knowledge use have been suggested: instrumental, conceptual and symbolic use (Beyer & Trice, 1982). The instrumental uses of knowledge are specific and direct (Transfield, Denyer, Marcos & Burr, 2004). For example, introduction of new seed variety by NARC in some geographical areas is instrumental use of knowledge. The conceptual use is indirect and concentrates on mental process without changing direct behavior. Thinking differently of a situation or a thing is conceptual use of knowledge. The symbolic use is often made to clarify or to prove the course of action and therefore (Transfield et al., 2004) stated "…the utilization phase requires a full understanding of organizational change processes" (p.380). They view adaptation and utilization of knowledge as a social process. All the critical success factors reviewed above are exogenous variables linked to group process and knowledge application path in the present structural model. Linking these critical success factors to knowledge application is done in the backdrop of literature review.

2.14 Technique of the Structural Equation Modeling

Social and behavioral scientists generally use a causal language either explicitly or implicitly, and they lack a common and systematic approach to causal analysis. Psychologists in particular have relied on a language that grew out of randomized experimental design. The key notions of independent and dependent variables from experimental design are potentially misleading in a non-experimental analysis. What follows is an exposition of a set of terms which econometricians and sociologists have found useful in non-experimental causal inference by replacing the terms exogenous and endogenous with independent and dependent concepts respectively. Structural modeling includes combination of analytical skills like model specification, model identification, structural modeling, handling singular covariance matrix, and checking misspecification errors, simulation of result and its interpretation. These are cited in many structural equation modeling literatures (Anderson, 1957) (Fox, 1980) (Hoelter, 1983) (Stelzl, 1986) (MacCallum, 1986) (Bollen, 1986, 1987) (Bentler, 1990) (Faucher,1994) (Schafer & Olsen, 1998) (Fan, Thompson & Wang, 1999) (Hu & Bentler, 1999) (Kline, 2005) (Sharma, Mukherjee, Kumar & Dillon, 2005) (Tabachnick & Fidell, 2007) (Hooper, Coughlan & Mullen, 2008).

2.15 Model Specification

Structural equation models require a blend of mathematics and theory. Although there are many interesting issues in the mathematics of models, the most difficult issues are those related to translation of concerned theory into equations. The process of translation is called specification. Theory specifies the form of equations, which in turn, need to have a mathematical definition path. Theoretical link of the current model has been described in the preceding part. As Blalock (1969) has pointed out, most theories in social sciences are not strong enough to elaborate the exact form of equations, and so the causal modeler must make several theoretical assumptions or specifications. Although a specification may be stated in number of ways from equation to structural path (syntax) forms, the specification should have some justification drawn from theory.

However, specifications need not be based only on substantive theory. There are two other sources of specification–measurement theory and experimental design. The theory of test measurement has been well developed (Guilford, 1954), and is useful in specifying structural equations. For instance, classical test theory posits that errors of measurement are uncorrelated with the true score. Measurement theory is often helpful in formulating structural models. Moreover, for the confirmatory approach of measurement model, assessment and exploration skills are becoming irrefutable characters of advanced and complex structural models in the contemporary field of KM. Unspecified models are usually detected by computing LaGrange multiplier and checking the lower 90% bound of the Steiger-Lind RMSEA index (Saris, Satorra & Sörbom, 1987).

2.16 Model Identification

Structural equation modeling researchers are often interested in working with over-identified models or those having positive degree of freedom. A saturated or just identified model is one in which the number of parameters to be estimated and number of correlation/covariance in the path diagram are equal. It means that there is zero degree of freedom in the hypothesized model. An over-identified model has at least one degree of freedom.

It has earlier been stated that model identification (saturated model) is the minimum condition of structural modeling. The description of procedures applied for the detection of the status of model identification is summarized below:

1. Establish correlation among all measured independent variables. The number of correlation, two headed lines, is equivalent to n (n-1)/2.
2. A minimum condition required for model identification is to have the number of correlations equal to the number of parameters.
3. If a model is truly over-identified, the number of free parameters plus the number of independent over-identifying restrictions is equal to the number of correlations.
4. Over-identifying restrictions are constraints on the structure of a correlation matrix.

In structural equation modeling, a researcher attempts to estimate the unknown variables from the known variables. The number of over-identifying restrictions effectively reduces the number of free correlations. One must then subtract the number of independent restrictions from the number of correlations to determine the fulfillment of minimum condition. In structural equation modeling, these restrictions have vital function as they can be applied to test model validity. In SEPATH module, it is necessary to check LaGrange multiplier if the standard error exceeds significant level employed. An over-identified model has positive degree of freedom. The degree of freedom is the parameter of known variables. It is not possible to test the degree of freedom of a model before the model is actually analyzed in SEPATH module, but AMOS program has this facility in graphic mode. Any over-identifying restriction can be stated as a null hypothesis in structural equation modeling and then tested. An over-identifying restriction rarely holds exactly in the sample, but if the model is valid, it should hold within the limits of sampling error.

An important point to be noted is that a negative degree of freedom is the hallmark of empirically under-identified status in which the solution to all equation paths of a model is not possible. Therefore, good models are those that are either just-identified (saturated) or over-identified. The second valuable point is that non-recursive models are always over-identified, thus making it possible to estimate the parameter with alternative measures depending on the degree of freedom available.

In structural equation modeling, after relationships among variables are explored from the theory of relevant disciplines, a great deal of skill is required to know how to express correlations in a path diagram from a set of equations and vice versa. Analysis software available today has a range of alternatives to writing tedious equations from drawing path diagram to visual basic programming.

2.17 The Structural Equation Modeling Steps

The general steps followed in confirmatory structural modeling are summarized below. All these steps are supported by SEPATH module except step number two, which is possible in AMOS program.

1. Based on literature, design relationships of variables in structural path.
2. Check identification status (degree of freedom) of hypothesized model.
3. Examine convergence of variables in confirmatory factor analysis.
4. Continue modeling if minimum requirement is achieved; otherwise switch to other feasible analysis methods.
5. From the input matrix or transformed data (treat as raw data) estimate the parameters, t-statistics or p-level, and standard error of the model.
6. Test the model using available fit indices.
7. Test fulfillment of multivariate and non-centrality based assumptions.
8. Ensure the stability of fit indices and parameters by simulating model.

Once the minimum condition of identification in structural equation model is fulfilled, one can proceed to estimate the parameters. The model that fulfills the minimum identification condition is also known as just-identified or saturated model. In other words, there is zero degree of freedom in the hypothesized model. It is desirable to have one's model over-identified because there are extra advantages with such models.

Complete multi-colinearity in structural equation modeling will result into singular covariance matrix. In such a condition, one cannot make certain calculations like matrix inversion, but can certainly encounter convergence problem because division by zero will occur. The probable cause of this error messages, like covariance matrix (sigma) not being positive definite, is multi-colinearity among the indicator variables. In addition, when correlation between independent variables is above 0.85, multi-colinearity is considered high, and empirical under identification of model may be a problem.

2.18 Handling Singular Covariance Matrix

Dealing with this problem is possible by the removal of one or more highly correlated items to reduce multi-colinearity. Using different starting values than default value in the program, using different reference items for the metrics, replacing tetrachoric correlations with Pearsonian correlations in the input correlation matrix are a few strategies to resolve this problem. The simple precautionary action to address multi-collinearity is transformation of observed or surveyed data. Transformation is the data preparation step followed before actual analysis. Retransformation of the transformed data is a useless effort in structural equation modeling and this may contaminate the whole meaning the data deserved originally.

Comparative fit index and other measures of fit compare model-implied co-variances with observed co-variances. This is done for measuring the improvement in fit compared to the difference between null models and the observed co-variances on the other. As the observed co-variances approach zero, there is no lack of fit to explain (that is, the null model approaches the observed covariance matrix). In general, good fit will be harder to demonstrate as the variables in the structural equation modeling have low correlations with each other. That is, low observed correlations often estimate bias model Chi-Square, CFI, NFI, and Steiger-Lind RMSEA while other fit measures may report good fit although it may not be.

2.19 Checking the Misspecification Error

A hypothesized specification error must be examined carefully to observe its effect on the model. Signs of specification error can be checked with the lower limit RMSEA value of the structural model result. A well-specified model is one which has lower 90% confidence-bound of RMSEA being equal or near zero. Another examination of specification error is to check the LaGrange multiplier. Principally, the LaGrange multiplier statistics should be zero if the constraints act completely as identification constraints. If it is non-zero, or it significantly exceeds the standard error, then it can be construed that the model may have been misspecified, or that estimation failed to achieve normal convergence. Sometimes a model may report abnormal value of point estimate, and lower and upper bounds of RMSEA. In this case, it is better to confirm from simulation results of the model with large sample size or with more replication. The criterions mentioned above have been carefully maintained in forecasting parameters of the models in this thesis.

2.20 Model Studies in Knowledge Management

There have been increasing slew of models in KM literature but only a few of them are structural model researches. This job requires integration of findings from different studies, conceptualization of a logical model and its hypotheses grounded on the existing literatures to embark on its testing project. Besides, a mix of own raw concepts and existing theories could be the source to begin a structural model studies. The following structural model studies being reviewed in this section have been grounded from both the alternatives. Unofficial names of the models, indicated by asterisk, are used for identification purpose only.

2.20.1 Nonaka's (1994) SECI Model

One of the earliest and important model contributions known in KM is SECI model (Nonaka, 1994) which conceptualized many thoughts on socialization, externalization, combination and internalization. The process of SECI model requires different spaces for human interaction known as *ba*. The SECI model helps in description of creation, diffusion, adoption and utilization phases of knowledge management. The SECI as well as *ba* have now extended from four to six. The added transcending modes in this model are the visualization and potentialization which respectively require imagination *ba* and futurizing *ba* (Uotila, Melkas & Harmaakorpi, 2005). The two important aspects of KM, namely specification of sound knowledge base and uptake of knowledge into practice were extended further by different studies. For example, works in areas of knowledge adoption (Weick, 1991; 1995) (Gear, Lindo & Scott, 1989), in knowledge utilization (Beyer & Trice, 1982) (Muir-Gray, 1997) (Hamer & Collinson, 1999) (Trinder & Reynolds, 2000), and those related to knowledge diffusion (Nonaka, 1994) (Brown & Duguid, 2001).

2.20.2 Sabherwal, and Fernandez's (2003) Level Effectiveness Model

One structural model emerged from a survey research conducted at John F. Kennedy Space Center of the National Aeronautics and Space Administration (NASA) to develop understanding of the impact of SECI process at three levels (individual, group and organizational) of KM effectiveness (Sabeherwal, & Fernandez, 2003). This cross-sectional model study analyzed and tested a total of nine hypotheses of which six were found in significant paths. There are, however, no descriptions on whether multivariate and noncentrality assumptions were fulfilled by their structural model and execution of any procedure to check Haywood cases, except that they utilized intercorrelations, descriptive statistics, and validation regression tools for analysis. Their model concludes that externalization and combination process of SECI do not facilitate 'group-level knowledge management effectiveness'. Similarly, the 'individual-level knowledge management effectiveness' does not facilitate 'organizational-level knowledge management effectiveness'. Though the result of this study derives from 156 usable responses, the reported model fit indices were strong enough for acceptance of the conclusions. The contribution of this study in the context of practice is that it provides support for organizational learning theory; it shows effect of Nonaka's (1994) SECI process at three levels; highlights the importance of 'combination' process of KM; and finally, indicates that 'internalization' and 'externalization' process are intrinsic to individual learning. In the end, discussion on findings and directions for future research has been provided.

2.20.3 Janz, and Prasarnphanich's (2003) Organizational Climate Model

Another structural model, published in *Decision Science* which represents the academic field, is a work of Professor Janz, B. D. and Prasarnphanich, P. (2003). It explains the relationship among variables like 'organizational climate, the level of cooperative learning' that takes place between knowledge workers, and the resulting level of knowledge created and disseminated as measured by 'team performance' and 'individual satisfaction' levels. The 'cooperative learning' becomes the intermediate variable in which the 'group process' is combined with 'promotive interaction' and 'positive interdependent' constructs in their model (Janz, & Prasarnphanich, 2003). The study empirically tests the proposed research model by investigating the 'climate' of organizations, and seeks to understand the linkage between a set of 'organizational and individual characteristics' and knowledge-related activities found in cooperative learning in groups and the resulting work outcomes. The hypothesized research model is tested by applying Joreskog-friendly program, LISREL, with data collected from 203 information systems professionals engaged in systems development activities.

The paper concludes that 'organizational climate' is linked to 'cooperative learning', which further facilitates both 'growth satisfaction' and 'job satisfaction' levels of information system professionals. However, they do not bother to test structural model assumptions and execute simulation for their model for reconfirmation of the result. Finally, this provides a discussion that focuses mainly on the implications of the model study results for future research and managerial practice.

2.20.4 Ko, Kirsch, and King's (2005) Knowledge Transfer Model

This study published in *Decision Science*, forwards a model drawing from knowledge transfer, information system and communication literatures, which posits that knowledge transfer is influenced by knowledge, motivation and communication related factors. A structural model was developed based on the data collected from internet survey of consultants and client matched-pair samples of 96 enterprise resource planning (ERP) implementation projects. The components of knowledge factors in the model were absorption capacity, shared understanding and arduous relationship. Source credibility, encoding competence and decoding competence were included as communication factors, while the four components of motivational factors comprised of intrinsic and extrinsic motivation of consultants and recipients. Unlike prior studies, this one uses behavioral measure of knowledge transfer that incorporates the application of knowledge (Ko, Kirsch, & King, 2005).

The result suggests that factors such as *knowledge, motivation* and *communication* influence *knowledge transfer*. This has provided support for nine of 13 hypotheses. This model provides several valuable contributions. Firstly, it adopts previous researches done in non-information system to ERP implementation context. Secondly, it claims to enhance prior findings by confirming the antecedents that showed mixed results in the past. Thirdly, this study incorporates new information system related constructs and measures for development of an integrated model, which may be broadly applicable to inter-firm information system implementation context. The weakness of this study is similar to that of other studies under review. In particular, there is dearth of assurance on fulfillment of structural equation model (SEM) assumptions, and it does not indicate whether the model is infected by the Haywood cases. However, the researchers have provided ample discussion on the model results and a few recommendations for future studies.

2.20.5 Wang, Lan, and Xie's (2008) Trust and Openness Model

Another model study in KM comes from the Peoples' Republic of China in which a team of three researchers designed a model containing four variables – 'trust, open-mindedness, knowledge application' and 'organizational performance'. Wang, Lan, and Xie (2008) analyzed the hypothesized structural paths using a structural equation modeling procedure with samples of 208 manufacturing and service firms operating in China. One very strong aspect of this model is that it provides empirical ground for researchers to conceptualize that 'knowledge application' is antecedent of 'organizational performance'. The online source containing this research article is silent on whether their model satisfied the assumptions of structural equation model and whether their results were also verified in simulation. The model concludes that: (1) ‘trust’ is positively related to ‘open-mindedness’; (2) ‘trust’ is a function of its ‘knowledge application’; (3) ‘open-mindedness’ is a function of its ‘knowledge application’; and, (4) ‘knowledge application’ significantly impacts on ‘organizational performance’. Finally, implications for future researchers and practitioners are presented.

2.20.6 Hsiu-Fen’s (2011) System Quality Model

In this relatively recent study, Hsiu-Fen, (2011) seeks to develop a research model from 241 managers who were also ‘in charge of knowledge management practices’ in large Taiwanese companies by examining the impact of ‘individual’, ‘organizational’, and ‘information technology’ contexts on the KM ‘evolution’ along ‘initiation’, ‘implementation’ and ‘institutionalization’ stages. The individual components covered in this structural equation model (SEM) are “knowledge self-efficacy’, ‘openness in communication’, and ‘reciprocal benefits’. The organizational components covered by this model are ‘management support’, ‘organizational rewards’, and ‘sharing culture’. Similarly, the ‘information technology’ contexts comprised of ‘KM system infrastructure’ and its ‘quality’. The shortcoming of this study is that SEM assumptions have not been examined comprehensively, and there is no description on whether the model has been free from Haywood dilemmas.

The results of the study reveal that ‘knowledge self-efficacy’, ‘top management support’, and ‘KM system quality’ have positive effects on ‘initiation’, ‘implementation’ and ‘institutionalization’ stages. It can be concluded that creation of an organizational climate characterized by ‘top management support’ and ‘knowledge-sharing culture’ is likely to assist socialization and interaction between management and employees, thus ‘driving KM effectiveness’. Finally, this study concludes by providing a forum for discussion and recommendations for the forthcoming studies.

Since there is dearth of prior structural model studies on KM in Nepal, the reviewed international models have important bearing on further development and understanding of its theories and practices. Ideas or concepts, which are scattered across multidisciplinary literatures, have certainly supported the quest of model studies particularly in the academia since both KM and SEM are evolving disciplines.

CHAPTER 3

RELIABILITY ANALYSIS AND DATA TRANSFORMATION

3.1Chapter Theme

This chapter includes basic concept of reliability analysis, summary statistics for scales and their itemized statistics of variables namely work process, ICT, supportive culture, HRD, organizational memory, budget, group process, and knowledge application. It also covers methodological basics of the Box-Cox transformation applied only to reliable variables of structural equation model based on 90% confidence limits.

3.2 Reliability Analysis of Scales

Data reliability plays an irrefutable role in analysis and interpretation of its result. Reliability is simply the consistency to which participants have made rating. It is defined as the extent to which a measurement taken with multiple-item scale (e.g., questionnaire) reflects most the so-called true score of the dimension that is to be measured relative to the error. In practical sense, reliability measures the consistency of data, which obviously gives strength in prediction under the assumption that sample is bias-free. The extreme values also need analysis since this extremeness of data may capture the emerging pattern in the variables being studied particularly in the areas of social researches. Participant or researcher biasness such as developing bias scales used in survey due to hidden interests, or biasness in rating question items by participants to fulfill hidden goals, further clouds the purpose of research, i.e., truth seeking.

Various reliability measures such as standard Pearson r (Cronbach's alpha), Tetrachoric r (quick cos p approx), Tetrachoric r (iterative approx) etc. are available. The traditional measure of reliability is Cronbach's alpha, which is included in most commercial data analysis software. Its minimum recommended value is 0.60 (Nunnally, 1978) (Bagozzi & Yi, 1988) (Baker et al., 2002). Reliability is affected by variation in number of items included in a variable and the sample size. It means that items in a variable and the sample size compensate the value of reliability. When sample size is fairly large, fewer numbers of items per variable can produce high value of reliability measurement and vice versa. The reliability of scale used in this thesis is standard Pearson r (Cronbach's alpha). The formula to compute alpha is $(k/(k-1)) * [1- S(s^2_i)/s^2_{sum}]$ where, s^2_i's denotes the variances for the 'k' individual items and s^2_{sum} denotes the variance for the sum of all items. The reliability analysis of scale for exogenous and endogenous variables of the current sample has been explained below.

3.2.1 Work Process

This scale with five items is developed uniquely for this study. The scale stands for this structural model based on its value of Cronbach alpha 0.73, which is acceptable low reliability category. Summarized statistics for scale of this variable is given in Table 3 and item statistics of the scale including mean, standard deviation and number are given in Table 4.

Table 3: Summary Statistics for Scale Work Process

Summary for scale: Mean=21.94 Std.Dv.=4.07 Valid N:160 Cronbach alpha: 0.73 Standardized alpha:0.71 Average inter-item corr.: 0.36					
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl if deleted	Alpha if deleted
wpro1	17.15	12.75	3.57	0.40	0.71
wpro2	17.22	13.86	3.72	0.25	0.78
wpro3	17.88	9.12	3.02	0.72	0.57
wpro4	17.99	9.77	3.13	0.58	0.64
wpro5	17.51	10.69	3.27	0.50	0.68

Table 4: Item Statistics of Work Process

Scale Items	Mean	Std. Deviation	N
This institution has process to combine knowledge, information and data from different sources.	4.79	0.97	160
My work processes maintain sufficient face-to-face or informal interaction opportunities.	4.72	0.93	160
We have process to externalize experiential knowledge in publication, conferences, media etc.	4.06	1.30	160
Necessary fix are implemented on time to ensure process effectiveness.	3.95	1.34	160
It is necessary for us to prepare for possible risk factors before starting work-process.	4.43	1.28	160

3.2.2 Information Communication Technology

This scale with six items measures the provision and use of ICT (telephone, internet, emails, text and voice SMS, teleconferencing, Skype, Viber, multimedia etc.) by participants for information sharing with other team members of the organization and outsiders. In terms of reliability, its Cronbach alpha is approximately 0.66. Therefore, this scale is considered as the second exogenous variable in the model. Summary statistics for scale of this variable is given in Table 5 and item statistics of the scale including mean, standard deviation and number are given in Table 6.

Table 5: Summary Statistics for Scale ICT

Summary for scale: Mean=25.32 Std.Dv.=5.22 Valid N:157 Cronbach alpha: 0.66 Standardized alpha: 0.64 Average inter-item corr.: 0.25					
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl if deleted	Alpha if deleted
ict1	20.54	24.03	4.90	0.14	0.69
ict2	20.66	22.80	4.77	0.29	0.65
ict3	21.48	16.85	4.10	0.57	0.54
ict4	21.15	17.94	4.23	0.50	0.57
ict5	21.36	18.83	4.34	0.42	0.60
ict6	21.43	20.08	4.48	0.39	0.61

Table 6: Item Statistics of ICT

Scale Items	Mean	Std. Deviation	N
This institution has maintained information communication technology (ICT) for needy units and departments.	4.78	1.19	157
Information communication technology (ICT) is blended in processing day-to day operations of work teams and departments.	4.67	1.11	157
The updated information and operational data are posted in my organization's official web site.	3.85	1.63	157
I make use of available information communication technology (ICT) to share job related problems.	4.17	1.58	157
I make use of available information communication technology (ICT) to contact outside professionals.	3.96	1.58	157
I make use of available information communication technology (ICT) experience and idea with members of work team.	3.89	1.42	157

3.2.3 Supportive Culture

The five-item scale measures organization's culture in terms of management support, incentive for high performance, value to human resource. From the reliability perspective, this scale produced the worst Cronbach alpha 0.55 among all scales surveyed. There is a possibility to slightly increase the value of alpha by deleting certain item but this effort would mean sacrificing valuable items related to two sites. This means, the attempt to increase numerical reliability could decrease the representation of the field. Therefore, from the reliability perspective, this scale is rejected for model analysis simply to avoid unstable parameters estimates. Summary statistics for the scale of this variable is given in Table 7 and item statistics of the scale including mean, standard deviation and number are given in Table 8.

Table 7: Summary Statistics for Scale Supportive Culture

Summary for scale: Mean=18.92 Std.Dv.=4.20 Valid N:159 Cronbach alpha: .55 Standardized alpha: .54 Average inter-item corr.: .21					
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl if deleted	Alpha if deleted
culture1	15.58	12.15	3.49	0.21	0.57
culture2	15.04	9.50	3.08	0.65	0.25
culture3	15.139	11.19	3.34	0.44	0.41
culture4	14.84	14.02	3.74	0.21	0.55
culture5	15.10	15.67	3.96	0.10	0.59

Table 8: Item Statistics of Supportive Culture

Scale Items	Mean	Std. Deviation	N
This institution provides incentives to people for their high performance outcomes.	3.34	1.71	159
It gives impression that institution is committed to people first than other things.	3.88	1.47	159
This institution fairly maintains organizational justice to its people.	3.80	1.46	159
Our management's role is right and supportive to enhance works accomplishments.	4.08	1.26	159
Institutional culture is influential to retain knowledge champions at work.	3.82	1.05	159

3.2.4 Human Resource Development

This scale is originally developed for this study. The reliability measured in Cronbach alpha is 0.78 which is close to recommended moderate level value of 0.80. The summary statistics for the scale of this variable is given in Table 9 and item statistics of the scale including mean, standard deviation and number are given in Table 10.

Table 9: Summary Statistics for Scale HRD

Summary for scale: Mean=11.49 Std.Dv.=3.17 Valid N:156 Cronbach alpha: 0.78 Standardized alpha: 0.78 Average inter-item corr.: 0.55					
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl if deleted	Alpha if deleted
hrd1	8.02	5.85	2.42	0.51	0.81
hrd2	7.40	4.20	2.05	0.72	0.58
hrd3	7.56	4.73	2.17	0.63	0.68

Table 10: Item Statistics of HRD

Scale Items	Mean	Std. Deviation	N
There are training programs sufficient to meet institutional need	3.47	1.14	156
Training program meets the skill gap created by change in job.	4.09	1.35	156
Training emphasizes skills to master the technical aspect of technology.	3.93	1.30	156

3.2.5 Organizational Memory

This scale is originally developed for this study with five items. The reliability measured in Cronbach alpha is 0.65, which accounts in the low acceptable level as this construct is being used for the first time to maintain the degree of freedom for the specified structural model. This scale measures the efficiency in the system of using information and documents stored in archive and knowledge repository. Deletion of item from the scale could have been a way to extend the value of alpha, but that would not possibly offer any substantial benefit. Summary statistics for scale of this variable is given in Table 11 and item statistics of the scale including mean, standard deviation and number are given in Table 12.

Table 11: Summary Statistics for Scale Organizational Memory

Summary for scale: Mean=18.33 Std.Dv.=4.42 Valid N:161 Cronbach alpha: 0.65 Standardized alpha: 0.66 Average inter-item corr.:0.31					
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl if deleted	Alpha if deleted
memory1	14.66	14.83	3.85	0.22	0.69
memory2	14.77	14.86	3.85	0.29	0.65
memory3	14.64	12.28	3.50	0.61	0.50
memory4	14.73	12.51	3.54	0.54	0.53
memory5	14.54	13.03	3.61	0.40	0.60

Table 12: Item Statistics for Organizational Memory

Scale Items	Mean	Std. Deviation	N
There is system of storing knowledge in electronic database or documents for the future reference.	3.67	1.46	161
Institution store work process and result in its repository developed by network of individuals.	3.57	1.29	161
There is system of sharing stored knowledge with concerned clients when needed.	3.70	1.29	161
Institution has system of retrieval of documented knowledge for use when needed.	3.61	1.33	161
The effectiveness of our memory systems compared to other institutions I know.	3.80	1.46	161

3.2.6 Budget

This five-item scale measured the mean Cronbach's alpha around 0.75 indicating acceptable low reliability. This independent variable (budget) has been selected more from the reliability perspective than for its omnipresent importance found elsewhere. Summary statistics for scale of this variable is given in Table 13 and item statistics of the scale including mean, standard deviation and number are given in Table 14.

Table 13: Summary Statistics for Scale Budget

Summary for scale: Mean=17.81 Std.Dv.=4.69 Valid N:160 Cronbach alpha: 0.75 Standardized alpha: 0.74 Average inter-item corr.:0.39					
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl if deleted	Alpha if deleted
budget1	14.32	13.66	3.69	0.59	0.67
budget2	13.63	14.15	3.76	0.62	0.66
budget3	14.48	18.36	4.28	0.19	0.80
budget4	14.11	14.82	3.85	0.46	0.72
budget5	14.69	13.48	3.67	0.74	0.62

Table 14: Item Statistics for Budget

Scale Items	**Mean**	**Std. Deviation**	**N**
This institution's financial resources are sufficient to support for the running projects.	3.48	1.42	160
This institution's financial resources are sufficient to support for the new projects.	4.18	1.30	160
This institution receives external budgetary support for the new projects.	3.32	1.24	160
This institution also receives external budgetary support for the running projects.	3.70	1.43	160
The financial resources are available on time in case of the project I work.	3.12	1.26	160

3.2.7 Group Process

This variable is adopted in the current structural model from Campbell and Hallam's team development survey (1994), and it yielded moderate reliability measured in Cronbach alpha 0.80. This scale is considered exogenous of knowledge application but endogenous of ICT and budget factors. Thus, group process is taken as a mediating variable in the model from reliability perspective. Summary statistics for the scale of this variable is given in Table 15 and item statistics of the scale including mean, standard deviation and number are given in Table 16.

Table 15: Summary Statistics for Scale Group Process

	Summary for scale: Mean=19.76 Std.Dv.=4.76 Valid N:157 Cronbach alpha: 0.80 Standardized alpha: 0.81 Average inter-item corr.: .52				
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl if deleted	Alpha if deleted
gpro1	14.42	14.85	3.85	0.59	0.76
grpo2	14.50	14.64	3.83	0.61	0.75
gpro3	15.15	11.53	3.40	0.79	0.65
gpro4	15.20	13.13	3.62	0.51	0.81

Table 16: Item Statistics for Group Process

Scale Items	Mean	Std. Deviation	N
Members of my team learn many important things from each other.	5.34	1.32	157
We take the time as a team to examine areas in which we need more skill or experience.	5.26	1.33	157
We occasionally stop to consider how we can work better as a team.	4.61	1.59	157
We have recently discussed what we did right or wrong on a particular project of job.	4.55	1.75	157

3.2.8 Knowledge Application

This scale indicates creative use of knowledge representing the initiatives to knowledge application and creation dimension of organizations, which is a dependent variable of entire model paths. This scale measures reliability in Cronbach alpha as 0.81, indicating moderate level of recommended reliability. From the reliability perspective, it is found acceptable to include this scale in current structural model as indigenous manifest variable. Summary statistics for the scale of this variable is given in Table 17 and item statistics of the scale including mean, standard deviation and number are given in Table 18.

Table 17: Summary Statistics for Scale Knowledge Application

Summary for scale: Mean=29.87 Std.Dv.=6.66 Valid N:160 Cronbach alpha: 0.81 Standardized alpha: 0.82 Average inter-item corr.: 0.42					
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl if deleted	Alpha if deleted
kapply1	25.54	31.86	5.64	0.65	0.77
kapply2	25.91	31.32	5.60	0.78	0.75
kapply3	25.56	32.57	5.71	0.65	0.77
kapply4	25.12	38.36	6.19	0.19	0.85
kapply5	25.12	36.87	6.07	0.42	0.81
kapply6	25.99	31.79	5.64	0.59	0.78
kapply7	26.01	30.94	5.56	0.66	0.77

Table 18: Item Statistics for Knowledge Application

Scale Items	Mean	Std. Deviation	N
In my department, people verify through experiment if perceived knowledge works in the new context.	4.34	1.40	160
We provide consultation service to others relating our professional areas of expertise.	3.96	1.27	160
There are customized work processes in place, which we have acquired from others.	4.32	1.32	160
This is necessary for work team to record descriptions for future reference on how a job completes.	4.75	1.50	160
In my job, knowledge use also represents replication of practices in the same context and cases to measure the volume of work performance.	4.76	1.16	160
In my job, application of knowledge represents replication of practices in the different context to measure the volume of work performance.	3.89	1.50	160
In this institution, application of knowledge produce both qualitative and quantitative outcomes like product, services and new knowledge	3.86	1.49	160

3.3 Power Transformation of Data

Outliers data obtained from survey were initially removed using 95% confidence limit criterion, and the property of sample data was assessed with reliability analysis of scale. Only the variables with Cronbach alpha above 0.65 are selected and Box-Cox transformation has been administered to achieve approximately normalized data for modeling. The Box-Cox transformations based on 90% confidence limits were administered to reduce probable cases of multi co-linearity during structural model iteration by using the following rules given in the Table 19.

Table 19: Basis for Power Transformation of Variables

Transformed Variable	Lambda	Lower Confidence Limit	Upper Confidence Limit	Box-Cox Rules
Work Process	1.25	0.53	2.02	((v1^(1.25))-1)/(1.25)
ICT	1.27	0.67	1.89	((v2^(1.27))-1)/(1.27)
HRD	1.79	1.34	2.27	((v3^(1.79))-1)/(1.79)
Organizational Memory	1.09	0.49	1.71	((v4^(1.09))-1)/(1.09)
Budget	0.42	-0.12	0.97	((v5^(0.42))-1)/(0.42)
Group Process	1.60	1.00	2.22	((v6^(1.60))-1)/(1.60)
Knowledge Application	1.07	0.39	1.76	((v7^(1.07))-1)/(1.07)

CHAPTER 4

CONFIRMATORY FACTOR ANALYSIS

4.1 Chapter Theme

In this chapter, the focus of description is the CFA, and it is executed to assess the normal convergence criteria of all variables included in structural equation model. This analysis is recommended to be practiced prior to structural equation modeling (StatSoft Inc., 2001). The central themes included here are concept, basic summary statistics, fit strength of independence model, assumptions test in reflector matrix and input matrix produced by CFA.

4.2 Concept of Confirmatory Factor Analysis

This technique is useful for two purposes in structural equation modeling. Firstly, it can be used for exploratory purpose of model building to search for relationships not mentioned anywhere in the existing theories. Its second use is for reassuring that the measurement model is strong enough to provide support for the credibility of the estimated parameters reported by structural models.

Under confirmatory approach of structural equation modeling, a model is accepted only when it is not disconfirmed. Thus, it provides an evaluation of the variable's relationship in the hypothesized model indicating that the provided data converges normally. A successful convergence of variables of the structural path diagram provides the measurement model for the comparison of estimated parameters in structural equation.

When variables do not converge normally or the measurement model reported by CFA becomes poor, the estimated parameters of the model suffer from high standard error, and thus the entire model may lose its credibility. One should then proceed to structural modeling steps provided that the measurement model produced by CFA technique indicates support for fit of the manifest variables being analyzed. For this, one should review single sample fit indices and fit indices related to adherence to assumptions by the measurement model. One should discontinue the task of structural modeling where the following conditions prevail - when convergence of the hypothesized relational link of the model variables is not successful due to singular covariance matrix during iteration; when the convergence changes to low criterion; or, when the presence of covariance matrix reported by the program as sigma is not positive.

A quick reference to tackle problems arising when sigma is not positive definite or when there is presence of singular covariance matrix is given in Chapter 3. It would be better to adopt other methods of analysis if none of the single sample fit indices reported by measurement model has the minimum recommended value for acceptance of model. Thus, the CFA is a precious gift for both designers and evaluators of the structural equation models.

4.3 Basic Summary Statistics of Confirmatory Factor Analysis

The basic summary statistics indicates that the five correlated independent variables, one mediating variable and one dependent variable executed CFA which indicated normal convergence achieved in five iterations. The boundary condition produced a zero value is the evidence of fulfillment of normal convergence. The values of residual cosine, absolute gradient, invariance under a constant scale factor (ICSF) criterion, and invariance under a constant scale (ICS) criterion indicated good statistics for strength of measurement model as given in the Table 20.

Table 20: Basic Summary Statistics of CFA

Discrepancy Function (ML)	2.20
Maximum Residual Cosine	**0.00**
Maximum Absolute Gradient	**0.00**
ICSF Criterion	**0.00**
ICS Criterion	**0.00**
ML Chi-Square	263.77
Degrees of Freedom	11.00
p-level	0.00
RMS Standardized Residual	0.28
Boundary Conditions	**0**

Note: The bold type support model fit

The CFA procedure is not the appropriate tool to examine and make judgments about the significant of model paths. This step indicates optimistic or pessimistic impression by its result to decide whether one should continue structural equation modeling or switch to another analysis procedure instead.

4.4 Rejection of Null Model

Selected outputs of measurement model obtained by the administration of CFA that has been used for ML estimation procedure are given in Annex 2. Table 21 indicates that the independent model has been rejected by applying Chi-Square/d.f. ratio condition which is greater than upper acceptable limit of 3. These ratios only provide initial hope and indication among all reported values since other values keep changing in the subsequent procedures of structural equation model.

Table 21: Chi-square / D.F. Ratio in CFA

Independence Model Chi-Square	406.66
Independence Model d.f.	21.00
Chi-Square / d.f. Ratio	19.36

The hypothesis of independent model (null model) that all the values of input matrix are zero is rejected by Chi-square test because the Chi-square/degree of freedom ratio crossed the acceptable maximum limit of 3. If one checks the values of input correlation matrix in Table 23, the validity of test result becomes obvious. This supports the acceptance of hypothesized model for further analysis and at the same time rejects the null model.

4.5 Test of Assumptions Fit in Reflector Matrix

One of the best ways to check the fulfillment of structural modeling assumption is to check values in the reflector matrix obtained from CFA. The reflector matrix evaluates the invariance property of a structural model. The individual diagonal elements of the reflector matrix are all zero. If they are not all zero, one can conclude that either a minimum value has not been obtained or the structural model is not invariant under changes of scale, or both. The reflector matrix, given in Table 22, shows that the tested model adequately meets the assumptions of structural model.

Table 22: Reflector Matrix in CFA

	wpro	ict	hrd	memory	budget	gpro	kapply
wpro	0.00						
ict	-0.00	0.00					
hrd	0.00	0.00	0.00				
memory	-0.00	0.00	0.00	-0.00			
budget	-0.00	0.00	-0.00	0.00	0.00		
gpro	-0.39	-0.23	0.13	-0.48	-0.08	0.00	
kapply	-0.87	-0.32	-0.18	-0.67	-0.33	-0.55	0.00

The test of multivariate property of the measurement model in confirmatory factor analysis also supports the fit or the strength of the model.

4.6 Input Matrix Produced by Confirmatory Factor Analysis

The input matrix (Table 23) shows that knowledge application and work process are highly correlated (r=0.86) variables in hypothesized structural model, and they are dependent and independent variables respectively. Such a high correlation between dependent factors may signal potential for singular covariance matrix that stops model iteration.

Table 23: Input (Correlation) Matrix

	wpro	ict	hrd	memory	budget	gpro	kapply
wpro	1.00						
ict	0.35	1.00					
hrd	0.30	0.18	1.00				
memory	0.65	0.21	0.37	1.00			
budget	0.36	-0.10	0.15	0.49	1.00		
gpro	0.39	0.23	-0.13	0.48	0.08	1.00	
kapply	0.87	0.32	0.19	0.67	0.33	0.55	1.00

The Chi-Square/d.f. ratio test's indication that all values of the above input correlation matrix are not zero can be verified by comparing the representing figures in it. These indications are encouraging points for a researcher of structural equation modeling to proceed forward for the final equation modeling steps, which require estimating model parameters, standard errors, t-statistic and probability values**.** The correlation matrix produced by CFA is loaded into analysis program as input matrix to run the assessment of hypothesized structural equation model described in the next chapter.

CHAPTER 5

PARAMETERS OF THE HYPOTHESIZED MODEL

5.1 Chapter Theme

This chapter deals with estimating the values of the hypothesized structural model paths as previously shown in the Figure-1. Now, one may find it easier to identify the significant structural paths of the model besides information on the conditions applied in estimating model and basic statistics of hypothesized model (now estimated model), model path parameters, standard error, t-statistics and probability, LaGrange multiplier, reproduced matrix and standardized residual matrix.

5.2 Basic Statistics of the Hypothesized Model

The minimum acceptable fit of measurement model found in the CFA is a source of encouragement for structural equation modeling. When the directional relationships of manifest exogenous (independent) and manifest endogenous (dependent) variables and the correlation among all exogenous variables of the input matrix produced by CFA is defined as per the hypothesized model path and executed in SEPATH module, it yielded optimistic results.

The basic summary statistics of structural equation modeling is presented in Table 24 as a brief reference to understand how well the hypothesized model has been found fit in maximum likelihood method of estimation. It shows that ICS, ICSF, maximum absolute constraint, maximum absolute gradient and maximum residual cosine of the hypothesized model respectively have all indicated zero values or value less than cut off point, i.e., 0.05. As a matter of fact, these criterions should be zero in value if a model has achieved the maximum likelihood estimation function.

The RMS standardized residual value is approximately 0.06 indicating moderate fit status of the same model if one were to use conventional cut off point. Structural equation modeling literature revealed that a close fitting model comes with a cutoff value below 0.05 (Byrne, 1998) (Diamantopoulos & Siguaw, 2000) and recommended that the acceptable high value be 0.08 (Hu & Benter, 1999). This model appears an acceptable one from the RMS standardized residual perspective.

Table 24: Basic Summary Statistics of the Hypothesized Model

Discrepancy Function	0.08
Maximum Residual Cosine	**0.00**
Maximum Absolute Gradient	**0.04**
ICSF Criterion	**0.00**
ICS Criterion	**0.00**
ML Chi-Square	9.56
Degrees of Freedom	1.00
p-level	0.00
RMS Standardized Residual	**0.06**
Boundary Conditions	2

Note: The bold type support for model fit

The discrepancy function represents the value that the last iteration procedure of the model estimation applied in order to achieve convergence and the boundary conditions are incapable of minimizing the discrepancy function along the search direction.

Similarly, Steiger-Lind RMSEA lower 90% confidence bound of the fitted model is computed as 0.136, which is not zero. If this value was zero, the model could be considered to be free from misspecification error. The non-zero value of RMSEA leads one to be skeptical about proper model specification.

One of the tests of misspecification error for the standardized solution is to check the LaGrange multiplier (Table 26) for any variable that has standard error exceeding the cutoff point of alpha applied in testing significant, i.e., 0.05. This check makes one confident that there are no such errors detected in LaGrange multiplier. This multiplier is usually applied to improve model-designing works, whereas, the Monte Carlo simulation serves multiple purposes such as detecting Heywood cases, estimating parameter and standard errors for structural path that is not possible by running estimate from given data files. Its deeper investigation is possible by simulating the model and rechecking RMSEA lower 90% bounds, point estimate and upper 90% bounds. Steiger (2007), recommends that the upper limit of RMSEA should be less than 0.07 for a close fitted model. Simulation result reports strong support for the close fit of this model, which is described in Chapter 8.

5.3 Estimate of the Model Path Parameters

Based on the evaluation of various fit criteria, the overall model is found to be very near to close fit. The paths originating from ICT and budget moving towards group process (Campbell & Hallam, 1994) are found significant at $p < 0.001$ levels. This reveals that interactive strength of budget and using various ICT products lead to very significant effect on group process of knowledge workers. The only one direct causal path departing from work process to knowledge application is found significant at $p < 0.001$ levels.

Strength of organizational knowledge repository system (memory) and fits of HRD programs in organizations have no statistical evidence, at the tested level of alpha, to claim any linkage to knowledge application. This further widens a controversial debate on the conventional research findings reported in the literature. For example, the use of organization's knowledge repository systems or organizational memory by work teams (Devenport et al., 1998) (Liebowitz, 1999) (Herschel & Nemati, 2000) (Hasanali, 2002) (Wong & Aspinwall, 2005) (Shankar et al., 2009) and strong HRD programs (Horak, 2001) (Yahya & Goh, 2002) (Mentzas, 2001) (Wong & Aspinwall, 2005) are highly appreciated critical success factors of KM.

This model further indicates that group process is linked with knowledge application, which is statistically significant at $p < 0.05$ levels. The estimate of parameter, standard error, and t-value of the hypothesized maximum likelihood model are given in Table 25.

Table 25: Estimate of Model Path Parameters

Model Path	**Parameter Estimate**	**St. Error**	**t-value**
ICT to Group Process	0.47	0.14	3.37**
Budget to Group Process	0.53	0.10	5.02**
Group Process to Knowledge Application	0.27	0.12	2.27*
Work Process to Knowledge Application	0.78	0.12	6.52**
HRD to Knowledge Application	-0.08	0.09	-0.86
Organizational Memory to Knowledge Application	0.11	0.16	0.69

** Significant at $p < 0.001$, * Significant at $p < 0.05$

5.4 LaGrange Multiplier

The LaGrange multiplier suggested for the model improvement (applicable to the hypothesized model path diagram) is given as zero, and its standard error is also zero in value (Table 26). These values should be zero or standard error should not exceed the p-level employed for assessment of structural model (Saris, Satorra & Sorbom, 1987). The StatSoft Inc., (2001) electronic manual provides the following description of this multiplier:

> "The LaGrange multiplier statistics should be zero, if the constraints serve (as they are meant to) solely as identification constraints. If any are non-zero, or significantly exceed the standard error, then the model has probably been miss-specified, or estimation did not converge properly" (StatSoft Inc., 2001).

This model bears positive degree of freedom when all the manifest variables are allowed free moment in the model. When more positive degree of freedom is available to an over identified model, there is always the possibility of getting fit conditions of critical success factor in the model which is better than what is reported in the above parameter estimate. Theoretically, when standardized solution is achieved in SEPATH module, it estimates a completely standardized path model where all variables are standardized to have unit variance (by fixing exogenous critical success factors to unit variance).

Table 26: LaGrange Multiplier

Variables	Variance	LaGrange	Standard
Work Process	1.00	0.00	-0.00
ICT	1.00	0.00	0.00
HRD	1.00	0.00	0.00
Organizational Memory	1.00	0.00	0.00
Budget	1.00	0.00	-0.00
Group Process	1.00	-0.00	-0.00
Knowledge Application	1.00	-0.00	-0.00

5.5 Reproduced Matrix and Standardized Residuals Matrix

The reproduced matrix generated by hypothesized model (Table 27) show that variance is adequately extracted and standardized residuals (Table 28) appear all right for a normally distributed multivariate sample data from which outliers are displaced before modeling. The standardized residuals represent the difference between the input matrix and the reproduced matrix, standardized in the correlation matrix. One can express the residuals in this form to eliminate the effects of the scale of the variables in model residuals.

Table 27: Reproduced Matrix Generated by the Hypothesized Model

	wpro	ict	hrd	memory	budget	gpro	kapply
wpro	1.00						
ict	0.34	1.01					
hrd	0.30	0.20	1.01				
memory	0.65	0.21	0.37	1.00			
budget	0.28	-0.15	-0.06	0.41	1.00		
gpro	0.46	0.24	0.01	0.55	0.13	1.00	
kapply	0.88	0.32	0.21	0.68	0.29	0.60	1.02

Table 28: Standardized Residuals Produced by the Hypothesized Model

	wpro	ict	hrd	memory	budget	gpro	kapply
wpro	0.00						
ict	0.00	-0.01					
hrd	0.00	-0.01	-0.01				
memory	0.00	0.00	-0.00	-0.00			
budget	0.08	0.05	0.21	0.08	0.00		
gpro	-0.07	-0.01	-0.14	-0.06	-0.05	-0.00	
kapply	-0.01	0.00	-0.03	-0.01	0.05	-0.05	-0.02

The traces value in the diagonal section of the residual matrix should not be higher than p-value, i.e., 0.05 employed for evaluation criterion to conclude close fit of the observed data to the hypothesized model in maximum likelihood estimation method. The smaller diagonal values of the above standardized residual matrix indicate this model is also regarded in close fit category. As stated earlier, that standardized residual matrix is simply the result of deducting reproduced matrix from input matrix, a few values in the entire standardized residual matrix may sometimes appear slightly different from the actual results because of effects of invisible numbers contained in analysis-software beyond digits displayed to users. The negative values of standard errors appearing in Table 26 and Table 28 suggest one to conclude about the model parameters after reexamining through simulation procedure.

CHAPTER 6

SINGLE SAMPLE FIT EVALUATION OF THE ESTIMATED STRUCTURAL MODEL

6.1 Fit Indices Applied for Evaluation

The single sample fit indices of the estimated model should achieve improvement in terms of values rather than that reported for the measurement model. If one were to compare the RMS Standardized Residuals of the measurement model produced by confirmatory factor analysis (Table 20) and the fitted hypothesized structural equation model produced by analysis of structural path (Table 24), this becomes an obvious reality. In addition, single sample fit indices of CFA output and SEM output should exhibit improvements (See Annex 2 and Annex 3). Here, comparison of PGI instead of GFI, NFI, CFI and Bollen's Delta satisfy the threshold values of 0.95 which is recommended for strongly fitted and acceptable model (Table 29). These single sample indices are explained in the forthcoming parts of this thesis.

Table 29: Single Sample Fit Indices

Basis of Fit Judgments	Value
Joreskog GFI	**0.98**
Joreskog AGFI	0.36
Akaike Information Criterion	0.53
Schwarz's Bayesian Criterion	1.16
Browne-Cudeck Cross Validation Index	0.56
Independence Model Chi-Square	406.66
Independence Model df	21.00
Bentler-Bonett Normed Fit Index	**0.98**
Bentler-Bonett Non-Normed Fit Index	0.53
Bentler Comparative Fit Index	**0.98**
James-Mulaik-Brett Parsimonious Fit Index	0.05
Bollen's Rho	0.51
Bollen's Delta	**0.98**

Note: Bold types indicate model achieved thresholds for close fit.

6.1.1 Joreskog GFI

In structural equation modeling communities, there is decreasing use of GFI due to various shortcomings, and it is even recommended against the use of this index (Sharma, Mukherjee, Kumar & Dillon, 2005). The PGI provides a superior realization of the same rationale. The PGI gives lower 90% value, point estimate and upper 90% value respectively as 0.95, 0.98 and 0.99 (see Table 30). Therefore, this criterion supported close fit for this model as it approaches close to 1. Conventionally, values above 0.95 indicate close fit of the model under GFI too, but this index is negatively biased estimate of the population GFI and tends to produce pessimistic view of the quality of population fit.

6.1.2 Bentler-Bonett Normed Fit Index

One of the most powerful and original fit indices available in structural equation modeling, the Bentler-Bonett (1980) NFI, measures the relative decrease in the discrepancy function caused by switching from a null model or baseline model, to a more complex model. StatSoft Inc. (2001) electronic manual mentions the following formula to compute this index:

“$B_k = (F_0 - F_k)/F_0$

Where,

F_0 = the discrepancy function for the null model

F_k = the discrepancy function for the k^{th} model” (StatSoft Inc., 2001).

This index approaches to 1 in value as fit becomes perfect. However, it does not compensate for model parsimony at any rate. The value of NFI for this model is 0.98. Therefore, this criterion does support the close fit for this model.

6.1.3 Bentler-Bonett Non-Normed Fit Index

This comparative index is biased to the models which are less parsimony. In addition to that, this index may exhibit poor fit although other indices point towards good fit when a structural equation model is estimated with small sample size (Bentler, 1990) (Kline, 2005) (Tabachnick & Fidell, 2007). StatSoft Inc. (2007)

electronic manual states the following equation to compute this index:

"BBNk = $[(\chi_0^2/\nu_0) - (\chi_k^2/\nu_k)]/[(\chi_0^2/\nu_0)-1]$

Where,

χ_0^2 chi-square for the Null Model

χ_k^2 chi-square for the k'th model

ν_0 degrees of freedom for the Null Model

ν_k degrees of freedom for the k'th model" (StatSoft Inc., 2007).

The value of NNFI for the model is 0.53 and the model under evaluation does not achieve recommended fit threshold of 0.95 (Hu & Bentler, 1999), since this model is one with very low parsimony character, i.e., 0.05 and its sample size is less than 200. This empirical result also supports that NNFI evaluation is not a good fit tool to use in such a case as prescribed in structural modeling literature.

6.1.4 Bentler Comparative Fit Index

Bentler **(**1990) brought into practice this index, which is a revised version of NFI. The reason for high popularity of comparative fit index in recent structural model studies is that it is unprejudiced to sample size (Fan, Thompson & Wang, 1999). Studies have shown that this index is equally good in the case of small sample (Tabachnick & Fidell, 2007). StatSoft Inc. (2007) electronic manual mentions the following formula to compute this index:

"CFI = 1 - (τ-hat$_k$/τ-hat$_0$)

Where,

τ-hatk estimated non-centrality parameter for the k'th model

τ-hat$_0$ estimated non-centrality parameter for the Null Model" (StatSoft Inc., 2007).

The computed value of CFI for this model is 0.98. Therefore, following the cutoff point recommendation of 0.95, the criterions (Hu & Bentler, 1999) supported good fit for the estimated model.

6.1.5 Bollen's Delta

This index appears more similar to the logics of Bentler-Bonnet index in computation, but it has tendency to be more liberal towards those models, which have higher degrees of freedom. In fact, although the present model when solved has D.F. 1, it gave close fit indication. StatSoft Inc. (2007) electronic manual mentions the following formula to compute Bollen's delta:

" $\Delta_k = (F_0 - F_k)/(F_0 - \nu_k/N)$

Where,

F_0 discrepancy function for the Null Model

F_k discrepancy function for the k'th model

ν_k degrees of freedom for the k'th model"(StatSoft Inc., 2007).

For a perfectly fitted model, this value approaches to 1. The reported value of Bollen's delta for this model is 0.98, which indicates that it exceeds the recommended threshold of 0.95 and, therefore, this criterion supported close fit for the estimated model.

CHAPTER 7

TEST OF ASSUMPTIONS FIT STATUS OF THE ESTIMATED STRUCTURAL MODEL

7.1 Chapter Theme

This chapter examines whether estimated structural equation model meets assumptions like non-centrality based, univariate and multivariate kurtosis. Its mention is important because there are many single sample fit indices which further intensify complexities in the correct evaluation of a model fit. The supererogatory flow of variables in the structural path, improper data supplied for factor loading of manifest variables, Heywood effects, improper model identification, inconsistence translation of theoretical meaning into structural paths, machine error and human error (which are often missed in reporting), are few examples of known causes that dilute the credibility of fitted models.

7.2 Test of Non-Centrality Based Assumptions

The two-tailed test of non-centrality based assumptions fulfilled by structural model has been reviewed by computing values for lower 90% bound, point estimates, and upper 90% bound respectively of Population Non-Centrality Parameter, Steiger-Lind RMSEA Index, McDonald Non-Centrality Index, Population Gamma Index and Adjusted Population Gamma Index (Table 30), which are all based on single sample assessment result. Excluding the McDonald Non-Centrality Index due to software limitation, all other indices have been reassessed in simulation experiment for more reliable conclusions.

Table 30: Non-Centrality Based Assumption Fit Indices

Basis of Judgment	Lower 90%	Point	Upper 90%
Population Non-centrality Parameter	0.02	0.07	0.19
Steiger-Lind RMSEA Index	0.14	0.27	0.44
McDonald Non-centrality Index	0.91	0.96	0.99
Population Gamma Index	0.95	0.98	0.99
Adjusted Population Gamma Index	-0.45	0.42	0.85

7.2.1 Steiger-Lind RMSEA Index

This index is a more stable index of fit than Chi-Square and GFI. Its value is the result of dividing PNP by the degree of freedom. Theoretically, the Steiger-Lind RMSEA Index compensates for model parsimony. Basically, this ratio represents a mean square badness-of-fit. Taking the square root leads to a measure that is similar to a root mean square measure of model misfit. If *PBF* is the population badness-of-fit, and ν the degrees of freedom, the Steiger-Lind index can be written as:

Steiger-Lind RMSEA Index = $\sqrt{PBF/v}$

In general, values of the RMSEA index below 0.05 indicate good fit, values below 0.01 indicate outstanding fit, and value below 0.09 is considered moderate fit. Benter recommends 0.06 as the cut-off point for good fit. In general, the RMSEA index tends to produce the same conclusions about population fit as the APGI does.

The model produced 0.272 point estimate for RMSEA index which indicates that the model is not fitted using 0.05 as the cut-off points. The simulation result indicates that mean value of RMSEA point estimate at 90% confident level is 0.009 with S.D. 0.014 (see Table 33), which is sufficient condition to consider close fit. This result points out that the sample data did produce unacceptable RMSEA index because iteration failed to reduce the discrepancy function of maximum likelihood along the search direction, and this index probably has the tendency to inflate in case a model lacks parsimony.

7.2.2 McDonald Non-Centrality Index

This index came into existence in structural equation modeling more than two decades back. The index represents one approach to transforming the population non-centrality index *F** into the range from 0 to 1. The index does not compensate for model parsimony, and the rationale for the exponential transformation it uses is primarily pragmatic. The index may be expressed as $e^{-F*/2}$. Good fit is indicated by any value above 0.95 and this estimated structural equation model produced its McDonald Non-Centrality Index equal to 0.96 at 90% confidence level.

7.2.3 Population Gamma Index

Steiger (1989), as an extension popularized this index for the Jeroskog GFI ,which is strictly sample-based statistics. However, Tanaka and Huba (1989) demonstrated that the GFI and AGFI could be justified based on a coefficient of determination. The PGI is an estimate of the population GFI that would be obtained if one could analyze the population covariance matrix. The computed PGI 0.97 in value at 90% confident level indicates good fit of the estimated model.

7.2.4 Adjusted Population Gamma Index

This index is related to the Joreskog and Sorbom's AGFI as the PGI is to the GFI. It is basically an estimate of the population GFI corrected for model parsimony. Good fit is indicated by values above 0.95. Obviously, the computed point estimate value of APGI at 90% confident level is 0.42 which indicates poor fit of the structural equation model. The Steiger-Lind RMSEA index and APGI produce the same conclusion of fit status, which is mentioned as encouraging value found with RMSEA in simulation result.

7.3 Test of Univariate and Multivariate Assumptions

Mardia-Based Kappa family indices are measures that examine the property of multivariate kurtosis in population by using sample data. The test of hypothesized structured model has been reviewed by the use of Mardia-Based Kappa, Mean Scaled Univariate Kurtosis, Adjusted Mean Scaled Univariate Kurtosis, and Relative Multivariate Kurtosis respectively. Their test results have been described in the subsequent paragraphs.

7.3.1 Mardia-Based Kappa

The elliptical distribution family includes the multivariate normal distribution as a special case. In this distribution family, all variables have a common kurtosis parameter. This parameter can be used to rescale the Chi-Square statistics if the assumption of an elliptical distribution is valid. The Mardia-Based-Kappa is an estimate of Kappa obtained by rescaling Mardia's coefficient of multivariate kurtosis.

This number should be close to zero if the population distribution is perfect multivariate normal, which is computed as -0.004 in value for this model. Since this value tends to move close to zero, one can deduce that satisfactory Kappa is present in the model.

7.3.2 Mean Scaled Univariate Kurtosis

This is an alternate estimate of Kappa obtained simply by averaging the Rescaled Univariate Kurtoses. This value too should be zero for normally distributed multivariate population. Since the approximate value of -0.157 is close to zero, it indicates support for model fit.

7.3.3 Adjusted Mean Scaled Univariate Kurtosis

Kappa must not be less than -2/(p+2), where *p* is the number of variables. The preceding two estimates do not always remain within this bound. This estimate averages the Scaled Univariate Kurtosis, but adjusts each one that falls below this bound to be at the lower bound point. This coefficient should be close to zero if the distribution is multivariate normal. The value calculated for this model is -0.148, which indicates strong fulfillment of assumptions of multivariate normal population if one views this value by approximation technique.

7.3.4 Relative Multivariate Kurtosis

It is notable that Relative Multivariate Kurtosis is the most important test of assumption of multivariate normal population in structural equation modeling. This measure is the Mardia-Based Kappa rescaled to have a mean of 1. Theoretically, it should be close to 1 in value if the distribution is multivariate normal. This model generates a value of 0.996, which provides strong evidence to deduce that multivariate assumptions of normal population are perfectly maintained by this model.

Overall, the assumption test results mentioned above are summarized in Table 31 for comparison indicating the prescribed indices for a cent percent assumption fit conclusion and the fit indices produced by the hypothesized model. Because structural equation modeling literature mentions that negative estimates are usually not significantly different from zero in z-test (Gerbing & Anderson, 1987), the Mardia-Based Kappa, Mean Scaled Univariate Kurtosis and adjusted Mean Scaled Univariate Kurtosis values produced by the structural model under evaluation that meet the perfect fit criteria leads one to conclude that univariate and multivariate assumptions are fulfilled.

Table 31: Test of Univariate Kurtosis and Multivariate Kurtosis

Test Methods	Model Value	Reference Value
Mardia-Based Kappa	-0.004	0
Mean Scaled Univariate Kurtosis	-0.157	0
Adjusted Mean Scaled Univariate Kurtosis	-0.148	0
Relative Multivariate Kurtosis	0.996	1

7.4 Reflector Matrix

Due to numerous assumptions and their test methods found in the structural equation modeling literature, majority of which are performed in preceding parts of this thesis, it may be difficult to make appropriate conclusion when one-method reports fit and the other rejects fit for the same equation model. These acceptance and rejection conditions are rooted from the implicit assumptions of developers of the concerned testing tools, on the one hand, and measurement errors of inconsistent methodological property adapted by the structural equation modelers, on the other.

One should also be aware that structural equation modeling technique itself is in under-construction phase as is the KM. Therefore, to work effectively in such a dilemma, it would be wise to make use of the reflector matrix and conclude based on its values. The values of variables included in Table 32 indicate that the structural model is fairly free from misfit of assumptions since its diagonals are zero. If diagonal values were not all zero, we may conclude that either a minimum has not been obtained or the model is not invariant under changes of scale.

Table 32: Reflector Matrix of the Estimated Model

	wpro	ict	hrd	memory	budget	gpro	kapply
wpro	-0.00						
ict	-0.04	0.00					
hrd	0.00	-0.00	0.00				
memory	-0.00	0.02	0.02	-0.00			
budget	-0.09	-0.06	-0.25	-0.09	-0.00		
gpro	0.09	0.00	0.18	0.08	0.09	0.00	
kapply	0.00	0.00	0.00	0.00	0.00	-0.00	0.00

Having completed the comparisons, one has no option but to accept the estimated structural model and ensure that it meets the required assumption conditions of the multivariate normal population. Besides, the negative symbols of the diagonal values in Table 32 also suggest that the model might be potential for Heywood cases that can be assured only by reexamining simulation results.

CHAPTER 8

MONTE CARLO EVALUATION OF THE STRUCTURAL MODEL

8.1 Chapter Theme

This chapter accounts the reevaluation of the estimated structural equation model in 50 replications with a sample size of 2,500 using Monte Carlo simulation. Some of the parameters and fit indices generated by small sized input correlation matrix (N=121) may be unstable. Therefore, reassessment of the result is beneficial to researchers. In particular, this section includes description on prospects of simulation in research, population estimate of the structural model, fit indices observed in Monte Carlo like Steiger-Lind RMSEA index, Chi-square p-level, IRGLS and other fit indices.

8.2 Prospects of Simulation in Research

The Monte Carlo simulation is one of the procedures known to be very useful for experimental research where repeating the observations to review results into another set of samples may become difficult or impossible due to time, cost or unavailability of sufficient number of similar items or situation. Rather than setting up a series of real experiments, clinical researchers, nuclear researchers, aeronautical researchers as well as behavior researchers use Monte Carlo technique to support them in making relatively better conclusions about the population by replicating the experiments of the real observation data with the multiple simulated samples.

In addition, the single sample fit indices may be biased due to known and unknown causes (like Heywood cases) and may give unstable parameters estimate for the model. Monte Carlo examination of the hypothesized model in several simulated samples can be worthwhile for the modelers and model evaluators in exploring their consistency. Thus, it is recommended to validate the stability of a model from statistical points of view as well.

8.3 Population Estimate of the Structural Model

The measurement error of a single sample due to one or other reasons is obvious in concluding about the reliability of the structural model fit indices, parameters and standard errors etc. with greater certainty in the population scale. Given this context, this model has been tested with 50 simulated samples (N=2,500) using the Monte Carlo procedure in which population was estimated from the fitted model.

8.4 Fit Indices Observed in Monte Carlo Simulation

Monte Carlo observation of the model in multiple samples is done with the primary motive of reviewing fit indices reported by the structural equation modeling under maximum likelihood method of estimation. A brief explanation of the model fit indices, the Steiger-Lind RMSEA point estimate, the upper 90% bound and the Chi-square probability respectively obtained by simulating the estimated model and iteratively reweighted generalized least squares appear in this section.

8.4.1 The Steiger-Lind RMSEA Index

The result from the simulated 50 samples exhibiting 90% upper bound of Steiger-Lind RMSEA has remained within the range of 0 to 0.09. This clearly indicates that there is no rationality to hope RMSEA 90% lower bound, and point estimate will be greater than 0 - 0.09 range in any of the cases. This leads one to deduce that report from the original sample is inconsistent. Another aspect of the observations in simulation experiment of this hypothesized structural model suggests that values of Steiger-Lind RMSEA index has tendency to inflate if a model has very less parsimony feature or the James-Mulaik-Brett Parsimonious Fit Index is less than or equal to the p-level.

Monte Carlo result also shows that all of the observed samples demonstrate Steiger-Lind-based RMSEA point estimate below 0.05, indicating good fit in the population estimated by model. A surprising element of this experiment is that 56% of the samples indicated perfect fit of this model since the point estimate of RMSEA at 90% confident level is found to be zero. No sample showed the point estimate value of RMSEA 0.06 or moderate fit if one were to use the conventional cut-off point of

0.05. This scenario leads one to be optimistic for cent percent samples in the real world may likely produce the good fit result of the hypothesized structural model. Table 33 summarizes the result of Steiger-Lind RMSEA observed in simulation of the model.

Table 33: Steiger-Lind RMSEA Observed in Monte Carlo Simulation

	Lower 90% Bound	Point Estimate	Upper 90% Bound
Median	0	0	0.049
Mean	0.001	0.009	0.047
SD	0.004	0.014	0.017

From the above result, it is obvious to confirm that the model has been found perfectly fitted in the population though, initially, some skeptical figures were reported in single sample assessment.

8.4.2 Chi-Square Probability

The Chi-square fit index measures the model's badness-of-fit if it is significant. It has already been mentioned that this index is sensitive to sample size, and a model with over 200 sample sizes may have significant Chi-square probability even if the covariance difference is very small. Thus, one cannot conclude that a model is fit based on this probability alone. The biasness of this value is, therefore, examined by Chi-square (critical value)/ d.f. ratio. Table 34 demonstrates that tested 45 structural equation model samples (i.e. 90 percent) out of 50 in Monte Carlo simulation produced Chi-square probability above 0.05 alpha levels for the goodness of fit consideration.

Table 34: Chi-Square P-Level Observed in Monte Carlo Simulation

P-Level	Frequency	Percent	Cumulative Percent
Below 0.05	5	10.0	10.0
0.05 to 0.48	26	52.0	62.0
Above 0.49	19	38.0	100.0
Total	50	100.0	

It appears that there are some misconceptions in structural equation modeling literature as simulation report failed to support the description that Chi-Square test rejects nearly all models employing large sample size (Bentler & Bonnet, 1980)

(Joreskog & Sorbom, 1993). The report indicates Chi-Square has tendency to reject good models twice as much the level of alpha employed for the assessment of a model in comparison to Steiger-Lind RMSEA index.

8.4.3 Other Fit Indices

In addition to the above descriptions of reevaluation a comprehensive result generated by Monte Carlo simulation procedure confirms (summarized in Annex 4) that IRGLS value of tested model as zero. Similarly, all 50 replications of simulated samples also exhibited values either zero or close to zero, which support that the observed data from questionnaire survey fits well in maximum likelihood estimation, when the hypothesized structural model is tested. Most of the evaluation criteria applied in the both simulation and single sample analysis yielded optimistic results that indicated the model is good fit in the population and satisfies stability criterion at 90% confidence intervals.

A separate analysis of simultaneous equation system in STATA package for the same structural model paths produced zero value for eigenvalue stability index (see Annex 7) because all the values were located inside the unit circle. This is an extra obvious evidence to support that the hypothesized and estimated structural equation model satisfies stability condition as it has been reported in simulation experiments.

CHAPTER 9

THE PERSISTENT, EARLY AND LATE ENABLERS OF KNOWLEDGE APPLICATION

9.1 Chapter Theme

This chapter reviews and validates the results obtained in structural equation model for the controversial findings regarding the links of few variables mentioned in literatures. Applying context based analysis (involvement year of the participants and functional sector of the surveyed organizations), the justification of the result is reviewed through multiple regression analysis, which finds that there is permanent and contextual linear link of predictor variables to ‘knowledge application’. While organization-wise analysis reveals that ‘work process’ is the common critical success factor in IOE, NARC and IOM/TUTH, the knowledge application model indicates that only NARC and IOM/TUTH share common features. At the same time, principal component analysis explores various degrees of power and importance in sample data of the concerned organizations.

9.2 Involvement Effect in the Linear Link of Variables

The result of the ‘organizational memory’, in the case where their involvement period/job tenure is less than or equal to 5 years, indicated significant reverse contribution (negative Beta coefficient) to ‘knowledge application’. This factor is not significant for all groups and organizations under study. This implies several possible situations – the participants do not trust that their organizations’ repository and memory systems have applicable knowledge; the knowledge from their organizational memory system provided bad result when applied; workload does not permit access to arranged memory system; and, they switch to other sources for need information and knowledge.

The predictors work process, budget, ICT, organizational memory and group process have positive coefficient contribution in the model within the same context (Table 36). This implies that the people who recently joined those organizations find multiple critical success factors significant. The group process has been found significant up to ten years of involvement/job tenure (Table 37). After that, it is no longer significant for ‘knowledge application’. HRD is not a significant factor for those who are involved in jobs equal to or less than five years. HRD is significant for the participants who were engaged in their jobs since last 15 years (Table 39). However, it again ceases being statistically significant when one’s job tenure or involvement reaches to 20 years and above (Table 40). This result has several implications – that participants are over confident in their own skills; that they are not motivated to show others that they are still learning; and, that there is no compatible HRD practice in these organizations.

The comparative Table 35 summarizes the overall finding of the analysis in which direct link of six variables to knowledge application is tested by changing year of involvement of the participants.

Table 35: Involvement Effect in the Linear Link of Model Variables

Variables	5 yrs or less	10 yrs or less	10 yrs or more	15 yrs or more	20 yrs or more
Work Process					
ICT		■	■	■	■
HRD	■	■	■		■
Organizational Memory		■	■	■	■
Budget		■	■	■	■
Group Process			■	■	■

Note: The variables not significant at $p < 0.05$ are indicated by black.

The regression analysis results of only significant variables have been given (For detail results see Annex 5) with their beta coefficients, standard error, t-statistics and two-tailed significant p-values in Table 36, Table 37, Table 38, Table 39 and Table 40.

The results of regression analysis indicate that ‘work process’ is the one critical success factor that has unrelenting link with ‘knowledge application’ construct regardless of involvement/employment tenure. The ‘ICT', ‘organizational memory’, ‘budget strength’ and ‘group process’ are early enablers. The ‘HRD’ is the only critical success factor in this model of knowledge application that is found to be late enabler.

Table 36: Significant Independent Variables (Involvement <= 5 years)

Variables	β	Std. Error	Standardized β	t-value	Sig.
Work Process	.399	.076	.422	5.285	.000
ICT	.151	.051	.226	2.960	.005
Organizational Memory	-.402	.187	-.245	-2.151	.037
Budget	2.019	.777	.183	2.598	.013
Group Process	.287	.053	.577	5.443	.000

Table 37: Significant Independent Variables (Involvement <= 10 years)

Variables	β	Std. Error	Standardized β	t-value	Sig.
Work Process	.602	.079	.645	7.646	.000
Group Process	.113	.046	.234	2.453	.017

Table 38 Significant Independent Variables (Involvement >= 10 years)

Variables	β	Std. Error	Standardized β	t-value	Sig.
Work Process	.585	.119	.623	4.933	.000

Table 39: Significant Independent Variables (Involvement >= 15 years)

Variables	β	Std. Error	Standardized β	t-value	Sig.
Work Process	.485	.144	.501	3.377	.002
HRD	.147	.064	.331	2.290	.027

Table 40: Significant Independent Variables (Involvement >= 20 years)

Variables	β	Std. Error	Standardized β	t-value	Sig.
Work Process	.725	.215	.776	3.373	.002

9.3 Organizational Effect in the Linear Link of Variables

Multiple regression analysis result revealed that ‘work process’ is the only common critical success factor that is significant to knowledge application path in case of all surveyed organizations. In NARC and IOM/TUTH, besides ‘work process’, there is another independent variable, the ‘group process’ that exhibits significant contribution to ‘knowledge application’. Summary results of regression analysis showing only significant variables for ‘knowledge application’ of IOE, IOM/TUTH and NARC are given in Table 41, Table 42 and Table 43 respectively (For detail see Annex 5).

Table 41: Significant Independent Variables in IOE

Variables	β	Std. Error	Standardized β	t-value	Sig.
Work Process	.715	.115	.753	6.232	.000

Table 42: Significant Independent Variables in IOM/TUTH

Variables	β	Std. Error	Standardized β	t-value	Sig.
Work Process	.654	.098	.670	6.680	.000
Group Process	.183	.063	.312	2.897	.006

Table 43: Significant Independent Variables in NARC

Variables	β	Std. Error	Standardized β	t-value	Sig.
Work Process	.771	.127	.742	6.074	.000
Group Process	.104	.049	.211	2.117	.043

The above findings of the analysis uncover one important lesson to managers, policy makers and researchers - that critical success factors react differently in different contexts of the organization, and has to be accorded research-based priority and focus in organization-wise resource mobilization. It does not seem logical to provide conventional emphasis to critical success factors by assuming that they are always result-yielding machines. One needs to be aware of any factor that contributes negatively in the organization, thereby slowing down the positive contribution of the other factors.

9.4 Principal Component Analysis

Principal component analysis throws light on how model variables indicate different importance in sample organization-wise data (Table 44) used for regression analysis, and their collective data (Table 45) used for SEM. Table 44 shows one common feature in surveyed data – that 'work process' is the second most important variable for all organizations. The remaining variables show prismatic characters, which are observable in PCA result from combined data of the three organizations. The HRD has remained the least important and low powered factor as indicated in collective data. Knowledge application, work process, organizational memory, budget, ICT, group process and HRD appear in descending order of importance for NARC, IOM/TUTH and IOE (Table 45).

Table 44: Power and Importance of Model Variables

Variables	NARC		IOM/TUTH		IOE	
	Power	Importance	Power	Importance	Power	Importance
Knowledge Application	0.806	1	0.817	1	0.790	3
Work Process	0.791	2	0.788	2	0.783	2
Organizational Memory	0.709	4	0.773	4	0.781	1
Budget	0.703	6	0.690	3	0.632	5
ICT	0.664	7	0.628	6	0.590	6
Group Process	0.449	3	0.619	5	0.519	4
HRD	0.328	5	0.229	7	0.481	7

Table 45: Power and Importance of Model Variables (All Sectors)

Variables	Power	Importance
Knowledge Application	0.813	1
Work Process	0.777	2
Organizational Memory	0.724	3
Budget	0.682	4
ICT	0.570	5
Group Process	0.513	6
HRD	0.358	7

Both the SEM and regression analysis results relating to ‘HRD’ and ‘organizational memory’ are antagonistic to earlier KM literatures. However, it does not mean literatures of critical success factor are wrong, but that they failed to configure well in ‘knowledge application’ of the surveyed organizations in Nepal.

CHAPTER 10

MAJOR FINDINGS

10.1 Chapter Theme

This chapter includes major findings based on the objectives of this study, mainly the status of the hypothesized model path, fit-indices reported by sample data and Monte Carlo simulation.

10.2 Only Seven Variables Meet Minimum Reliability

The variables slightly above the recommended minimum standard of 0.60 Cronbach's alpha of scale (Nunnally, 1978) (Bagozzi & Yi, 1988) (Baker et al., 2002) – work process, ICT, HRD, budget, organizational, group process and knowledge application respectively have been included in the model. Since supportive culture fails to yield minimum value of reliability, this critical success factor has been discarded from structural model analysis. The selected seven variables applied power transformation formula for further data preparation.

10.3 Seven Variables of Model Converged Normally

The selected model variables (work process, ICT, HRD, budget, organizational memory, group process and knowledge application) converged normally in confirmatory factor analysis in five iterations. The zero value of boundary condition (Table 20) confirms this fact.

10.4 Four Statistically Significant Model Paths Detected

Structural model analysis accepted H_1, H_2, H_5 and H_6 related structural paths, whereas H_3 and H_4 are found to be rejected paths in the same structural model that are described below.

H_1: Structural path originating from the work process to the knowledge application is found significant. Statistically, very strong acceptance of its direct causal link to knowledge application in structural path is evident, and that this factor is still relevant in Nepal. The link of work process to knowledge application is evident and is unaffected by selection variables like involvement year/job tenure of the participants and organization.

H_2: Structural path originating from the ICT use to group process is statistically significant. The indirect link of ICT adaptation to knowledge application and, at the same time, its direct causal relations to group process has been established by this model analysis. Furthermore, it is found that this factor is early enabler of knowledge application.

H_3: Structural path originating from the organizational memory to the knowledge application variable is not significant. In the current structural model assessment study, the significant causal link of organization's memory and knowledge application could not be supported by empirical data, and, therefore, it is concluded that for representative knowledge application model of IOE, IOM/TUTH and NARC this critical success factor is irrelevant. In addition, this critical success factor is early enabler of knowledge application.

H_4: Structural paths originating from the HRD to the knowledge application is not significant. Numerous studies emphasized HRD as emulsifier of high productivity, but this critical success factor is late enabler of knowledge application.

H_5: Structural path originating from the budget to group process is significant. Financial resources are considered critical success factor of omnipresence in the studied organizations because other factors like tools and equipment cited in the literature are dependent on this variable. This factor is perceived to be the activator of group process which is necessary to maintain frequent discussion about strength and weakness of completed work with members of their team. Result of analysis strongly supported the indirect link of budget resource to knowledge application and, at the same time, its direct causal relations to group process. Furthermore, it is found that budget is early enabler of knowledge application.

H_6: Structural path originating from the mediating variable group process to the knowledge application is significant. In addition, group process is early enabler of knowledge application construct.

10.5 Field Data Closely Fits to the Hypothesized Structural Model

Single sample fit indices produced by the analysis exceed the recommended close fit values of 0.95 in case of PGI, NFI, CFI and Bolen's delta. These results indicate that field data closely fits with the hypothesized structural model under maximum likelihood method of estimation.

10.6 Model Fulfills Centrality and Non-Centrality Assumptions

The values of McDonald non-centrality index and PGI appeared adequate to support strong fit of non-centrality assumptions (Table 30). The relative multivariate kurtosis and Mardia-based kappa indicated perfect assumption fit (Table 31). Therefore, the hypothesized structural model does not violate centrality and non-centrality based assumptions.

10.7 Model Stability Observed in Simulation Experiments and Simultaneous Equation System

Review of multiple replications of Monte Carlo simulation experiment results suggests the hypothesized model is stable although the single sample did not report well in case of few indicators, namely Steiger-Lind RMSEA index and Chi-Square test. In case of large sample simulation, the same index stabilizes at even below the value of RMR standardized residuals reported in single sample evaluation.

The Chi-Square test in large sample simulation shows twice as sensitive behavior as the employed p-level in rejecting good models. The Steiger-Lind RMSEA index did not reject any models that were rejected by Chi-Square test. With a larger field sample perspective, there is great optimism that these results and interpretations are stable as revealed by model simulation result summary given in Annex 4. Moreover, an analysis of simultaneous equation system also satisfied the stability condition of the examined structural model as all eigenvalues lay inside the unit circle (Annex 7).

10.8 Organizational and Involvement Effect are Nil in Work Process to Knowledge Application Link

The work process is the only critical success factor in the present structural model, which is linked persistently and significantly to knowledge application regardless of changes in involvement period of the participants and organization. The ICT, organizational memory, budget and group processes are significant at the earliest stages of involvement/job tenure. Therefore, these variables are early enablers of knowledge application. The HRD is the only critical success factor found to have significant link with knowledge application construct for involvement between 15 to 20 years. Therefore, HRD is hallmarked as late enabler. Above descriptions further lead to conclude that, except for the work process, there are obvious situational effects in data in explaining linear link of the other dependent variables to knowledge application in the model.

10.9 Critical Success Factors Have Both Broad and Narrow Implications on Knowledge Management

The work process and group process are common significant factors of knowledge application for both NARC and IOM/TUTH. Although operating under the same university, IOE and IOM/TUTH differ in the context of the group process not being shared as critical success factor for knowledge application. The critical factor common to engineering, agriculture research and hospital sector that contributes to knowledge application is work process. Therefore, critical success factors have broad and narrow implications on KM because the work process has been found significant in all sectors while the group process remained significant for two of three sectors respectively in their knowledge application models.

CHAPTER 11
CONCLUSIONS AND RECOMMENDATIONS

11.1 Chapter Theme

This chapter covers overall conclusions of the thesis and provides recommendation for future research in knowledge management using the methodology of structural equation model.

11.2 Conclusions

The ‘work process’ is found to be only critical success factor functioning without effects of organization type and involvement years of participants, which has a direct and significant linkage to ‘knowledge application’ there by also creating value. In general, the ‘ICT' and ‘budget’ factors in conjunction are necessary to activate ‘group process’ of organizations, which ultimately has a significant contribution to ‘knowledge application’ model. Despite the ‘HRD’ and use of ‘organizational memory’ are crucial factors of knowledge management, they have no significant and commendable impacts appeared in the current ‘knowledge application’ scenario of the studied organizations in Nepal.

This result may help building a block to the theoretical debate particularly on the link of ‘HRD’ and ‘organizational memory’ to ‘knowledge application’. The ‘organizational memory’ is not significant in structural model. If one considers recommendation of Liebowitz (1999), one cannot but conclude that the organizations under study are not champions of knowledge management. However, the participants who were involved in their jobs for less than five years are the champions because the ‘organizational memory’ shows significant link to ‘knowledge application’ only to this group of people. Again, this significant link comes from regression analysis using unreliable predictors by splitting the sample. The significant link of ‘ICT' and ‘budget’ through ‘group process’ to ‘knowledge application’ is established by this structural model. HRD may be conventionally viewed as contributing to organization’s result and productivity. A study further indicates that higher-level involvement and opinions of beneficiaries on the quality of training process have a positive effect on perceived effectiveness of HRD (Wognum & Fond, 2000), but this seems to be obscured in the sampled sites. In NARC, the existing human resource practice is not compatible for creating effective knowledge application environment. For example, a Ph.D. holder in horticulture who also received additional training abroad was assigned as the head of information and documentation section. Besides, in NARC, there is the trend of quitting jobs by trained research scientists due to comparative monetary benefits and better working conditions elsewhere. Official record (2012) shows that only 59.12 % (i.e., 243 of 441 approved posts) of research scientists are working in its 17 agriculture research stations, and there is shortage of research scientists. However, this record excludes those that have remained absent for long, but have not yet resigned. NARC's existing value creation role in Nepal's food security by introducing 244 new varieties of grains, oil-seeds, lentils, vegetables, and grasses are characterized by significant 'work process' and 'group process' in the knowledge application model. There is ground for optimism that 'HRD' could contribute to 'knowledge application' if the strategic human resource practices (Huslid, 1995) (Budhwar & Khatri, 2001) (Adhikari, 2010) were appropriately in place.

In addition to faculty doctors, there are also students who represent the survey sample of IOM/TUTH cannot apply the knowledge of what they actually learned in classrooms because the patients in hospital wards are already undergoing treatment of their senior faculty doctors. They are usually allowed to visit wards and make inquiries about the progress of treatments based on IOM/TUTH's mission to provide the best care to every patient through integrated clinical services, education and research (Administrator, 2009). More importantly, medical ethics also restrict the use of knowledge directly from 'HRD' programs of the campus to protect against possible risk of professional hazard caused by practicing immature knowledge. Besides, significant 'work process' and 'group processes' in model, the socialized environment enjoyed by the participants may also have characterized in the group's effectiveness (Sabherwal & Farnandez, 2003) of IOM/TUTH in 'knowledge application'.

In IOE, the classroom trainings are irrelevant and not sufficient for one to be competent in making a complete robot individually unless faculties and students of both mechanical and electrical departments combine their skills together in this project. In fact, robot making is not a separate subject currently being taught according to prescribed syllabus for engineering. Therefore, making new robot models is a voluntary process, which continues by combining the knowledge of interested faculties and students when they find occasions to show their talents, usually in international robot competitions. It is interesting to find how a small positive coefficient of 'group process' in the regression model made it possible to combine their knowledge to create robots in IOE. If it is so, the combination process is significant for 'organizational level perceived KM effectiveness' (Sabherwal & Farnandez, 2003) and for 'knowledge application' as well. This further implies that when 'group process' is positively activated, it may accelerate the combination mode of SECI model (Nonaka, 1994), and it might (in context) substitute for the role of formal HRD program. This logic derived by synthesizing the IOE case and KM literature needs to be verified.

This study finds that there are critical factors that are persistent, early enablers and late enabler to retain linear link to knowledge application based on involvement/job tenure. For the group of participants with involvement/job tenure of five years or less, HRD is not a significant critical success factor to knowledge application. It is possible that these fresh groups of people/employees have just completed their degrees and perceive that they are updated in the job technology and its application process. Only those who continued in their jobs for 15 years or more were tested HRD significant, which indicates that the critical success factor is late enabler. It may be possible that people who remained working for 15-20 years are either eager for promotion before getting retirements for which training becomes an extra advantage or that they realize that their skills have become obsolete and cannot fulfill the increasing job demands in the knowledge market. Those who remained in the current job for 20 years or more, HRD factor is no more significant critical success factor for knowledge application. In case of Nepalese organizations too, the use of hierarchical influences reduces the need for individuals to absorb knowledge (Conner & Prahalad, 1996) disseminated in trainings, which cannot contribute in knowledge application model.

The only critical success factor with significant link to knowledge application is 'work process' construct. This implies that organizations need to focus the critical success factors by examination of their own context for best utilization of resources to generate value, but not simply on recommendations of literatures. In the surveyed organizations of Nepal, research-based investment and emphasis to critical success factors would seem more appropriate for both the follow-up replicator users (knowledge imitators) and the research based creative users (innovators). Excluding 'work process' and 'group process', organization-wise regression analysis fails to report other critical success factors having significant links to 'knowledge application'. The principal component analysis reveals there is organization wise variation in importance and power of the model variables.

The indication by Verganti (2006), that money is not what makes talented designers would not justify in reality if one observes that the largest number of innovations have been taking place in the U.S. Considering the competitive demands for knowledge workers globally, knowledge sharing is beneficial for those less knowledgeable workers and the concerned organizations. However, from the talented workers' point of view, it would be a form of severe exploitation to clone knowledge to other people in the same labor market. Therefore, justifiable incentives and compensation for sharing knowledge is proposed as knowledge management's critical success factor (Dvir & Pasher, 2004). The budget is found to be significant critical success factor in Nepal's organizational context where almost everything from HRD program to equipment purchase for laboratory is hard to imagine without it. The budget resource is identified as the early enabler for knowledge application. The empirical result of this study also indicates 'budget' factor emerges as a significant path in the structural model when integrated to 'group processes'.

A remark in Sanskrit literature (Jha) that 'everything in this world is perfectly capable to work if they are arranged and utilized in the proper places' becomes valid for 'work process', 'budget', 'ICT', 'group process' and 'knowledge application' in this model analysis. It means that ambivalence found in the literature about the status of critical success factors being linked to outcomes (effectiveness) earlier emanated from their (Davenport et al., 1998) imagination, which has now become quite clear as they have indicated significant link to ‘knowledge application’.

There is no dearth of literature on various critical success factors for KM success. Naturally, without application of knowledge it is not possible to attain any result, whether qualitative or quantitative. In the context of earlier study by Janz and Prasarnphanich (2003), in which the outcome variable satisfaction was used, it was safe to consider organizational outcome because it is difficult to measure the exact knowledge or information downloaded and its impact on quantitative outcomes. Obviously, there are no readymade formulas for determining the impact of KM leading to money earned or saved. Leaders of the knowledge-based organizations insist that problems should be evaluated, but they accept anecdotes about successful (or failed) knowledge reuse, stories of productive (or unproductive) collaborative projects, and surveys of employee and customer satisfaction as the best indicators of value (Cohen, 2006). Knowledge workers of organizations covered in this study had different patterns of quantitative values to represent knowledge application construct that was not homogenous in time, unit and value that could be expressed collectively. In the lack of such collective numerical transformation of knowledge application output content, the use of context side expression is found to be practical. Thus, it is realized that telling anecdotes is perhaps a better measure to express knowledge application rather than stating precise numbers, i.e., the output unit, number of successful operations, value the new seed certifications in food security of country, money saved by new robot utilized at work etc. It could be possible to achieve these quantitative outcomes in any of the organizations under study only after the application of knowledge. In other words, value creation naturally takes place after applying knowledge. Therefore, this model opens the door to design a model compatible to value creation construct (Vorakulpipat & Rezgui, 2008) of the third generation KM of which the ‘knowledge application’ is antecedent in the model path.

Finally, this over-identified structural model preceded one lap further to show empirically that critical success factors and ‘group processes’ as an antecedent of ‘knowledge application’. This effort would bring the future SEM and simulation researchers nearer to test if ‘knowledge application’ really links to other quantitative KM outputs.

11.4 Recommendations for Future Research

In case of 'HRD' and the 'organizational memory', the unprecedented results of both structural model and regression analysis have emerged out of tune with existing literature. There could possibly be lack of sufficient validity in constructs of surveyed questionnaire, which could have resulted due to problem of integration of more than two dozen stories received during interaction programs with champions of the concerned organizations. At this point of time, it becomes evident that the 'HRD' construct needs to be modified to capture additional aspects of organization's current human resource management practices to further enhance field representation to the model paths in the future. The three-item HRD construct used in this study require upgrading by two more items:

1. The skills and knowledge I gained in the training programs are transferable to given work content and context of this organization.
2. Human resource practices adopted by this organization are appropriate for application of learned skills and knowledge by its people.

Similarly, the five-item 'organizational memory' construct requires capturing identified new field reality by adding these additional items:

1. We have trust to find information and knowledge in this organization's archived memory system than other sources.
2. Our repository and memory system practically helps improve my job performance.

Identification of structural model as well as direction of paths of included variables have been established in fairly good position as they are based on the logics and descriptions found in existing KM literature, and deployment of both the firsthand and secondhand scales for this study. Two pretest surveys as well as absence of financial incentives to participants may have reduced motivation to respond in the final round survey. This situation has derailed sector wise assessment of hypothesized model in sample sufficiency condition. In case of replication of the same research, it is suggested that incentives be used to enhance response rate at least to a size of 225 so that analyses of individual organizations may review some variations not accounted by this study. This size is recommended because some variables in the current analysis are represented with a minimum reliability. When performing sector wise analysis, their scale reliability will obviously tend to shrink further, and may lead to raising questions on the estimated parameters. Similarly, longitudinal study will be productive in NARC and IOM/TUTH to validate this structural model since there are regular knowledge application activities take place every year. However, robot making at IOE is irregular and extracurricular work. It will be useful to assure that the estimated model demonstrates consistency among simulated multiple results. It is advised to retest if there is any discrepancy in the prevailing SEM literature.

Finally, 'knowledge application' is prior model path to create quantitative or qualitative value of output. When critical success factors link to 'knowledge application', one would infer that 'knowledge application' further links to output variables. In other words, if one attempts to test independent critical factor's link in structural model in the future, it is suggested that 'knowledge application' might be taken as the mediating variable since this finally links to output variable.

The End

BIBLIOGRAPHY

Abecker, A., Bernardi, A., Hinkelmann, K., Ku, Hn o., & Sintek, M. (1998).Towards a Technology for Organizational Memories. *IEEE Intelligent Systems 13*(3), 40-48. As cited in Apostolu, D., Abecker, A., & Mentzas, G. (2007). Harmonising Codification and Socialisation in Knowledge Management. *Knowledge Management Research & Practice,5,* 271-285. Retrieved September 21, 2012, from http:// www.palgrave-journals.com.kmrp.

Adhikari, D. R. (2010). Human Resource Development for Performance Management. *International Journal of Productivity and Performance Management*, *49*(4), 306-324. Retrieved May 15, 2013, from http://www.emeraldinsight.com.

Administrator. (2009, November 24). *TU Teaching Hospital*. Retrieved June 19, 2013, from Institute of Medicine: http://www.iom.edu.np.

Ahmed, P. K., Lim, K. K., & Loh, A.Y.E. (2002). *Learning Through Knowledge Management*. Oxford: Butterworth-Heinemann. As cited in Xu, J., & Quaddus, M. (2005). From Rhetoric Towards a Model of Practical Knowledge Management Systems. *Journal of Management Development, 24*(4), 291-319.

Alavi, M., & Leidner, D. E. (1999). Knowledge Management Systems: Issues, Challenges, and Benefits. *Communications of the Association for Information System, 1, Article 7*. Retrieved May 15, 2011, from http://www.cais.isworld.org.

Alavi, M., & Leidner, D. E. (2001). Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues. *MIS Quarterly*, *25*(1), 107-146.

Allen, V. (1998). 12 Principles of Knowledge Management. Retrieved October 08, 2010, from http:// www.astd.org.

American Productivity & Quality Center (1999). Knowledge Management: Executive Summary. *Consortium Benchmarking Study Best-Practice Report*. Houston: APQC Retrieved December 23, 2009 from http://www.apqc.org.

Anderson, T.W., (1957). Maximum Likelihood Estimates for a Multivariate Normal Distribution When Some Observations Are Missing. *Journal of the American Statistical Association, 52*, 200-203.

Appleyard, M. M., & Kalsow, G. A. (1999). Knowledge Diffusion in the Semiconductor Industry. *Journal of Knowledge Management, 3*(4), 288-295.

Bagozzi, R. P., &Yi, Y. (1988). On the Evaluation of Structural Evaluation Models. *Journal of the Academy of Marketing Science, 16*(1), 74-94. As cited in Sabherwal, R., & Becerra-Fernandez, I. (2003). An Empirical Study of the Effect of Knowledge Management Process at Individual, Group and Organizational Levels. *Decision Sciences, 34*(2), 225-260.

Baker, J., Parasuraman, A., Grewal, D., & Voss, G. B., (2002). The Influence of Multiple Store Environment Cues on Perceived Merchandise Value and Patronage Intentions. *Journal of Marketing, 62*(2), 120-141. As cited in Sabherwal, R., & Becerra-Fernandez, I. (2003). An Empirical Study of the Effect of Knowledge Management Process at Individual, Group and Organizational Levels. *Decision Sciences, 34*(2), 225-260.

Bentler, P. M., & Chou, C. (1987). Practical Issues in Structural Modeling. *Sociological Methods Research, 16*(78). Retrieved February 26, 2012, from http:// www.smr.sagepub.com. DOI: 10.1177/0049124187016001004

Bentler, P.M. (1990). Comparative Fit Indexes in Structural Models. *Psychological Bulletin*, 107(2), 238-46. As cited in Hooper, D., Coughlan, J., Mullen, M. Structural Equation Modelling: Guidelines for Determining Model Fit. *Electronic Journal of Business Research Methods, 6*(1), 53-60.

Bentler, P.M., & Bonnet, D.C. (1980). Significance Tests and Goodness of Fit in the Analysis of Covariance Structures. *Psychological Bulletin, 88*(3), 588-606.

Beyer, J. M., & Trice, H.M. (1982). The Utilization Process: A Conceptual Framework and Synthesis of Empirical Findings. *Administrative Science Quarterly*, *27*(4), 591-622.

Bhatt, G. D. (2000). Organizing Knowledge in the Knowledge Development Cycle. *Journal of Knowledge Management,4*(1), 15-26.

Blumentritt, R., & Johnston, R. (1999). Towards a Strategy for Knowledge Management. *Technology Analysis and Strategic Management, 11*(3), 287-300.

Bollen, K. A., (1986). Sample Size and Bentler and Bonett's Nonnormed Fit Index. *Psychometrika, 51,* 375-377.

Bollen, K. A., (1987). Outliers and Improper Solutions: A Confirmatory Factor Analysis Example. *Sociological Methods and Research, 15,* 375-384.

Bolloju, N., Khalifa, M., & Turban, E. (2002). Integrating Knowledge Management into Enterprise Environments for the Next Generation Decision Support. *Decision Support Systems, 33*(2), 163-176.

Bonner, D. (2000). *Leading Knowledge Management and Learning,* Alexandria : American Society of Training & Development.

Box, G. E. P., Jenkins, G. M., & Reinsel, G. C. (1994). *Time Series Analysis, Forecasting and Control*, 3rd ed. Englewood Clifs, NJ : Prentice Hall.

Brachos, D., Kostopoulos, K., Soderquist, K. E., & Prastacos, G. (2007). Knowledge Effectiveness, Social Context and Innovation. *Journal of Knowledge Management, 11*(5), 31-44.

Brooking, A. (1999). *Corporate Memory: Strategies for Knowledge Management*. London: International Thomas Business Press.

Brown, J. S., & Duguid, P. (2001). Knowledge and Organization: A Social-Practice Perspective, *Organization Science*, *12*(2), 198-213.

Budhwar, P., & Kharei, N. (2001). Comparative Study of HR Practices in Britain and India. *International Journal of Human Resource Management*, *12*(5), 800-26. Retrieved May 23, 2013, from http://www.sebon.gov.np.

Burton-Jones, A. (1999). *Knowledge Capitalism: Business, Work, and Learning in the New Economy*. New York : Oxford University Press.

Byrne, B. M. (1998). *Structural Equation Modeling with LISREL, PRELIS and SIMPLIS: Basic Concepts, Applications and Programming*. New Jersey: Lawrence Erlbaum Associates.

Callaghan, J. (2002). *Inside Intranets and Extranets: Knowledge Management and the Struggle for Power*. New York: Palgrave.

Campbell, D., & Hallam, G. (1994). *Manual for the Campbell-Hallam Team Development Survey*. Minneapolis: National Computer Systems. As cited in Janz, B. D., & Pattarawan, P. (2003). Understanding the Antecedents of Effective Knowledge Management: the Importance of a Knowledge-Centered Culture. *Decision Sciences, 34*(2), 352-373.

Carayannis, E. G. (1999). Fostering Synergies Between Information Technology and Managerial and Organizational Cognition: The Role of Knowledge Management. *Technovation, 19*(4), 219-233.

Chourides, P., Longbottom, D., and Murphy, W. (2003). Excellence in Knowledge Management: An Empirical Study to Identify Critical Factors and Performance Measures. *Measuring Business Excellence, 7*(2), 29-45.

Cohen, D. (2006).What's Your Return on Knowledge? *Harvard Business Review, December*,28.

Conner, K. R., & Prahalad, C. K. (1996). A Resource-Based Theory of Firm: Knowledge Versus Opportunism. *Organization Science*, *7*(5), 477-501.

Cortada, J. W., & Woods, J. A. (2000). *The Knowledge Management Yearbook: 2000-2001*. Boston, MA: Butterworth-Heinemann. Retrieved February 18, 2010, from http://www.amazon.com.

Darroch, J., & McNaughton, R. (2002). Examining the Link Between Knowledge Management Practices and Types of Innovation. *Journal of Intellectual Capital*, *3*(3), 210-222.

Davenport, T. H., & Prusak, L. (1998). *Working Knowledge: How Organizations Manage What They Know.*Boston, MA: Harvard Business School Press. As cited in Taro, U., & Joshi, M. J.(n.d.) *A Review of Literature on Knowledge Management Using ITC in Higher Education Computer Technology & Application,4*(11), 62-67. Retrieved December 31, 2012 from www.ijcta.com/documents/volumes/vol4issue1/ijcta2013040110.pdf

Davenport, T. H., & Volpel, S.C. (2001).The Rise of Knowledge Towards Attention Management. *Journal of Knowledge Management, 5*(3), 212-221.

Davenport, T. H., Long, D. W. D., & Beers, M. C. (1998). Successful Knowledge Management Projects. *Sloan Management Review, 39*(2), 43-57.

Diamantopoulos, A., & Siguaw, J. A. (2000). *Introducing LISREL*. London: Sage Publications. As cited in Hooper, D., Coughlan, J., & Mullen, M. R. (2008) Structural Equation Modelling: Guidelines for Determining Model Fit. *The Electronic Journal of Business Research Methods 6*(1), 53-60. Retrieved May 01, 2012, from http:// www.ejbrm.com.

Duffy, J. (1999). *Harvesting Experience: Reaping the Benefits of Knowledge*. Prairie Village, KS : ARMA International.

Dvir, R., & Pasher, E.(2004). Innovation Engines for Knowledge Cities: An Innovation Ecology Perspective. *Journal of Knowledge Management, 8*(5), 16-27.

Earl, M. (2001). Knowledge Management Strategies: Toward a Taxonomy. *Journal of Management Information Systems,18*(1), 215-233.

Fahey, L., & Prusak, L. (1998). The Eleven Deadliest Sins of Knowledge Management. *California Management Review, 40*(3), 265-276.

Fan, X., Thompson, B., & Wang, L. (1999). Effects of Sample Size, Estimation Methods, and Model Specification on Structural Equation Modeling Fit Indexes. *Structural Equation Modeling*, *6*(1), 56-83.

Faucher, P.L., Everett, A. M., & Lawson, R. (2008). Reconstituting Knowledge Management. *Journal of Knowledge Management,12*(3), 3-16.

Fiol, M. C., & Lyles, M. A. (1985). Organizational Learning. *The Academy of Management Review,* 803-813. Retrieved November 12, 2011, from www.http://links.jstor.org.

Fox, J.,(1980). Effect Analysis in Structural Equation Models. *Sociological Methods and Research,9,*3-28.

Fukuda, Y. (1995). *Variations of Knowledge in Information Society*. ISMICK, (pp. 3-8). As cited in Fabian, G.(2009). *Artificial Intelligence and Knowledge Management: Ontologies and Multi-Agent Systems for a Corporate Semantic Web* (Ph.D. Thesis, INRIA and University of Nice, Sophia Antipolis) Retrieved February 26, 2010 from http://www.sop.inria.fr/acacia/fabien/research/PhD2002/

Galagan, P. (1997). Smart Companies (Knowledge Management). *Training and Development*, *51*(12), 20-25.

Gammelgaard, J., & Ritter, T. (2005). The Knowledge Retrieval Matrix: Codification and Personification as Separate Strategies. *Journal of Knowledge Management*, *9*(4), 133-143.

Gear, M. C., Liendo, E. C., & Scott, L.L. (1989). *Changing Mindset: The Potential Unconscious*. New York, NY: New York University Press. As cited in Tranfield, D., Denyer, D., Marcos, J., & Burr, M. (2004). Co-producing Management Knowledge. *Management Decision, 42* (3/4), 375-386. DOI: 10.1108/00251740410518895

Gerbing, D.W., & Anderson, J.C. (1987). Impropor Solutions in the Analysis of Covariance Structures: Their Interpretability and a Comparision of Alterrnative Respecifications. *Psychometrica,52*, 255-271. As cited in Bentler, P. M., & Chou, C. (1987). Practical Issues in Structural Modeling. *Sociological Methods Research, 16*(78). Retrieved February 26, 2012, from http:// www. smr.sagepub.com DOI: 10.1177/0049124187016001004

Guilford, J. P. (1954). *Psychometric* . McGraw Hill Education.

Hasanali, F. (2002). *Critical Success Factors of Knowledge Management*. Retrieved November 11, 2011 from http:// www.kmadvantage.com.

Hatcher, L.(1994). A Step-by-Step Approach to Using SAS for Factor Analysis and Structural Equation Modeling. Cary, NC: SAS Institute Inc.

Heffner, M., & Sharif, N. (2008). Knowledge Fusion for Technological Innovation in Organizations. *Journal of Knowledge Management ,12*(2), 79-93.

Herschel, R. T., & Nemati, H.R. (2000). Chief Knowledge Officer: Critical Success Factors for Knowledge Management. *Information Strategy: The Executive's Journal, 16*(4), 37-45.

Hoelter, J. W., (1983). The Analysis of Covariance Structures: Goodness-of-fit Indices. *Sociological Methods and Research, 11*, 325-344.

Holsapple, C. W., & Joshi, K. D. (2000). An Investigation of Factors that Influence the Management of Knowledge in Organizations. *Journal of Strategic Information Systems, 9*(2/3), 235-261.

Horak, B. J. (2001). Dealing with Human Factors and Managing Change in Knowledge Management: A Phased Approach. *Topics in Health Information Management, 21*(3), 8-17.

Hu, L. T., & Bentler, P. M. (1999). Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria Versus New Alternatives. *Structural Equation Modeling, 6*(1),1-55.

Huber, G. (1991). Organizational Learning: The Contributing Processes and the Literatures. *Organization Science, 2*(1), 88-115.

Hult, M. T., Ketchen, J. D., & Earnest, J. N. (2003). Organization Learning as a Strategic Resource in Supply Management. *Journal of Operations Management*, 541-556. Retrieved September 22, 2010, from www.http://elsevier.com/locate/dsw.

Huselid, M. A. (1995). The Impact of Human Resource Management Practices on Turnover, Productivity and Corporate Financial Performance. *Academy of Management Journal*, *38*(3), 635-672.

Jacobson, A., & Prusak, L. (2006). The Cost of Knowledge. *Harvard Business Review*, *December*, 34.

Janz, B. D., & Pattarawan, P. (2003). Understanding the Antecedents of Effective Knowledge Management: The Importance of a Knowledge-Centered Culture. *Decision Sciences, 34*(2), 352-373.

Jha, B. K. (Ed.). (n.d.). India: Sarasvat-Niketanam. Retrieved May 29, 2013, from http://sarasvat-niketanam-varshankjvinisa.blogspot.com.

Johnson, D. W., Johnson, R. T., Buck, M. L. A., & Richards, P. S. (1988). The Effect of Prolonged Implementation of Cooperative Learning on Social Support within the Classroom. *Journal of Psychology*, *119*(5), 405-411.

Jöreskog, K., & Sörbom, D. (1993). *LISREL 8: Structural Equation Modeling with the SIMPLIS Command Language.* Chicago, IL: Scientific Software International Inc. As cited in Hooper, D., Coughlan, J. & Mullen, M. R. (2008). Structural Equation Modelling: Guidelines for Determining Model Fit. *The Electronic Journal of Business Research Methods, 6*(1), 53-60. Retrieved March 10, 2012, from http:// www.ejbrm.com.

Junnarkar, B., & Brown, C.V. (1997). Re-Assessing the Enabling Role of Information Technology in KM. *Journal of Knowledge Management, 1*(2), 142.

Kline, R. B. (2005). *Principles and Practice of Structural Equation Modeling* (2nd ed.). New York: The Guilford Press. As cited in Hooper, D., Coughlan, J., & Mullen, M. R. (2008). Structural Equation Modelling: Guidelines for Determining Model Fit. *Electronic Journal of Business Research Methods, 6*(1), 53-60. Retrieved March 10, 2012, from http:// www.ejbrm.com.

Knotts, T. L., Jones, S. C., Udell, G. G. (2006). Using a Balanced Approach to Measure Merchandising Supplier Performance. *Measuring Business Excellence*, *10*(1), 4-13.

Koenig, M. E. D. (2002). The Third Stage of KM Emerges. *KM World, 11*(3), 20-1. As cited in Vorakulpipat, C., & Rezgui, Y. (2008). An Evolutionary and Interpretive Perspective to Knowledge Management. *Journal of Knowledge Management, 12*(3), 17-34.

Leonard, D., & Sensiper, S. (1998). The Role of Tacit Knowledge in Group Innovation. *California Management Review, 40*(3), 112-132.

Liebowitz, J. (1999). Key Ingredients to the Success of an Organization's Knowledge Management Strategy. *Knowledge and Process Management, 6*(1), 37-40.

Loehlin, J. C. (1992). Manifest variable models: An Introduction to Factor, Path, and Structural Analysis. Hillsdale, NJ: Lawrence Erlbaum.

MacCallum, R. C., (1986). Specification Searches in Covariance Structure Modeling. *Psychological Bulletin, 100,* 107-120.

McArdle, J. J. & Roderick, P. M. (1984). Some Algebraic Properties of the Reticular Action Model Moment Structures. *British Journal of Mathematical and Statistical Psychology, 37*(2), 234-251. DOI: 10.1111/j.2044-8317.1984.tb00802.x

McDermott, R., & O'Dell, C. (2001). Overcoming Cultural Barriers to Sharing Knowledge. *Journal of Knowledge Management, 5*(1), 76-85.

McElroy, M. W. (1999). The Second Generation of Knowledge Management. *Knowledge Management*. As cited in Vorakulpipat, C., & Rezgui, Y. (2008). An Evolutionary and Interpretive Perspective to Knowledge Management. *Journal of Knowledge Management, 12*(3), 17-34.

Mentzas, G. (2001). A Holistic Approach to Realizing the Full Value of Your Knowledge Assets. *Knowledge Management Review, 4*(3), 10-11.

Moody, D. L., & Shanks, G. G. (1999). Using Knowledge Management and the Internet to Support Evidence Based Practice: A Medical Case Study. *Proceedings of the 10th Australasian Conference on Information Systems* (pp. 660-676), Wellington, New Zealand.

Muir-Gray, J.A. (1997). *Evidence-Based Health Care: How to Make Health Policy and Management Decisions*, London: Churchill-Livingstone.

(2012). *Briefing to Secretary,Ministry of Agriculture.* NARC, Executive Director. Kathmandu: PowerPoint Presentation on October 08.

Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation. *Organization Science*, *5*(1), 14-37.

Nonaka, I., & Konno, N. (1998). The Concept of Ba Building a Foundation for Knowledge Creation. *California Management Review, 40*(3), 40-54.

Nunnally, J. C. (1978). *Psychometric Theory*. New York: McGraw-Hill. As cited in Sabherwal, R., & Becerra-Fernandez, I. (2003). An Empirical Study of the Effect of Knowledge Management Process at Individual, Group and Organizational Levels. *Decision Sciences, 34*(2), 225-260.

Oinas-Kukkonen, H. (2004). The 7C Model for Organizational Knowledge Creation and Management. *Proceedings of the 5th European Conference on Organizational Knowledge, Learning and Capabilities.* Innsbruck. As cited in Chalee Vorakulpipat, C., & Rezgui, Y. (2008). An Evolutionary and Interpretive Perspective to Knowledge Management. *Journal of Knowledge Management*, *12*(3), 17-34.

Pentland, B. T. (1995). Information Systems and Organizational Learning: The Social Epistemology of Organizational Knowledge Systems. *Accounting, Management and Information Technologies, 5*(1), 1-21.

Polanyi, M. (1962). *Personal Knowledge: Toward a Post-Critical Philosophy*. London: Routledge and Kegan Paul.

Polanyi, M. (1967). *The Tacit Dimension*. Garden City, NY: Archor Books, Doubleday.

Rockart, R. F. (1979). Chief Executives Define Their Own Data Needs. *Harvard Business Review, 57*(2), 81-93.

Sabherwal, R., & Becerra-Fernandez, I. (2003). An Empirical Study of the Effect of Knowledge Management Process at Individual, Group and Organizational Levels. *Decision Sciences*, *34*(2), 225-260.

Saris, W. E., Satorra, A., & Sörbom, D. (1987). The Detection and Correction of Specification Errors in Structural Equation Models. As cited in Clogg, C.C. [Ed.]. *Sociological Methodology* 1987. San Francisco: Jossey-Bass.

Schafer, J. L., & Olsen, M. K., (1998). Multiple Imputation For Multivariate Missing-Data Problems: A Data Analyst's Perspective. *Multivariate Behavioral Research, 33*(4), 545-571. DOI:10.1207/s15327906mbr3304_5

Shane, S. (1995). Uncertainty Avoidance and the Preference for Innovation Championing Roles. *Journal of International Business Studies*, *26*(1), 47-68.

Shankar, R., Acharia, S., & Baveja, A. (2009). Soft-System Knowledge Management Framework for New Product Development. *Journal of Knowledge Management, 13*(1), 135-153.

Sharma, S., Mukherjee, S., Kumar, A., & Dillon, W.R. (2005). A Simulation Study to Investigate the Use of Cutoff Values for Assessing Model Fit in Covariance Structure Models. *Journal of Business Research*, *58*(1), 935-943.

Skyrme, D., & Amidon, D. (1997). The Knowledge Agenda. *Journal of Knowledge Management*, *1* (1), 27-37.

Skyrme, D., & Amidon, D. (1998). The Knowledge Agenda. As cited in Cortada, J. W., & Woods, J. A. (Eds), *The Knowledge Management Yearbook 1999-2000*. Wobum, MA: Butterworth-Heinemann.

Smirlock, M., Gilligan, T., & Marshall, W. (1984). Tobin's Q and the Structure-Performance Relationship. *American Economic Review*, *74*, 1051-1060.

Snowden, D. (2002). Complex Acts of Knowing; Paradox and Descriptive Self-Awareness. *Journal of Knowledge Management*, *6*(2), 1-14.

Spender, J.C. (1996). Organizational Knowledge, Learning, and Memory: Three Concepts in Search of a Theory. *Journal of Organizational Change Management*, *9*, 63-78.

StatSoft, Inc. (2001). STATISTICA (data analysis software system), Version 6. Retrieved July 12, 2009, from http://www.statsoft.com.

StatSoft, Inc. (2007). STATISTICA (data analysis software system), Version 8.0. Retrieved March 12, 2011, from http://www.statsoft.com.

Steiger, J. H. (1989). EzPATH: A supplementary module for SYSTAT and SYGRAPH. Evanston, IL: SYSTAT, Inc. As cited in StatSoft, Inc. (2007). STATISTICA (data analysis software system), Version 8.0. Retrieved March 12, 2011, from http://www.statsoft.com.

Steiger, J. H. (2007).Understanding the Limitations of Global Fit Assessment in Structural Equation Modeling. *Personality and Individual Differences,42*(5), 893-898.

Stelzl, I. (1986). Changing a Causal Hypothesis without Changing the Fit: Some Rules for Generating Equivalent Path Models. *Multivariate Behavioral Research, 21,* 309-331.

Tabachnick, B.G., & Fidell, L.S. (2007). Using Multivariate Statistics (5th ed.). New York: Allyn and Bacon. As cited in Hooper, D., Coughlan, J., Mullen, M.: Structural Equation Modelling: Guidelines for Determining Model Fit. *Electronic Journal of Business Research Methods, 6*(1), 53-60.

Tian, J., Nakamori, Y., & Wierzbicki, A. P. (2009). Knowledge Management and Knowledge Creation in Academia: A Study Based on Surveys in a Japanese Research University. *Journal of Knowledge Management, 13*(2), 76-92.

Tobin, J. (1969). A General Equilibrium Approach to Monetary Theory. *Journal of Money, Credit, and Banking, 11*(1), 15-29.

Tranfield, D., Denyer, D., Marcos, J., & Burr, M. (2004). Co-producing Management Knowledge. *Management Decision, 42* (3/4), 375-386.

Trinder, L., & Reynolds, S. (Eds) (2000). *Evidence-Based Practice: A Clinical Approach,* Oxford: Blackwell Science.

Uotila, T., Melkas, H., & Harmaakorpi, V. (2005). Incorporating Futures Research into Regional Knowledge Creation and Management. *Futures, 37*(8), 849-866.

Van Dijk, S., Berends, H., Jelinek, M., Romme, A. G. L., & Weggemen, M. (2011). Micro-Institutional Affordances and Strategies of Radical Innovation. *Organization Studies, 32*(11), 1485-1513.

Verganti, R. (2006). Innovating Through Design. *Harvard Business Review, December*,121.

Vorakulpipat, C., & Rezgui, Y. (2008). An Evolutionary and Interpretive Perspective to Knowledge Management. *Journal of Knowledge Management*, *12*(3), 17-34.

Wang, F. W., & Plaskoff, J. (2002). *An Integrated Development Model.* As cited in Bellaver, R. F., & Lusa, J. M. (Eds). *Knowledge Management Strategy and Technology*. Boston: Artech House.

Weick, K. E. (1991). The Nontraditional Quality of Organizational Learning. *Organization Science*, *2*(1), 116-124.

Weick, K. E. (1995). *Sensemaking in Organizations*, Newbury Park, CA: Sage.

Wognum, I., & Fond, L. J. (2000). Stakeholder Involvement in Strategic HRD Aligning: The Impact on HRD Effectiveness. *International Journal of Training and Development,4*(2), 98-110. Retrieved September 17, 2010, from http:// onlinelibrary.wiley.com. DOI/10.1111/1468-2419.00099

Wong, K. Y. (2005). Critical Success Factors for Implementing Knowledge Management in Small and Medium Enterprises. *Industrial Management & Data Systems, 105*(3), 261-279.

Wong, K. Y., & Aspinwall, E. (2005). An Empirical Study of the Important Factors for Knowledge-Management Adoption in the SME Sector. *Journal of Knowledge Management, 9*(3), 64-82.

Wong, K. Y., & Aspinwall, E. (2004). Characterizing Knowledge Management in the Small Business Environment. *Journal of Knowledge Management, 8*(4).

Xu, J., & Quaddus, M. (2005). From Rhetoric Towards a Model of Practical Knowledge Management Systems. *Journal of Management Development*,*24*(4), 291-319.

Yahya, S., & Goh, W. K. (2002). Managing Human Resources toward Achieving Knowledge Management. *Journal of Knowledge Management*, *6*(5), 457-568.

Zhiyi, A., & Massingham, P. (2007). National Culture and the Standardization Versus Adaptation of Knowledge Management. *Journal of Knowledge Management*, *11*(2), 5-21.

ANNEXURES

Annex 1: Outlier Removed Data File

sn	wpro	ict	hrd	memory	budget	gpro	kapply	InvYear	Site
1	14	19	4	13	12	12	23	22	IOM/TUTH
2	25	23	15	18	21	16	39	26	IOM/TUTH
3	21	38	12	11	12	14	27	20	IOM/TUTH
4	19		8	12	11	14	28	17	IOM/TUTH
5	20	20		26		18	38	4	IOM/TUTH
6	26	21		17	14	16	34	9	IOM/TUTH
7	19	21	11	18	16		29	17	IOM/TUTH
8	21		12	19	11	16	35	17	IOM/TUTH
9	24	26	9	20	13	15	31	20	IOM/TUTH
10	28	27	12	23	13	17	36	23	IOM/TUTH
11		31	13	24	14	14		27	IOM/TUTH
12	15	25	14	15	13	9	18	4	IOM/TUTH
13	19	21	3	18	18		32	4	IOM/TUTH
14	17	22	10	11	18	8	22	5	IOM/TUTH
15	18	25	14	19	14	13	21	4	IOM/TUTH
16	24	24	11	18	21	12	28	4	IOM/TUTH
17	22	27	14	15	16	10	27	4	IOM/TUTH
18	26	36	15	20	20	14	37	4	IOM/TUTH
19	11	13	14	17	17	12	20	4	IOM/TUTH
20	18	19	3	22	23	16	26	5	IOM/TUTH
21	19	26	11	22	22	16	33	4	IOM/TUTH
22	24	30	7	21	21	18	39	4	IOM/TUTH
23	16	15	10	16	27	7	17	5	IOM/TUTH
24	22	33	12	22	20	16	32	31	IOM/TUTH
25	23	25	13	20	18	14	33	29	IOM/TUTH
26	19	26	11	16	16	18	22	7	IOM/TUTH
27	20	25	9	16	16	16	34	29	IOM/TUTH
28		21	12	25		21		15	IOM/TUTH
29	23	25	12	22	17	17	34	25	IOM/TUTH
30	24	25	13	27	20	18	33	23	IOM/TUTH
31	24	27	11	22	21	17	33	17	IOM/TUTH
32	25	23	15	18	21	16	39	26	IOM/TUTH
33	24	21	13	18	21	16	36	11	IOM/TUTH
34	21	38	12	11	12	14	27	20	IOM/TUTH
35	19		8	12	11	14	28	17	IOM/TUTH
36	28	22	17			11	41	27	IOM/TUTH

37	26	21	17	17	14	16	34	9	IOM/TUTH
38	19	21	11	18	16		29	17	IOM/TUTH
39	21		12	19	11	16	35	17	IOM/TUTH
40	27	31	13	24	14	14		27	IOM/TUTH
41	17	31	6	11	9	17	23	26	IOM/TUTH
42	21	19	9	14	16	10	25	15	IOM/TUTH
43	25	32	14	21	23	15	31	4	IOM/TUTH
44	15	25	14	15	13	9	18	4	IOM/TUTH
45	21	21	6	10	14	12	25	4	IOM/TUTH
46	17	22	10	11	18	8	22	4	IOM/TUTH
47	27	22	13	15	27		36	4	IOM/TUTH
48	18	25	14	19	14	13	21	4	IOM/TUTH
49	26	36	15	20	20	14	37	4	IOM/TUTH
50	11	13	14	17	17	12	20	4	IOM/TUTH
51	20	33	12	20	24	14	27	4	IOM/TUTH
52	24	30	7	21	21	18	39	4	IOM/TUTH
53	16	15	10	16	27	7	17	4	IOM/TUTH
54		32	15	25	24	15	36	14	IOM/TUTH
55	22	33	12	22	20	16	32	31	IOM/TUTH
56	23	25	13	20	18	14	33	29	IOM/TUTH
57	19	26	11	16	16	18	22	7	IOM/TUTH
58	27	22	15	23	21	17	38	24	IOM/TUTH
59	27	30	14	26	24	18	36	4	IOE
60	23	25	12	22	17	17	34	25	IOE
61	24	27	11	22	21	17	33	17	IOE
62	26	25	10	18	23	15	33	7	IOE
63	28	27	12	23	13	17	36	22	IOE
64	27	31	13	24	14	14		27	IOE
65	17	22	10	11	18	8	22	4	IOE
66	27	31	13	24	14	14	43	29	IOE
67	17	31	6	11	9	17	23	26	IOE
68	21	19	9	14	16	10	25	15	IOE
69	25	32	14	21	23	15	31	4	IOE
70	28	27	12	23	13	17	36	21	IOE
71	21	30	14	16	13	15	29	12	IOE
72	17	31	6	11	9	17	23	26	IOE
73	19	21	3	18	18		32	4	IOE
74	17	22	10	11	18	8	22	4	IOE
75	24	21	13	18	21	16	36	11	IOE

76	28	22	17			11	41	28	IOE
77	20	20		26	28	18	38	3	IOE
78	26	21	17	17	14	16	34	9	IOE
79	19	21	11	18	16		29	17	IOE
80	21	30	14	16	13	15	29	12	IOE
81	27	31	13	24	14	14	43	24	IOE
82	25	32	14	21	23	15	31	4	IOE
83	15	25	14	15	13	9	18	3	IOE
84	19	21	3	18	18	21	32	4	IOE
85	17	22	10	11	18	8	22	3	IOE
86	27	22	13	15	27		36	4	IOE
87	18	25	14	19	14	13	21	4	IOE
88	24	24	11	18	21	12	28	3	IOE
89	22	27	14	15	16	10	27	4	IOE
90		13	14	17	17	12	20	4	IOE
91	20	33	12	20	24	14	27	4	IOE
92	24	30	7	21	21	18	39	4	IOE
93	22	30		15	19	17	30	17	IOE
94	28	32	15	25	24	15	36	14	IOE
95	22	33	12	22	20	16	32	31	IOE
96	23	25	13	20	18	14	33	29	IOE
97	20	31	12	24	20	13	25	28	IOE
98	19	26	11	16	16	18	22	7	IOE
99	27	22	15	23	21	17	38	31	IOE
100	20	25	9	16	16	16	34	29	IOE
101	27	30	14	26	24	18	36	4	IOE
102	23	25	12	22	17	17	34	25	IOE
103	24	25	13	27	20	18	33	23	IOE
104	31	27		19	20	21		25	IOE
105	24	27	11	22	21	17	33	17	IOE
106	26	25	10	18	23	15	33	7	IOE
107	19		8	12	11	14	28	17	IOE
108	28	22	17			11	41	26	IOE
109	24	26	9	20	13	15	31	20	IOE
110	21	30	14	16	13	15	29	12	IOE
111	17	31	6	11	9	17	23	26	IOE
112	21	19	9	14	16	10	25	15	IOE
113	25	32	14	21	23	15	31	4	NARC
114	15	25	14	15	13	9	18	5	NARC

115	21	21	6	10	14	12	25	4	NARC
116	19	21	3	18	18	21	32	3	NARC
117	27	22	13	15	27		36	4	NARC
118	18	25	14	19	14	13	21	5	NARC
119	24	24	11	18	21	12	28	3	NARC
120	18		7	15	20	13	20	4	NARC
121	22	27	14	15	16	10	27	4	NARC
122		13	14	17	17	12	20	4	NARC
123	21	38	12	11	12	14	27	20	NARC
124	19		8	12	11	14	28	17	NARC
125	28	22	17			11	41	27	NARC
126	20	20		26	28	18	38	4	NARC
127	19	21	11	18	16	21	29	17	NARC
128	24	26	9	20	13	15	31	20	NARC
129	27	31	13	24	14	14	43	22	NARC
130	15	25	14	15	13	9	18	4	NARC
131	21	21	6	10	14	12	25	4	NARC
132	24	24	11	18	21	12	28	3	NARC
133	22	27	7		24	18	25	4	NARC
134	18		7	15	20	13	20	2	NARC
135	26	36	15	20	20	14	37	4	NARC
136	18			22	23	16	26	2	NARC
137	24	30	7	21	21	18	39	4	NARC
138	16	15	10	16	27		17	3	NARC
139	24	19	10	15	28	15	34	4	NARC
140	22	30		15	19	17	30	17	NARC
141	28	32	15	25	24	15	36	14	NARC
142	23	25	13	20	18	14	33	29	NARC
143	19	26	11	16	16	18	22	7	NARC
144	27	22	15	23	21	17	38	25	NARC
145		21	12	25	28	21		15	NARC
146	27	30	14	26	24	18	36	4	NARC
147	23	25	12	22	17	17	34	25	NARC
148	24	25	13	27	20	18	33	30	NARC
149	31	27		19	20	21		25	NARC
150	24	27	11	22	21	17	33	17	NARC
151	14	19		13	12	12	23	22	NARC
152	19		8	12	11	14	28	17	NARC
153	28	22	17	28		11	41	23	NARC

154	19	21	11	18	16	21	29	17	NARC
155	28	27	12	23	13	17	36	30	NARC
156	21	30	14	16	13	15	29	12	NARC
157	27	31	13	24	14	14	43	25	NARC
158	17	31	6	11	9	17	23	26	NARC
159	21	19	9	14	16	10	25	15	NARC
160	15	25	14	15	13	9	18	5	NARC
161	19	21		18	18	21	32	4	NARC
162	27	22	13	15	27		36	3	NARC
163	18	25	14	19	14	13	21	4	NARC
164	24	24	11	18	21	12	28	3	NARC
165	22	27	7		24	18	25	3	NARC
166	22	27	14	15	16	10	27	3	NARC
167		13	14	17	17	12	20	3	NARC

Annex 2: Confirmatory Factor Analysis Results

Data File: KMPhD BoxCox.sta

Model File: C:\Users\PC\Documents\CFA PhD.CMD

Data to Analyze: Correlations

Discrepancy Function: ML

Manifest Exogenous: Fixed

Standardization: New Method (Constrained Estimation)

Initial Values: 0.05 Defaults

Path Model Output

Iteration Results

Number of Iterations: 5

Termination Normal

Chi-Square: 263.765991

DF: 11

p-level: 0.000000

Iteration History

	ITN	DISC	RCOS	LAMBDA	MAXCON	NRP	NRC	NAIC	STEP
1	0	3.078471	0.242924	1.000000	0.250000	0	0	0	0.000000
2	1	2.389558	0.145153	1.000000	0.153169	7	0	0	0.181393
3	2	2.250678	0.086361	1.000000	0.082661	7	0	0	0.050289
4	3	2.198333	0.007635	1.000000	0.009173	7	0	1	0.048357
5	4	2.198052	0.001059	1.000000	0.000981	7	0	1	0.011735
6	5	2.198050	0.000005	1.000000	0.000003	7	0	1	0.000684

Summary Statistics

	Value
Discrepancy Function	2.20
Maximum Residual Cosine	0.00
Maximum Absolute Gradient	0.00
ICSF Criterion	0.00
ICS Criterion	0.00
ML Chi-Square	263.77
Degrees of Freedom	11.00
p-level	0.00
RMS Standardized Residual	0.28

Model Estimates				
	Parameter	Standard	T	Prob.
(Wpro)-1->[wpro]	0.96	0.00		
(ICT)-2->[ict]	0.67	0.35	1.93	0.05
(HRD)-3->[hrd]	0.62	0.18	3.52	0.00
(Memory)-4->[memory]	0.67	0.12	5.64	0.00
(Budget)-5->[budget]	0.73	0.16	4.58	0.00
(Gpro)-6->[gpro]	0.57	0.00		
(Kapply)-7->[kapply]	0.57	0.00		
(DELTA1)-->[wpro]				
(DELTA2)-->[ict]				
(DELTA3)-->[hrd]				
(DELTA4)-->[memory]				
(DELTA5)-->[budget]				
(DELTA6)-->[gpro]				
(DELTA7)-->[kapply]				
(DELTA1)-8-(DELTA1)	0.07	0.00		
(DELTA2)-9-(DELTA2)	0.55	0.47	1.18	0.24
(DELTA3)-10-(DELTA3)	0.62	0.22	2.81	0.00
(DELTA4)-11-(DELTA4)	0.55	0.16	3.44	0.00
(DELTA5)-12-(DELTA5)	0.47	0.23	2.04	0.04
(DELTA6)-13-(DELTA6)	0.68	-0.00		
(DELTA7)-14-(DELTA7)	0.68	-0.00		
(ICT)-15-(Wpro)	0.53	0.27	1.96	0.05
(HRD)-16-(Wpro)	0.50	0.14	3.53	0.00
(Memory)-17-(Wpro)	1.00	0.22	4.60	0.00
(Budget)-18-(Wpro)	0.52	0.00		
(HRD)-19-(ICT)	0.44	0.00		
(Memory)-20-(ICT)	0.47	0.32	1.48	0.14
(Budget)-21-(ICT)	-0.21	0.23	-0.93	0.35
(Memory)-22-(HRD)	0.89	0.00		
(Budget)-23-(HRD)	0.32	0.19	1.66	0.10
(Budget)-24-(Memory)	1.00	0.00		

Noncentrality Fit Indices			
	Lower 90%	Point	Upper 90%
Population Noncentrality Parameter	1.08	1.41	1.81
Steiger-Lind RMSEA Index	0.31	0.36	0.41
McDonald Noncentrality Index	0.41	0.49	0.58
Population Gamma Index	0.66	0.71	0.76
Adjusted Population Gamma Index	0.13	0.27	0.40

Single Sample Fit Indices	
	Value
Joreskog GFI	0.70
Joreskog AGFI	0.24
Akaike Information Criterion	2.48
Schwarz's Bayesian Criterion	2.88
Browne-Cudeck Cross Validation Index	2.50
Independence Model Chi-Square	406.66
Independence Model df	21.00
Bentler-Bonett Normed Fit Index	0.35
Bentler-Bonett Non-Normed Fit Index	-0.25
Bentler Comparative Fit Index	0.34
James-Mulaik-Brett Parsimonious Fit Index	0.18
Bollen's Rho	-0.24
Bollen's Delta	0.36

LaGrange Multiplier Statistics			
	Variance	LaGrange	Standard
wpro	1.00	-0.00	-0.00
ict	1.00	0.00	-0.00
hrd	1.00	-0.00	-0.00
memory	1.00	0.00	-0.00
budget	1.00	-0.00	-0.00
gpro	1.00	0.00	0.00
kapply	1.00	0.00	0.00

Measures of Multivariate Kurtosis	
	Value
Mardia Coefficient of Multivariate Kurtosis	-0.26
Normalized Multivariate Kurtosis	-0.13
Mardia-Based Kappa	-0.00
Mean Scaled Univariate Kurtosis	-0.16
Adjusted Mean Scaled Univariate Kurtosis	-0.15
Relative Multivariate Kurtosis	1.00

Reflector Matrix							
	wpro	ict	hrd	memory	budget	gpro	kapply
wpro	0.00						
ict	-0.00	0.00					
hrd	0.00	0.00	0.00				
memory	-0.00	0.00	0.00	-0.00			
budget	-0.00	0.00	-0.00	0.00	0.00		
gpro	-0.39	-0.23	0.13	-0.48	-0.08	0.00	
kapply	-0.87	-0.32	-0.19	-0.67	-0.33	-0.55	0.00

Univariate Kurtosis Indices			
	Kurtosis	Corrected	Normalized
wpro	-0.61	-0.58	-1.36
ict	0.04	0.09	0.09
hrd	-0.40	-0.37	-0.90
memory	-0.71	-0.69	-1.59
budget	-0.57	-0.54	-1.28
gpro	-0.40	-0.37	-0.90
kapply	-0.86	-0.84	-1.93

Univariate Skewness Indices			
	Skewness	Corrected	Normalized
wpro	-0.33	-0.33	-1.47
ict	0.19	0.19	0.86
hrd	-0.40	-0.40	-1.79
memory	-0.10	-0.10	-0.45
budget	-0.18	-0.18	-0.80
gpro	-0.14	-0.15	-0.64
kapply	-0.05	-0.05	-0.23

Input (Correlation) Matrix N = 121							
	wpro	ict	hrd	memory	budget	gpro	kapply
wpro	1.00						
ict	0.35	1.00					
hrd	0.30	0.18	1.00				
memory	0.65	0.21	0.37	1.00			
budget	0.36	-0.10	0.15	0.49	1.00		
gpro	0.39	0.23	-0.13	0.48	0.08	1.00	
kapply	0.87	0.32	0.19	0.67	0.33	0.55	1.00

Reproduced Matrix

	wpro	ict	hrd	memory	budget	gpro	kapply
wpro	1.00						
ict	0.35	1.00					
hrd	0.30	0.18	1.00				
memory	0.65	0.21	0.37	1.00			
budget	0.36	-0.10	0.15	0.49	1.00		
gpro	0.00	0.00	0.00	0.00	0.00	1.00	
kapply	0.00	0.00	0.00	0.00	0.00	0.00	1.00

Standardized Residuals

	wpro	ict	hrd	memory	budget	gpro	kapply
wpro	-0.00						
ict	-0.00	-0.00					
hrd	-0.00	-0.00	-0.00				
memory	-0.00	-0.00	-0.00	-0.00			
budget	-0.00	-0.00	-0.00	-0.00	-0.00		
gpro	0.39	0.23	-0.13	0.48	0.08	0.00	
kapply	0.87	0.32	0.19	0.67	0.33	0.55	0.00

Normalized Residuals

	wpro	ict	hrd	memory	budget	gpro	kapply
wpro	-0.00						
ict	-0.00	-0.00					
hrd	-0.00	-0.00	-0.00				
memory	-0.00	-0.00	-0.00	-0.00			
budget	-0.00	-0.00	-0.00	-0.00	-0.00		
gpro	4.30	2.56	-1.40	5.28	0.86	0.00	
kapply	9.49	3.48	2.03	7.35	3.67	6.05	0.00

Annex 3: Structural Equation Modeling Results

Data File: KMPhD BoxCox.sta

Model File: C:\Users\PC\Documents\SEM PhD.CMD

Data to Analyze: Correlations

Discrepancy Function: ML

Manifest Exogenous: Fixed

Standardization: New Method (Constrained Estimation)

Initial Values: Automatic

Path Model Output

Iteration Results

Number of Iterations: 29

Termination Normal

Chi-Square: 9.560865

DF: 1

p-level: 0.001988

Iteration History

	ITN	DISC	RCOS	LAMBDA	MAXCON	NRP	NRC	NAIC	STEP
1	0	2.907554	0.499724	1.000000	1.072672	0	0	2	0.000000
2	1	2.719763	0.511519	1.000000	0.965549	5	0	0	0.181437
3	2	2.067772	0.483515	1.000000	0.809857	4	0	0	0.403841
4	3	1.913375	0.508270	1.000000	0.726168	3	0	1	0.041674
5	4	1.531453	0.566158	1.000000	0.528043	3	0	2	0.077634
6	5	1.526184	0.569382	0.250000	0.521017	3	0	1	0.119038
7	6	1.516649	0.570687	1.000000	0.516533	3	0	1	0.001855

8	7	1.511527	0.572805	0.310461	0.511417	3	0	1	0.077255
9	8	1.505691	0.573599	1.000000	0.508698	3	0	1	0.001199
10	9	1.500989	0.575388	0.481434	0.504210	3	0	1	0.048627
11	10	1.496490	0.576989	1.000000	0.500055	3	0	1	0.023881
12	11	1.485807	0.578350	1.000000	0.495104	3	0	2	0.002039
13	12	1.442660	0.583725	1.000000	0.475299	3	0	3	0.008615
14	13	1.223107	0.654447	0.476491	0.317455	3	0	3	0.314985
15	14	1.131382	0.687218	1.000000	0.322840	3	0	1	0.107333
16	15	0.551634	0.743555	1.000000	0.168889	3	0	1	0.201199
17	16	0.416720	0.726983	1.000000	0.124296	3	0	1	0.060687
18	17	0.110937	0.234769	1.000000	0.017976	3	0	1	0.076302
19	18	0.102592	0.214792	1.000000	0.017694	3	0	2	0.034079
20	19	0.091713	0.183694	1.000000	0.014095	3	0	2	0.026290
21	20	0.080177	0.049504	1.000000	0.000487	3	0	2	0.019203
22	21	0.079736	0.011547	1.000000	0.000037	3	0	3	0.005615
23	22	0.079682	0.005690	1.000000	0.000008	3	0	3	0.001369
24	23	0.079675	0.001348	1.000000	0.000001	3	0	3	0.000648
25	24	0.079674	0.000716	1.000000	0.000000	3	0	3	0.000161
26	25	0.079674	0.035890	1.000000	0.000000	3	0	2	0.000222
27	26	0.079674	0.035862	1.000000	0.000000	3	0	2	0.000021
28	27	0.079674	0.035852	1.000000	0.000000	3	0	2	0.000010
29	28	0.079674	0.035849	1.000000	0.000000	3	0	2	0.000002
30	29	0.079674	0.000003	1.000000	0.000000	3	0	3	0.000001

Basic Summary Statistics

	Value
Discrepancy Function	0.08
Maximum Residual Cosine	0.00
Maximum Absolute Gradient	0.04
ICSF Criterion	0.00
ICS Criterion	0.00
ML Chi-Square	9.56
Degrees of Freedom	1.00
p-level	0.00
RMS Standardized Residual	0.06

Model Estimates				
	Parameter	Standard	T	Prob.
(Wpro)-1->[wpro]	1.00	0.07	1.478724E+01	0.00
(ICT)-2->[ict]	1.00	0.00	1.837852E+08	0.00
(HRD)-3->[hrd]	0.66	0.00	2.941350E+16	0.00
(Memory)-4->[memory]	1.00	0.00	1.338327E+17	0.00
(Budget)-5->[budget]	0.41	0.07	5.852104E+00	0.00
(DELTA1)-->[wpro]				
(DELTA2)-->[ict]				
(DELTA3)-->[hrd]				
(DELTA4)-->[memory]				
(DELTA5)-->[budget]				
(DELTA1)-6-(DELTA1)	0.01	0.13	7.290336E-02	0.94
(DELTA2)-7-(DELTA2)	0.00	0.00		
(DELTA3)-8-(DELTA3)	0.56	0.00		
(DELTA4)-9-(DELTA4)	0.00	0.00		
(DELTA5)-10-(DELTA5)	0.83	0.06	1.448498E+01	0.00
(ICT)-11-(Wpro)	0.34	0.08	4.105824E+00	0.00
(HRD)-12-(Wpro)	0.45	0.13	3.509922E+00	0.00
(Memory)-13-(Wpro)	0.65	0.07	9.429445E+00	0.00
(Budget)-14-(Wpro)	0.70	0.13	5.555262E+00	0.00
(HRD)-15-(ICT)	0.29	0.13	2.220038E+00	0.03
(Memory)-16-(ICT)	0.21	0.09	2.404519E+00	0.02
(Budget)-17-(ICT)	-0.37	0.21	-1.746884E+00	0.08
(Memory)-18-(HRD)	0.56	0.12	4.691976E+00	0.00
(Budget)-19-(HRD)	-0.22	0.24	-9.217952E-01	0.36
(Budget)-20-(Memory)	1.00	0.00		
(Gpro)-21->[gpro]	0.87	0.13	6.761218E+00	0.00
(Kapply)-22->[kapply]	0.91	0.04	2.041328E+01	0.00
(EPSILON1)-->[gpro]				
(EPSILON2)-->[kapply]				
(EPSILON1)-23-(EPSILON1)	0.24	0.22	1.073560E+00	0.28
(EPSILON2)-24-(EPSILON2)	0.16	0.08	1.984403E+00	0.05
(ZETA1)-->(Gpro)				
(ZETA2)-->(Kapply)				
(ZETA1)-25-(ZETA1)	0.68	0.13	5.444703E+00	0.00
(ZETA2)-26-(ZETA2)	0.00	0.00		
(ICT)-27->(Gpro)	0.47	0.14	3.368378E+00	0.00
(Budget)-28->(Gpro)	0.53	0.11	5.021810E+00	0.00
(Gpro)-29->(Kapply)	0.27	0.12	2.271613E+00	0.02
(Wpro)-30->(Kapply)	0.78	0.12	6.515673E+00	0.00
(HRD)-31->(Kapply)	-0.08	0.09	-8.602865E-01	0.39
(Memory)-32->(Kapply)	0.11	0.16	6.856239E-01	0.49

Noncentrality Fit Indices			
	Lower 90%	Point	Upper 90%
Population Noncentrality Parameter	0.02	0.07	0.19
Steiger-Lind RMSEA Index	0.14	0.27	0.44
McDonald Noncentrality Index	0.91	0.96	0.99
Population Gamma Index	0.95	0.98	0.99
Adjusted Population Gamma Index	-0.45	0.42	0.85

Single Sample Fit Indices	
	Value
Joreskog GFI	0.98
Joreskog AGFI	0.36
Akaike Information Criterion	0.53
Schwarz's Bayesian Criterion	1.16
Browne-Cudeck Cross Validation Index	0.56
Independence Model Chi-Square	406.66
Independence Model df	21.00
Bentler-Bonett Normed Fit Index	0.98
Bentler-Bonett Non-Normed Fit Index	0.53
Bentler Comparative Fit Index	0.98
James-Mulaik-Brett Parsimonious Fit Index	0.05
Bollen's Rho	0.51
Bollen's Delta	0.98

LaGrange Multiplier Statistics			
	Variance	LaGrange	Standard
wpro	1.00	0.00	-0.00
ict	1.00	0.00	0.00
hrd	1.00	0.00	0.00
memory	1.00	0.00	0.00
budget	1.00	0.00	-0.00
gpro	1.00	-0.00	-0.00
kapply	1.00	-0.00	-0.00

Measures of Multivariate Kurtosis	
	Value
Mardia Coefficient of Multivariate Kurtosis	-0.26
Normalized Multivariate Kurtosis	-0.13
Mardia-Based Kappa	-0.00
Mean Scaled Univariate Kurtosis	-0.16
Adjusted Mean Scaled Univariate Kurtosis	-0.15
Relative Multivariate Kurtosis	1.00

Reflector Matrix

	wpro	ict	hrd	memory	budget	gpro	kapply
wpro	-0.00						
ict	-0.04	0.00					
hrd	0.00	-0.00	0.00				
memory	-0.00	0.02	0.02	-0.00			
budget	-0.09	-0.06	-0.25	-0.09	-0.00		
gpro	0.09	0.00	0.18	0.08	0.09	0.00	
kapply	0.00	0.00	0.00	0.00	0.00	-0.00	0.00

Univariate Kurtosis Indices

	Kurtosis	Corrected	Normalized
wpro	-0.61	-0.58	-1.36
ict	0.04	0.09	0.09
hrd	-0.40	-0.37	-0.90
memory	-0.71	-0.69	-1.59
budget	-0.57	-0.54	-1.28
gpro	-0.40	-0.37	-0.90
kapply	-0.86	-0.84	-1.93

Univariate Skewness Indices

	Skewness	Corrected	Normalized
wpro	-0.33	-0.33	-1.47
ict	0.19	0.19	0.86
hrd	-0.40	-0.40	-1.79
memory	-0.10	-0.10	-0.45
budget	-0.18	-0.18	-0.80
gpro	-0.14	-0.15	-0.64
kapply	-0.05	-0.05	-0.23

Input (Correlation) Matrix N = 121

	wpro	ict	hrd	memory	budget	gpro	kapply
wpro	1.00						
ict	0.35	1.00					
hrd	0.30	0.18	1.00				
memory	0.65	0.21	0.37	1.00			
budget	0.36	-0.10	0.15	0.49	1.00		
gpro	0.39	0.23	-0.13	0.48	0.08	1.00	
kapply	0.87	0.32	0.19	0.67	0.33	0.55	1.00

Reproduced Matrix							
	wpro	ict	hrd	memory	budget	gpro	kapply
wpro	1.00						
ict	0.34	1.01					
hrd	0.30	0.20	1.01				
memory	0.65	0.21	0.37	1.00			
budget	0.28	-0.15	-0.06	0.41	1.00		
gpro	0.46	0.24	0.01	0.55	0.13	1.00	
kapply	0.88	0.32	0.21	0.68	0.29	0.60	1.02

Standardized Residuals							
	wpro	ict	hrd	memory	budget	gpro	kapply
wpro	-0.00						
ict	0.00	-0.01					
hrd	0.00	-0.01	-0.01				
memory	-0.00	-0.00	-0.00	-0.00			
budget	0.08	0.05	0.21	0.08	0.00		
gpro	-0.07	-0.01	-0.14	-0.06	-0.05	-0.00	
kapply	-0.01	0.00	-0.03	-0.01	0.05	-0.05	-0.02

Normalized Residuals							
	wpro	ict	hrd	memory	budget	gpro	kapply
wpro	-0.00						
ict	0.01	-0.10					
hrd	0.01	-0.13	-0.08				
memory	-0.00	-0.00	-0.00	-0.00			
budget	0.82	0.51	2.24	0.79	0.00		
gpro	-0.66	-0.06	-1.51	-0.61	-0.52	-0.02	
kapply	-0.11	0.01	-0.27	-0.11	0.47	-0.45	-0.14

Annex 4: Monte Carlo Simulation Summary Results

	SEED1	TERMCODE	DISCREP	RCOS	GRADIENT	NUM_ITER	ICSF	ICS	RED_PAR	RED_CON	BOUNDARY
MEAN case 1-50	9E+08	2E+00	7E-04	8E-02	3E-03	2E+01	5E-03	3E-03	3E+00	0E+00	1E+00
MEDIAN case 1-50	968836871	3	0	0.01	0	30	0	0	3	0	1
SD case 1-50	565402998	1	0	0.15	0.01	9	0.01	0.01	1	0	1
VALID_N case 1-50	50	50	50	50	50	50	50	50	50	50	50
SUM case 1-50		95	0.03	4.21	0.17	1206	0.27	0.15	160	0	61
MIN case 1-50	0	0	0	0	0	0	0	0	0	0	0
MAX case 1-50	2032808942	3	0	0.73	0.06	30	0.09	0.06	4	0	3
_25th% case 1-50	437821295	0	0	0	0	17	0	0	3	0	1
_75th% case 1-50	1352220645	3	0	0.11	0	30	0	0	4	0	2

	CHI_SQR	DF	PLEVEL	PAR_1	PAR_2	PAR_3	PAR_4	PAR_5	PAR_6	PAR_7	PAR_8
MEAN case 1-50	2E+00	1E+00	4E-01	6E-01	7E-01	7E-01	8E-01	7E-01	5E-01	5E-01	4E-01
MEDIAN case 1-50	0.9	1	0.37	0.59	0.57	0.62	0.9	0.55	0.65	0.66	0.58
SD case 1-50	2.1	0	0.27	0.23	0.24	0.25	0.24	0.25	0.3	0.33	0.34
VALID_N case 1-50	50	50	50	50	50	50	50	50	50	50	50
SUM case 1-50	82.9	62	19.79	32.28	33.45	34.37	39.39	34.12	25.67	23.84	22.4
MIN case 1-50	0	0	0	0	0	0	0	0	0	0	0
MAX case 1-50	11.6	2	0.92	1	1.01	1	1	1	0.87	0.83	0.83
_25th% case 1-50	0.3	1	0.17	0.48	0.5	0.48	0.61	0.5	0.31	0	0
_75th% case 1-50	1.9	2	0.59	0.81	1	0.98	1	1	0.77	0.75	0.76

	PAR_9	PAR_10	PAR_11	PAR_12	PAR_13	PAR_14	PAR_15	PAR_16	PAR_17	PAR_18	PAR_19
MEAN case 1-50	3E-01	5E-01	4E-01	4E-01	4E-01	4E-01	4E-01	4E-01	4E-01	3E-01	4E-01
MEDIAN case 1-50	0.17	0.69	0.4	0.4	0.35	0.37	0.35	0.34	0.35	0.32	0.34
SD case 1-50	0.32	0.35	0.2	0.16	0.2	0.21	0.2	0.16	0.17	0.13	0.21
VALID_N case 1-50	50	50	50	50	50	50	50	50	50	50	50
SUM case 1-50	15.12	22.66	21.98	20.34	18.73	21.65	20.61	17.83	20.28	16.45	20.56
MIN case 1-50	0	0	0	0	0	0	0	0	0	0	0
MAX case 1-50	0.83	0.84	0.85	0.74	1	0.96	0.84	0.77	1	0.77	0.97
_25th% case 1-50	0	0	0.27	0.31	0.25	0.29	0.29	0.24	0.32	0.27	0.26
_75th% case 1-50	0.61	0.75	0.63	0.5	0.46	0.56	0.55	0.44	0.48	0.39	0.54

	PAR_20	PAR_21	PAR_22	PAR_23	PAR_24	PAR_25	PAR_26	PAR_27	PAR_28	PAR_29	PAR_30
MEAN case 1-50	3E-01	8E-01	8E-01	3E-01	3E-01	5E-01	2E-01	4E-01	3E-01	2E-01	3E-01
MEDIAN case 1-50	0.33	0.77	0.81	0.38	0.34	0.63	0.17	0.41	0.2	0.17	0.2
SD case 1-50	0.16	0.2	0.16	0.27	0.18	0.24	0.19	0.5	0.5	0.16	0.3
VALID_N case 1-50	50	50	50	50	50	50	50	50	50	50	50
SUM case 1-50	17.11	38.63	40.65	17.21	14.76	27.19	9.77	22.01	13.2	11.33	13.4
MIN case 1-50	0	0	0	0	0	0	0	0	-2.2	0	-1.1
MAX case 1-50	0.8	1	1	0.72	0.53	0.82	0.56	3.21	0.9	0.7	0.9
_25th% case 1-50	0.25	0.61	0.74	0.02	0.16	0.36	0	0.14	0.1	0.13	0.1
_75th% case 1-50	0.39	0.96	0.91	0.6	0.45	0.76	0.36	0.56	0.5	0.32	0.5

	PAR_31	PAR_32	SE_1	SE_2	SE_3	SE_4	SE_5	SE_6	SE_7	SE_8	SE_9
MEAN case 1-50	3E-01	2E-01	6E-01	2E-01	2E-01	1E-01	4E-01	9E-01	3E-01	3E-01	2E-01
MEDIAN case 1-50	0.22	0.13	0.1	0.03	0.03	0.01	0.03	0.1	0.03	0.02	0.01
SD case 1-50	0.29	0.33	2	0.49	0.89	0.38	1.32	3.5	0.83	1.4	0.69
VALID_N case 1-50	50	50	50	50	50	50	50	50	50	50	50
SUM case 1-50	16.51	12.17	29	9.09	10.64	5.4	20.08	47.2	13.37	15.82	8.89
MIN case 1-50	-0.02	-0.02	0	0	0	0	0	0	0	0	0
MAX case 1-50	0.95	1.6	10.9	2.95	6.13	2.66	6.37	18.1	5.37	9.68	4.93
_25th% case 1-50	0.12	0.07	0	0	0	0	0	0	0	0	0
_75th% case 1-50	0.62	0.23	0.1	0.08	0.1	0.1	0.07	0.2	0.08	0.11	0.15

	SE_10	SE_11	SE_12	SE_13	SE_14	SE_15	SE_16	SE_17	SE_18	SE_19	SE_20
MEAN case 1-50	6E-01	3E-01	4E-01	2E-01	5E-01	2E-01	1E-01	3E-01	1E-01	3E-01	2E-01
MEDIAN case 1-50	0	0.08	0.07	0.04	0.07	0.06	0.05	0.04	0.05	0.07	0.05
SD case 1-50	2.3	0.75	1.16	0.52	1.08	0.32	0.16	0.67	0.21	0.66	0.37
VALID_N case 1-50	50	50	50	50	50	50	50	50	50	50	50
SUM case 1-50	32.3	16.19	17.6	10.42	24.33	9.16	6.17	14.72	5.89	14.34	8.83
MIN case 1-50	0	0	0	0	0	0	0	0	0	0	0
MAX case 1-50	11.1	4.6	6.47	2.75	4.85	1.78	0.72	3.18	1.32	3.39	1.56
_25th% case 1-50	0	0.04	0	0	0.04	0.03	0.03	0.04	0.02	0.03	0.03
_75th% case 1-50	0.1	0.22	0.18	0.13	0.23	0.13	0.16	0.16	0.15	0.19	0.1

	SE_21	SE_22	SE_23	SE_24	SE_25	SE_26	SE_27	SE_28	SE_29	SE_30	SE_31
MEAN case 1-50	7E-01	2E-01	1E+00	4E-01	6E-01	4E-01	4E-01	4E-01	3E-01	5E-01	3E-01
MEDIAN case 1-50	0.09	0.03	0.1	0.04	0.18	0.06	0.13	0.11	0.15	0.18	0.09
SD case 1-50	1.73	0.64	3	1.15	1.26	1.11	0.9	0.55	0.39	1.01	0.44
VALID_N case 1-50	50	50	50	50	50	50	50	50	50	50	50
SUM case 1-50	33.58	11.19	57	19.1	27.68	22.28	22.37	18.29	12.55	24.16	13.49
MIN case 1-50	0	0	0	0	0	0	0	0	0	0	0
MAX case 1-50	9.22	4.3	17.5	7.86	7.5	7.01	4.63	2.83	2.43	6.47	2.02
_25th% case 1-50	0	0	0	0	0.04	0	0.04	0.04	0.04	0.08	0.04
_75th% case 1-50	0.36	0.21	0.5	0.4	0.46	0.3	0.36	0.5	0.3	0.44	0.31

	SE_32	RMS_LO	RMS_PT	RMS_HI	NCP_LO	NCP_PT	NCP_HI	AIC	BIC	BR_CUD
MEAN case 1-50	2E-01	1E-03	9E-03	5E-02	3E-05	3E-04	3E-03	2E-02	8E-02	2E-02
MEDIAN case 1-50	0.08	0	0	0.05	0	0	0	0.02	0.08	0.02
SD case 1-50	0.3	0	0.01	0.02	0	0	0	0	0.01	0
VALID_N case 1-50	50	50	50	50	50	50	50	50	50	50
SUM case 1-50	9.85	0.06	0.47	2.38	0	0.02	0.15	1.08	4.13	1.08
MIN case 1-50	0	0	0	0	0	0	0	0	0	0
MAX case 1-50	1.51	0.02	0.05	0.08	0	0	0.01	0.03	0.09	0.03
_25th% case 1-50	0.04	0	0	0.04	0	0	0	0.02	0.08	0.02
_75th% case 1-50	0.2	0	0.02	0.06	0	0	0	0.02	0.09	0.02

	GAMMA_LO	GAMMA_PT	GAMMA_HI	GAMAD_LO	GAMAD_PT	GAMAD_HI	IRGLS
MEAN case 1-50	1E+00	1E+00	1E+00	1E+00	1E+00	1E+00	7E-04
MEDIAN case 1-50	1	1	1	0.98	1	1	0
SD case 1-50	0.14	0.14	0.14	0.14	0.14	0.14	0
VALID_N case 1-50	50	50	50	50	50	50	50
SUM case 1-50	48.96	49	49	47.98	48.89	48.99	0.03
MIN case 1-50	0	0	0	0	0	0	0
MAX case 1-50	1	1	1	1	1	1	0
_25th% case 1-50	1	1	1	0.97	1	1	0
_75th% case 1-50	1	1	1	0.99	1	1	0

Annex 5: Multiple Regression Analysis Results

(Linear effect for participant's involvement is less than or equal to 5 years)

Coefficients[a,b]

	Unndardized Coefficients		Standardized Coefficients	T	Sig.
	B	*Error*	*Beta*		
Constant	-4.461	3.668		-1.216	.230
wpro	**.399**	**.076**	**.422**	**5.285**	**.000**
ict	**.151**	**.051**	**.226**	**2.960**	**.005**
hrd	-.004	.036	-.009	-.112	.912
memory	**-.402**	**.187**	**-.245**	**-2.151**	**.037**
budget	**2.019**	**.777**	**.183**	**2.598**	**.013**
gpro	**.287**	**.053**	**.577**	**5.443**	**.000**

a. Dependent Variable: kapply

b. Selecting only cases for which involvement <= 5 yrs

ANOVA[b,c]

	Sum of Squares	df	Mean Square	F	Sig.
Regression	3505.022	6	584.170	74.912	.000[a]
Residual	358.713	46	7.798		
Total	3863.735	52			

a. Predictors: (Constant), gpro, hrd, budget, ict, wpro, memory

b. Dependent Variable: kapply

c. Selecting only cases for which involvement <= 5 yrs

Model Summary

R involvement <= 5 yrs (Selected)	R Square	Adjusted R Square	Std. Error of the Estimate
.952[a]	.907	.895	2.792509

a. Predictors: (Constant), gpro, hrd, budget, ict, wpro, memory

(Linear effect for participant's involvement is greater than or equal to 10 years)

Coefficients[a,b]					
	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	8.407	6.324		1.329	.189
wpro	**.585**	**.119**	**.623**	**4.933**	**.000**
ict	-.035	.045	-.059	-.785	.436
hrd	.083	.045	.199	1.825	.074
memory	.168	.146	.150	1.154	.254
budget	-.470	.908	-.057	-.518	.607
gpro	.048	.044	.079	1.098	.277

a. Dependent Variable: kapply
b. Selecting only cases for which involvement >= 10 yrs

ANOVA[b,c]					
	Sum of Squares	df	Mean Square	F	Sig.
Regression	2147.765	6	357.961	29.527	.000[a]
Residual	642.523	53	12.123		
Total	2790.288	59			

a. Predictors: (Constant), gpro, ict, wpro, budget, hrd, memory
b. Dependent Variable: kapply
c. Selecting only cases for which involvement >= 10 yrs

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
involvement >= 10 yrs (Selected)			
.877[a]	.770	.744	3.481820

a. Predictors: (Constant), gpro, ict, wpro, budget, hrd, memory

(Linear effect for participant's involvement is more than or equal to 15 years)

Coefficients[a,b]					
	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	11.834	8.317		1.423	.162
wpro	**.485**	**.144**	**.501**	**3.377**	**.002**
ict	-.013	.049	-.021	-.255	.800
hrd	**.147**	**.064**	**.331**	**2.290**	**.027**
memory	.238	.159	.209	1.497	.141
budget	-1.128	1.176	-.126	-.959	.343
gpro	.023	.045	.039	.514	.610

a. Dependent Variable: kapply

b. Selecting only cases for which involvement >= 15 yrs

ANOVA[b,c]	Sum of Squares	df	Mean Square	F	Sig.
Regression	2076.160	6	346.027	28.205	.000[a]
Residual	552.074	45	12.268		
Total	2628.234	51			

a. Predictors: (Constant), gpro, ict, wpro, budget, memory, hrd

b. Dependent Variable: kapply

c. Selecting only cases for which involvement >= 15 yrs

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
involvement >= 15 (Selected)			
.889[a]	.790	.762	3.502616

a. Predictors: (Constant), gpro, ict, wpro, budget, memory, hrd

(Linear effect for participant's involvement is more than or equal to 20 years)

Coefficients[a,b]

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	12.615	13.134		.961	.343
wpro	**.725**	**.215**	**.776**	**3.373**	**.002**
ict	-.064	.065	-.096	-.977	.335
hrd	.023	.110	.055	.213	.833
memory	.004	.201	.004	.020	.984
budget	.934	2.064	.106	.453	.654
gpro	-.119	.072	-.129	-1.648	.108

a. Dependent Variable: kapply

b. Selecting only cases for which involvement >= 20 yrs

ANOVA[b,c]

	Sum of Squares	df	Mean Square	F	Sig.
Regression	1798.751	6	299.792	24.018	.000[a]
Residual	436.860	35	12.482		
Total	2235.610	41			

a. Predictors: (Constant), gpro, hrd, ict, memory, wpro, budget

b. Dependent Variable: kapply

c. Selecting only cases for which involvement >= 20 yrs

Model Summary

R involvement >= 20 (Selected)	R Square	Adjusted R Square	Std. Error of the Estimate
.897[a]	.805	.771	3.532946

a. Predictors: (Constant), gpro, hrd, ict, memory, wpro, budget

Liner effect for Institute of Engineering (IOE)

Coefficients[a,b]

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	5.133	5.549		.925	.361
wpro	.715	.115	.753	6.232	.000
ict	-.015	.066	-.018	-.223	.825
hrd	-.047	.040	-.111	-1.181	.245
memory	.241	.187	.188	1.287	.206
budget	-.629	.808	-.071	-.779	.441
gpro	.072	.050	.139	1.438	.159

a. Dependent Variable: kapply

b. Selecting only cases for which Place = IOE

ANOVA[b,c]

	Sum of Squares	df	Mean Square	F	Sig.
Regression	2003.181	6	333.864	24.533	.000[a]
Residual	489.913	36	13.609		
Total	2493.094	42			

a. Predictors: (Constant), gpro, budget, hrd, ict, wpro, memory

b. Dependent Variable: kapply

c. Selecting only cases for which Place = IOE

Model Summary

R			
Place = IOE (Selected)	R Square	Adjusted R Square	Std. Error of the Estimate
.896[a]	.803	.771	3.688997

a. Predictors: (Constant), gpro, budget, hrd, ict, wpro, memory

Liner effect for Institute of Medicine/Tribhuvan University Teaching Hospital (IOM/ TUTH)

Coefficients[a,b]

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	-5.672	5.450		-1.041	.305
wpro	.654	.098	.670	6.680	.000
ict	-.009	.051	-.015	-.181	.858
hrd	.009	.035	.019	.246	.807
memory	-.011	.192	-.007	-.059	.953
budget	1.400	.991	.129	1.412	.167
gpro	.183	.063	.312	2.897	.006

a. Dependent Variable: kapply

b. Selecting only cases for which Place = IOM/TUTH

ANOVA[b,c]

	Sum of Squares	df	Mean Square	F	Sig.
Regression	2658.847	6	443.141	27.502	.000[a]
Residual	580.066	36	16.113		
Total	3238.912	42			

a. Predictors: (Constant), gpro, hrd, budget, ict, wpro, memory

b. Dependent Variable: kapply

c. Selecting only cases for which Place = IOM/TUTH

Model Summary

R Place = IOM/TUTH (Selected)	R Square	Adjusted R Square	Std. Error of the Estimate
.906[a]	.821	.791	4.014093

a. Predictors: (Constant), gpro, hrd, budget, ict, wpro, memory

Liner effect for Nepal Agriculture Research Council (NARC)

Coefficients[a,b]

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	-2.323	5.389		-.431	.670
wpro	.771	.127	.742	6.074	.000
ict	.056	.070	.073	.803	.429
hrd	-.050	.051	-.108	-.983	.334
memory	.270	.200	.185	1.353	.187
budget	-.714	.999	-.069	-.714	.481
gpro	.104	.049	.211	2.117	.043

a. Dependent Variable: kapply

b. Selecting only cases for which Place = NARC

ANOVA[b,c]

	Sum of Squares	df	Mean Square	F	Sig.
Regression	2094.074	6	349.012	27.401	.000[a]
Residual	356.636	28	12.737		
Total	2450.710	34			

a. Predictors: (Constant), gpro, ict, budget, hrd, wpro, memory

b. Dependent Variable: kapply

c. Selecting only cases for which Place = NARC

Model Summary

R Place = NARC (Selected)	R Square	Adjusted R Square	Std. Error of the Estimate
.924[a]	.854	.823	3.568892

a. Predictors: (Constant), gpro, ict, budget, hrd, wpro, memory

Annex 6: Questionnaire

Instruction: Please circle to rate the following statements in seven-point scale if they fit to your job or workplace situation. (Scale: 7 Extremely fit →1 Extremely not fit)

Work Process	This institution has process to combine knowledge, information and data from different sources.	1 2 3 4 5 6 7
	My work processes maintain sufficient face-to-face or informal interaction opportunities.	1 2 3 4 5 6 7
	We have process to externalize experiential knowledge in publication, conferences, media etc.	1 2 3 4 5 6 7
	Necessary fix are implemented on time to ensure process effectiveness.	1 2 3 4 5 6 7
	It is necessary for us to prepare for possible risk factors before starting work-process.	1 2 3 4 5 6 7
Information Communication Technology	This institution has maintained information communication technology (ICT) for needy units and departments.	1 2 3 4 5 6 7
	Information communication technology (ICT) is blended in processing day-to day operations of work teams and departments.	1 2 3 4 5 6 7
	The updated information and operational data are posted in my organization's official web site.	1 2 3 4 5 6 7
	I make use of available information communication technology (ICT) to share job related problems.	1 2 3 4 5 6 7
	I make use of available information communication technology (ICT) to contact outside professionals.	1 2 3 4 5 6 7
	I make use of available information communication technology (ICT) experience and idea with members of work team.	1 2 3 4 5 6 7
Supportive Culture	This institution provides incentives to people for their high performance outcomes.	1 2 3 4 5 6 7
	It gives impression that institution is committed to people first than other things.	1 2 3 4 5 6 7
	This institution fairly maintains organizational justice to its people.	1 2 3 4 5 6 7
	Our management's role is right and supportive to enhance works	1 2 3 4 5 6 7

	accomplishments.	
	Institutional culture is influential to retain knowledge champions at work.	1 2 3 4 5 6 7
HRD	There are training programs sufficient to meet institutional need.	1 2 3 4 5 6 7
	Training program meets the skill gap created by change in job.	1 2 3 4 5 6 7
	Training emphasizes skills to master the technical aspect of technology.	1 2 3 4 5 6 7
Organizational Memory	There is system of storing knowledge in electronic database or documents for the future reference	1 2 3 4 5 6 7
	Institution store work process and result in its repository developed by network of individuals.	1 2 3 4 5 6 7
	There is system of sharing stored knowledge with concerned clients when needed.	1 2 3 4 5 6 7
	Institution has system of retrieval of documented knowledge for use when needed.	1 2 3 4 5 6 7
	The effectiveness of our memory systems compared to other institutions I know.	1 2 3 4 5 6 7
Budget	This institution's financial resources are sufficient to support for the running projects.	1 2 3 4 5 6 7
	This institution's financial resources are sufficient to support for the new projects.	1 2 3 4 5 6 7
	This institution receives external budgetary support for the new projects.	1 2 3 4 5 6 7
	This institution also receives external budgetary support for the running projects.	1 2 3 4 5 6 7
	The financial resources are available on time in case of the project I work.	1 2 3 4 5 6 7
Group Process	Members of my team learn many important things from each other.	1 2 3 4 5 6 7
	We take the time as a team to examine areas in which we need more skill or experience.	1 2 3 4 5 6 7
	We occasionally stop to consider how we can work better as a team.	1 2 3 4 5 6 7
	We have recently discussed what we did right or wrong on a particular project of job.	1 2 3 4 5 6 7

Knowledge Application	In my department, people verify through experiment if perceived knowledge works in the new context.	1 2 3 4 5 6 7
	We provide consultation service to others relating our professional areas of expertise.	1 2 3 4 5 6 7
	There are customized work processes in place, which we have acquired from others.	1 2 3 4 5 6 7
	This is necessary for work team to record descriptions for future reference on how a job completes.	1 2 3 4 5 6 7
	In my job, knowledge use also represents replication of practices in the same context and cases to measure the volume of work performance.	1 2 3 4 5 6 7
	In my job, application of knowledge represents replication of practices in the different context to measure the volume of work performance.	1 2 3 4 5 6 7
	In this institution, application of knowledge produces both qualitative and quantitative outcomes like product, services and new knowledge.	1 2 3 4 5 6 7

Participant's Profile

Job Title:…………………………………………………………..

Department:……………………

Job involvement:……. Years

Place: TUTH/ NARC/IOE

Thank you

Annex 7: Simultaneous Equation System Result

Eigenvalue	Modulus
0	0
0	0

Stability Index = 0

Note: All the eigenvalues lie inside the unit circle. Therefore, structural equation model satisfies stability condition.