Research on the Relationship between Customer Knowledge Management and Innovation Capability, the Case of Architectural Design Enterprises in China

(Thesis submitted for the degree of Executive Doctorate in Business Administration)

Cohort: 2014
Candidate: WANG Wei
Supervisor: Kin Hang Chan

April 22, 2017
CONFIDENTIALITY AND AUTHORISATION

There is a need to protect the confidentiality of information provided by the interviewees and their organizations. For this reason, the data and other material included in the thesis have been presented in such a way as to protect the interests of the participants. This thesis has been accepted as confidential, and will be handled according to the Université Paris-Dauphine’s confidentiality policy.

Furthermore, the writer fully understands the relevant policy of Université Paris-Dauphine, regarding to the reservation and usage of the dissertation, namely that the University has the right to retain copies of the thesis, allow the thesis to be accessed and borrowed; The university may publish all or part of the contents of the thesis, and can save the thesis by photocopying, microprinting or other means.

Signature: _______________ Signature of Supervisor: _______________ Date: _______________
ACKNOWLEDGEMENT

My deepest gratitude goes first and foremost to Prof. Kin Hang Chan, my supervisor, for his constant encouragement and guidance. He has walked me through all the stages of the writing of this thesis. Without his consistent and illuminating instruction, this thesis could not have reached its present form. At the same time, Dr. Chen profound knowledge, rigorous scholarship, so I very much admire the attitude that I model for future study and work. Otherwise, I would like to thank Prof. Fernandez Bernard and Professor J P Segal for their careful review opinion on the theses. I shall extend my thanks to Prof. Pierre Romelaer, the founder of UPD EDBA program, and Prof. Pierre Volle, the director of UPD EDBA program and Prof. Fernandez Bernard, the Chinese region director of UPD EDBA program, for their guidance in the three-year EDBA study. My heartfelt thanks goes to Lu Zhijiang, Zhang Yingjun, Li Jun and Xu Dongyuan of Tsinghua University's Zhuoer Education Group for their management work on UPD EDBA program. At the same time, I would like to thank Yang Chen for his help in the revision and translation of the thesis.

The completion of the doctoral thesis is just the beginning of a new course. More than three years of study process has a great impact on my business management work, on my personal learning ability and especially on the way of thinking. During the academic exchange activities, I learned a lot from Prof. Fan Yushun from Tsinghua University, Prof. Zhang Shixian from the Chinese Academy of Sciences, Prof. Bergman from Stanford University, Prof. Jean-Denis BUDIN from UPD and Prof. Ying Runjian from Shanghai Jiaotong University.

In addition, I would like to express my heartfelt gratitude to Cong Xiaomi, the President of Beijing Jiangong Architectural Design and Research Institute. As my friend and leader, he provide selfless support and guidance all the time. At the same time, I would like to thank Wang Yue, the Vice President of Beijing Jiangong Architectural Design and Research Institute, and leaders from other design institutes for their enthusiasm to help.

Last, my thanks would go to my beloved family for their loving considerations and great confidence in me all through these years. I also owe my sincere gratitude to my friends and my fellow classmates who gave me their help and time in listening to me and helping me work out my problems during the difficult course of the thesis.
ABSTRACT

In recent years, the rapid development of global knowledge economy and information technology has brought increasing pressure on enterprise’s innovation. Many enterprises have adopted the concepts and mechanism of customer knowledge management, keeping up with changes through cooperation with customers and learning from customers. As the extension of knowledge management and customer relationship management, it is widely agreed that customer knowledge management has great influence on enterprise’s innovation capability. Many enterprises have already set down to the practice of customer knowledge management. However, studies on customer knowledge management are still immature, especially for customer knowledge management of architectural design enterprises. Due to limited perspective of theoretical research and lack of empirical support, existing conclusions are imperfect to some extent.

Against the background of Chinese architectural design enterprise, this thesis puts forward a customer knowledge management model according to knowledge flow and proves the influence of customer knowledge management on enterprise’s innovation capability, based on an in-depth review of the existing literature. To make the research more correct, more deep going, more comprehensive and more innovative, this thesis has carried out the research from three aspects focusing on one core concept—customer knowledge management.

Firstly, on the basis of literature review, this thesis has absorbed the essence of the existing models to combine with management practice of architectural design enterprises. Therefore, a customer knowledge management model based on knowledge flow and a new measurement scale of enterprise’s innovation capability bases on innovation type have been constructed.

Secondly, this thesis has revised the scales. After establishing measurement models for customer knowledge management and enterprise’s innovation capability, this research divides customer knowledge management into four dimensions: acquisition of customer knowledge, externalization of customer knowledge, integration of customer knowledge and internalization of customer knowledge. In addition, enterprise’s innovation capability is divided into four dimensions: management innovation, workflow innovation, technology innovation and business innovation. Amendments are made to the existing scales to gain a new version proved reliable and valid.

Finally, after the amendments of the scales, this thesis constructs a research model where four dimensions of customer knowledge management are antecedents to study their influence on enterprise innovation capability and put forward corresponding presumptions. Data collected through questionnaire help to make empirical analysis of presumptions and model. By structural equation analysis in Amos, this thesis has studied the correlation between customer knowledge management and enterprise’s innovation capability. Except the function path from customer knowledge internalization to workflow innovation, there are significant positive correlation between customer knowledge management and other three dimensions of enterprise’s innovation capability.

 Contributions of this research lie in: (1) According to related theories about knowledge management and customer relationship management, this thesis has set up a customer knowledge management model on the basis of knowledge flow, filling the vacancy of customer knowledge management research in architectural design industry. (2) Customer knowledge management of architectural design enterprises is classified into four dimensions—acquisition, externalization, integration and internalization, after which
this thesis has revised and proved the measurement scale is applicable to the customer knowledge management of architectural design enterprises. (3) This research puts forward and proves the relation mode of customer knowledge management—enterprise’s innovation capability against the background of Chinese architectural design enterprises.

Key Words: customer knowledge management (CKM), enterprise’s innovation capability (IC), structural equation model, empirical study
# CONTENT

CONFIDENTIALITY AND AUTHORISATION ........................................................................... I
ACKNOWLEDGEMENT .................................................................................................... II
ABSTRACT ...................................................................................................................... III
CONTENT ......................................................................................................................... V

## I Introduction ................................................................................................................. 1

1.1 Background and Theoretical Underpinning of the Study ........................................... 1
1.2 Significance of this Research ..................................................................................... 3
  1.2.1 Gaps in literature ................................................................................................. 3
  1.2.2 Theoretical significance ...................................................................................... 3
  1.2.3 Practical significance .......................................................................................... 3
1.3 Research Questions and Hypotheses ........................................................................ 4
1.4 Methodology .............................................................................................................. 4
  1.4.1 Research Methods ............................................................................................... 4
  1.4.2 Research Process Map ....................................................................................... 6
1.5 Outcome and Outline of this Research ...................................................................... 6
  1.5.1 Outcome of the Research .................................................................................. 6
  1.5.2 Outline of the Research .................................................................................... 7
1.6 Definitions .................................................................................................................. 7
1.7 Limitations .................................................................................................................. 8
1.8 Summary .................................................................................................................... 8

## II Literature Review .................................................................................................... 9

2.1 Knowledge Management .......................................................................................... 9
  2.1.1 Concept of Knowledge Management ................................................................. 9
  2.1.2 Theoretical Background of Knowledge Management ......................................... 11
  2.1.3 Summary ........................................................................................................... 13
2.2 Customer Relationship Management ........................................................................ 13
  2.2.1 Concept of Customer Relationship Management .............................................. 13
  2.2.2 Theoretical Development of Customer Relationship Management .................. 15
  2.2.3 Summary ........................................................................................................... 16
2.3 Customer Knowledge Management .......................................................................... 16
  2.3.1 Customer Knowledge ........................................................................................ 16
  2.3.2 Classification of Customer Knowledge ............................................................... 18
  2.3.3 The Concept of Customer Knowledge Management ......................................... 21
  2.3.4 Summary ........................................................................................................... 24
2.4 The Differences and Connections among CKM, CRM and KM .................................. 24
  2.4.1 CKM and CRM ................................................................................................ 24
  2.4.2 CKM and KM .................................................................................................... 26
  2.4.3 Summary ........................................................................................................... 28
2.5 Literature of Customer Knowledge Management: Research Gap Identification ......... 28
  2.5.1 Literature of CKM ............................................................................................. 28
  2.5.2 Gap Identification .............................................................................................. 30
  2.5.3 Summary ........................................................................................................... 30
2.6 Literature of Enterprise’s Innovation Capability: Research Gap Identification ............ 31
  2.6.1 Theories of Enterprise Innovation .................................................................... 31
    2.6.1.1 Schumpeter’s Innovation Theory ................................................................. 31
    2.6.1.2 Theories of Technological Innovation and Institutional Innovation: Innovation Research Following Schumpeter ......................................................... 31
    2.6.1.3 The Literature of Innovation Management Theory in China ....................... 34
  2.6.2 Enterprise Competence Theory ......................................................................... 36
    2.6.2.1 The Evolution of Enterprise Competence Theory ....................................... 37
    2.6.2.2 Enterprise Resource-based Theory ............................................................... 38
4.4.1 Analysis of Fitting Results of Primitive Structural Model ........................................... 105
4.4.2 Model Revising Analysis ............................................................................................... 108
4.5 Analysis of In-depth Interviewing Results ....................................................................... 110
4.6 Discussions .................................................................................................................... 114
  4.6.1 Discussions on Components of CKM ................................................................. 114
  4.6.2 Discussions on Components of IC ........................................................................ 119
  4.6.3 Results and Discussions on Relationship between CKM and IC ...................... 121
    4.6.3.1 Relationship between CKM and IC ............................................................. 121
    4.6.3.2 Relationship between CKM and Enterprise’s Workflow IC ...................... 122
    4.6.3.3 Relationship between CKM and Enterprise’s Technological IC ................ 124
    4.6.3.4 Relationship between CKM and Enterprise’s Business IC ....................... 125
  4.6.4 Discussions on Chinese Culture’s Impacts on CKM ........................................... 126
V Conclusions and Expectations ......................................................................................... 128
  5.1 Conclusions and Innovations of the Research .......................................................... 128
    5.1.1 Conclusions ....................................................................................................... 128
    5.1.2 Summary of Innovations .................................................................................... 128
  5.2 Implications of the Findings for Research and Literature ........................................ 129
  5.3 Implications of the Findings for Management, Business and Industry ................... 130
  5.4 Limitations and Future Research ................................................................................ 131
    5.4.1 Limitations of this Research ............................................................................. 131
    5.4.2 Future Research ............................................................................................... 131
APPENDIX .......................................................................................................................... 133
  Appendix I: Questionnaire .............................................................................................. 133
  Appendix II: Interview Outline ....................................................................................... 136
  Appendix III: Interview Records ..................................................................................... 137
BIBLIOGRAPHY .................................................................................................................. 146
DECLARATION ..................................................................................................................... 159
RESUME .............................................................................................................................. 160
List of TABLES

Table I-1: Hypotheses of the Research ................................................................. 4
Table II-1: Definition of CK Provided by Different Scholars ................................. 17
Table II-2: Concept Classification of CKM ............................................................ 23
Table II-3: The Connections and Differences among CKM, CRM and KM ............... 28
Table II-4: Core Abilities in Managing Innovation .................................................. 43
Table II-5: Research on the Dimensions of IC ....................................................... 45
Table II-6: Relevant Research on Innovation Categories and IC Measurement ......... 69
Table III-1: List of Interview with Senior Managers .............................................. 83
Table III-2: ACI Test Items .................................................................................. 84
Table III-3: EXN Test Items ................................................................................. 84
Table III-4: ING Test Items .................................................................................. 84
Table III-5: INN Test Items .................................................................................. 85
Table III-6: MAI Capacity Test Items .................................................................... 85
Table III-7: PRI Capacity Test Items .................................................................... 85
Table III-8: TEI Capacity Test Items .................................................................... 85
Table III-9: BSI Capacity Test Items .................................................................... 85
Table IV-1: Demographics of Respondents on Pre-test samples ............................. 86
Table IV-2: Descriptive Statistics of Variables ....................................................... 87
Table IV-3: Results of Validity Analysis ................................................................. 88
Table IV-4: KMO and Bartlett Test of Sphericity on CKM ....................................... 89
Table IV-5: Exploratory factor analysis (EFA) on variables of CKM ....................... 89
Table IV-6: KMO and Bartlett Test of Sphericity on IC ......................................... 90
Table IV-7: Example factory analysis (EFA) on variables of IC .............................. 90
Table IV-8: Demographics of Respondents on large sample ................................ 91
Table IV-9: Descriptive Statistics of Variables ....................................................... 92
Table IV-10: Reliability analysis of consistency .................................................... 93
Table IV-11: EFA on variables of CKM ................................................................. 95
Table IV-12: KMO and Bartlett Test of Sphericity on IC ......................................... 95
Table IV-13: EFA on variables of IC ................................................................... 96
Table IV-14: KMO and Bartlett Test of Sphericity on IC ......................................... 96
Table IV-15: EFA on variables of IC ................................................................... 96
Table IV-16: Reliability and Convergent Validity analysis of CKM scale ............... 97
Table IV-17: Reliability and Convergent Validity analysis of IC scale .................... 98
Table IV-18: Fit index of EFA on CKM scale ......................................................... 99
Table IV-19: Fit index of EFA on IC scale ............................................................. 100
Table IV-20: Results of discriminate validity analysis of CKM (AVE) ....................... 101
Table IV-21: Results of discriminate validity analysis of IC (AVE) .......................... 101
Table IV-22: Cross-validation test on CKM scale ................................................. 102
Table IV-23: Cross-validation test on IC scale ..................................................... 103
Table IV-24: Correlation analysis of variables ...................................................... 103
Table IV-25: Fit index of primitive structural model (M1) ...................................... 105
Table IV-26: Path analysis of primitive structural model M1 ................................. 107
Table IV-27: The fit index of revised structural model M2 ..................................... 108
Table IV-28: Path analysis of revised structural model ......................................... 109
Table IV-29: Results on presumption test ............................................................. 110
List of FIGURES

Figure I-1: Research Process Map ................................................................. 6
Figure II-1: The Pentagon Conceptual Model Framework of Enterprise Total Innovation Management .................................................. 35
Figure II-2: The Evolution of Enterprise Competence Theory .................................................. 38
Figure II-3: The conceptual model of the framework of firm’s total innovation management competence and the correlation of innovation performance .................................................. 44
Figure II-4: CKM Conceptual Model of Wayland and Cole .................................................. 64
Figure II-5: The Triangle of CKM Model ........................................................................ 65
Figure II-6: Five-Dimension Model of Knowledge Workers’ Knowledge Share System .................................................. 66
Figure III-1: CKM-IC Relation Model ........................................................................ 79
Figure IV-1: EFA on CKM ......................................................................................... 99
Figure IV-2: EFA on IC ......................................................................................... 100
Figure IV-3: Primitive structural equation model ............................................................ 105
Figure IV-4: Primitive structural model M1 ..................................................................... 106
Figure IV-5: Revised structural model M2 ..................................................................... 108
I Introduction

1.1 Background and Theoretical Underpinning of the Study

In 1990s, people stepped into the era of knowledge economy into the era of industry economy. As the substantial factor of knowledge economy, knowledge capital is playing an increasingly important role in modern enterprise management. Therefore, more and more scholars and enterprises focus their studies on knowledge management. International enterprises like Microsoft, IBM and Ford have learned from the concept of knowledge management and established knowledge management system to maintain their competitive advantages. It has been recorded that more than half of world Top 500 enterprises have reformed and improved traditional knowledge management system and developed knowledge management concepts conforming to the time, which worked well in the practice of operational management (Blosch, 2015).

Knowledge management is a modern management style against the background of knowledge economy. It is a new mechanism of management to improve enterprise performance and refine enterprise culture. Stewart believes that knowledge is more powerful than tangible capital such as land and factories. He believes that intellectual capital is a major source for organization to gain competitive advantages in knowledge-based economy, which includes human capital, structural capital, and customer capital (Stewart, 1994). Besides, Organization for Economic Cooperation and Development (OECD) also found that the proportion of intelligent industry in GDP of OECD countries increased fiercely (OECD, 2015).

In knowledge economy era, knowledge management is more than storage, development and application of knowledge. Actually, related theory system and management methods need to be reformed and innovated through knowledge building and communication among employees. Therefore, the knowledge management ability of enterprise not only influences the acquisition and maintain of competition, but also becomes a substantial condition to enterprise’s subsistence and development.

Innovation is an important source of competitive advantage as well as the engine of sustainable growth. Since the opening-up of China, competition environment for Chinese enterprises has witnessed more and more uncertainties. Faced with global competition and strong rivals, what Chinese enterprises should do to gain competitive advantages and achieve sustainable development is a serious problem. Compared with successful enterprises abroad, Chinese enterprises are relatively weak in terms of IC. After China’s entrance into WTO and Beijing Olympic Games, architecture in China increased greatly in both scale and speed, which has brought great opportunities to architectural industries. But at the same time, foreign enterprises flooded into Chinese architectural industry and occupied domestic market shares, causing great challenge to architectural enterprises (Zhang, 2010). In recent years, with the downward international and domestic economic trend, most design enterprises feel the stress of the slow-down or even declining output value. The market competition is especially intense in the field of traditional engineering survey and design. Only about 10% of the enterprises are not influenced (Zhang, 2010).

Currently, there are about 20,000 engineering survey and design enterprises in China, among which architectural design enterprises account for 25%, over 4800 in 2014 (Wang, 2015). However, the proportion of the number of architectural design enterprises to the total number of survey and design enterprises is declining, a drop of 10 percentage points from 35% in 2007 to 25% in 2014. This means that the survey and design industry in China is turning its focus to fields of industrial design, municipal design, transportation design, special design and general contracting. The field of architectural design is
approaching the western model, returning to the history. The total revenue of survey and design industry in 2014 was CNY 2.7 trillion, 69% from general contracting and special design (construction design), while only 30% from pure architectural design, which is still declining (Wang et al., 2015). Under such circumstances, an increasing number of top managers from architectural design enterprises begin to look for innovative breakthroughs and the path to enterprise management upgrading.

In 2014, about 2.5 million people were engaged in survey and design industry in China, among which architectural design industry had the most people – about 620,000, accounting for 24.8% of the total. The total revenue of architectural design enterprises was about CNY 150 billion, accounting for 17.5% of the general income, CNY 850 billion, of the industry. Per capita annual value of production was only CNY 240,000, less than that of the industry, which was CNY 340,000. Thus, architectural design industry becomes the “low-end production capacity,” which is even more obvious when compared with world-famous architectural design enterprises whose per capita annual value of production is over USD 200,000 (Wang et al., 2015). Given the same project, the design fees charged by domestic top design units are only a fraction of those by foreign well-known design firms. Therefore, it is extremely urgent for domestic design enterprises to enhance their capabilities.

At present, most of the domestic architectural design enterprises have extensive management, weak core competitiveness, simple operation model and serious vicious competitions with others, which cause continued decline of corporate profits. They feel confused under that call of “transforming from manufacturing-type to knowledge-based enterprises” and the policy advocacy of “popular entrepreneurship and innovation.” According to the operating data of American architectural design companies released by American professional analysis institution, the operating revenue of top 10% enterprises accounts for 50% of the total revenue of the industry (Goldberg & Huang, 1989). The architectural design market in China will certainly follow this trend. The market has entered the stage of survival of the fittest from the stage of extensive development, so the enhancement of the core competitiveness of architectural design enterprises has become much more important and urgent. This work attempts to find a new idea of innovation management in Chinese architectural design enterprises from the perspective of customer knowledge management capability and enterprise’s innovation capability by studying and analyzing the definition, components and quantitative measurement of these two capabilities.

Architectural design industry is an innovation-oriented industry, which requires engineers to provide customers with novel experience in feelings, convenience and comfort level. Therefore, IC is especially important to architectural design enterprises. CKM will help to promote the integration of enterprise’s data processing capacity with employee’s IC and at the same time improve enterprise’s adaptability, competition, and subsistence ability. Closely connected with CKM, enterprise innovation mainly focus on customer knowledge innovation, which includes identification, sharing and application of knowledge. Therefore, a good CKM system is the basis of enterprise’s innovation activities.

Against this background, this thesis focuses on the relationship between CKM and IC. The theoretical basis of this study is organizational management theories and organizational innovation ability theory. On the one hand, this research will help to apply CKM theories systematically to IC. On the other hand, though scholars and managers of architectural design enterprises show great enthusiasm for CKM, as management tool, CKM does not have an evaluation system. So it is necessary to have further researches on the influence of CKM on IC to provide supplementary and improvement to CKM system.
1.2 Significance of this Research

1.2.1 Gaps in literature

1. CKM is a new area, and many scholars focus on theoretical research. A large number of empirical researches from different industries are need to improve the theoretical model.

2. Though scholars and managers of architectural design enterprises show great enthusiasm for CKM, as management tool, CKM does not have an evaluation system of architectural design enterprise. So it is necessary to have further researches on the influence of CKM on IC to provide supplementary and improvement to CKM system.

3. Chinese architectural design enterprises have an increasingly higher demand for management. CKM is important to enterprises, but its application in Chinese architectural design industry is still at the initial stage and relevant studies are scarce. Hence, the research on the CKM of Chinese architectural design enterprises has great significance.

1.2.2 Theoretical significance

From Schumpeter to Drucker, from Pierre Benghozi to Nonaka, research on CKM theory has never stopped. CKM is a new area, which is of great practical significance and has been a focus of many researches both home and abroad. Based on existing researches, this thesis is going to develop these theories by empirical analysis. This research focused on the application of theories on CKM and IC. According to the reality of enterprise’s management in China, this thesis is an attempt to apply theories of CKM and IC to architectural design enterprises, supplementing and improving CKM system and exploring system of enterprise’s innovation. On the other hand, correlation between CKM and IC has been discussed and empirical evidence has been provided to prove the presumption that CKM will help to improve IC, which has enriched empirical researches in this area and provided some enlightenment to further research.

1.2.3 Practical significance

CKM is a systematic project, concerning activities in various aspects including organization structure, organization culture and support of leaders, etc. In combination with operation practice of Chinese enterprises, studies will be made focusing on one key word—CKM, which is of practical significance to analyze, solve and direct CKM practice in China.

Firstly, this research has examined the structural dimension of CKM, which will help enterprises to have a better understanding about the practice and effect of CKM. The research finds out that different CK activities have different influence on enterprise’s performance. These conclusions will help managers to have a better understanding about activities of CKM and take advantage of them accordingly. For instance, considering that acquisition of CK has positive influence on enterprise’s performance, enterprises can increase direct and indirect connections with enterprises so as to have a better understanding about the demand and preference of customers. In this way, enterprises can provide customer-oriented products and service and promote market competence, so as to improve enterprise’s performance.

Secondly, due to lack of CKM practice, the theory of CKM progressed very slowly and therefore is not able to direct practice due to lack of mature theory. CKM scales developed in this research will help enterprises to diagnose their weakness in CKM practice and help to find out and solve problems accordingly.

Finally, studies on influence of CKM on IC will help to change the ideas about management. The influence of CKM on different aspects of IC differs a lot. Therefore, in CKM practice, enterprise can undertake CK activities accordingly to promote a win-win relationship with customers.
1.3 Research Questions and Hypotheses

Against the background mentioned above, overarching research question of this study is what’s the relationship between CKM and IC in Chinese architectural design enterprises. Specifically, there are sub-questions (SQ): SQ1- Which are the factors, variables or indicators of CKM architectural design enterprises pay attention to; SQ2- Which are the factors, variables or indicators can reflect the substantial IC of architectural design enterprises; SQ3- Will CKM bring improvement to architectural design enterprises’ IC; SQ4-.

To solve the questions above, CKM-IC correlation model was modified based on previous research results. The overarching hypothesis is that CKM affects IC directly and positively. In this study, CKM was divided according to knowledge process into four dimensions including acquisition of CK (ACI), externalization of CK (EXN), integration of CK (ING) and internalization of CK (INN), while IC is divided into management innovation (MAI), workflow innovation (PRI), technology innovation (TEI) and business innovation (BSI). The hypotheses are designed in Table I-1 below:

<table>
<thead>
<tr>
<th>Number</th>
<th>Hypothesis Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1a</td>
<td>Implementation of CKM could have positive influences on MAI capacity</td>
</tr>
<tr>
<td>H1b</td>
<td>ACI has positive influences on MAI</td>
</tr>
<tr>
<td>H1c</td>
<td>EXN has positive influences on MAI</td>
</tr>
<tr>
<td>H1d</td>
<td>INN has positive influences on MAI</td>
</tr>
<tr>
<td>H2a</td>
<td>Implementation of CKM could have positive influences on PRI</td>
</tr>
<tr>
<td>H2b</td>
<td>ACI has positive influences on PRI</td>
</tr>
<tr>
<td>H2c</td>
<td>EXN has positive influences on PRI</td>
</tr>
<tr>
<td>H2d</td>
<td>INN has positive influences on PRI</td>
</tr>
<tr>
<td>H3a</td>
<td>Implementation of CKM could have positive influences on TEI</td>
</tr>
<tr>
<td>H3b</td>
<td>ACI has positive influences on TEI</td>
</tr>
<tr>
<td>H3c</td>
<td>EXN has positive influences on TEI</td>
</tr>
<tr>
<td>H3d</td>
<td>INN has positive influences on TEI</td>
</tr>
<tr>
<td>H4a</td>
<td>Implementation of CKM could have positive influences on BSI</td>
</tr>
<tr>
<td>H4b</td>
<td>ACI has positive influences on BSI</td>
</tr>
<tr>
<td>H4c</td>
<td>EXN has positive influences on BSI</td>
</tr>
<tr>
<td>H4d</td>
<td>INN has positive influences on BSI</td>
</tr>
</tbody>
</table>

1.4 Methodology

1.4.1 Research Methods

Research methods in this thesis mainly include literature review, questionnaire, and statistical analysis, etc.

1. Literature Review

A large amount of literature both home and abroad on CKM and IC has been reviewed to collecting researches about architectural design enterprises. Researches related to this thesis will be generalized, from which valuable theories will be picked out. Based on these valuable theories, a theoretical model will be set up and presumptions will be put forward.
2. Questionnaire

Scales and questionnaires are formed on the basis of preliminary presumption. Data collected by questionnaire will be exposed to statistical analysis to test presumptions put forward in this research.

3. Statistical Analysis

This thesis firstly carried out statistical analysis of survey results by SPSS software, mainly through methods of reality and validity analysis, descriptive systematic analysis and correlation analysis. There is also structural equation analysis by Amos in this thesis to examine and evaluate the presumptions and theory model.

4. Qualitative Analysis—In-depth Interview

This thesis takes interview analysis, a common method of qualitative analysis, as a supplement and cross-validation to questionnaire. This interview is semi-structural, selecting experienced chief executives in architectural design enterprises to interview, so as to verify and back up presumptions and conclusions.
1.4.2 Research Process Map

Figure I-1: Research Process Map

Source: Personal Original Drawing

1.5 Outcome and Outline of this Research

1.5.1 Outcome of the Research

The purpose of this research is to explore the influence of CKM on IC in combination with management practice of Chinese architectural design enterprise, so as to provide empirical support to the discovery of working mechanism of CKM on IC and provide theoretical support for the management
practice of Chinese architectural design enterprises. To be specific, the purpose of this research can be divided as follows:

1. Figure out the structural dimension of CKM in combination with management practice of architectural design enterprises. This thesis focuses on CKM and discusses the relationship between CKM and IC, so as to figure out the structural dimensions of CKM. This is not only the purpose of this research, but also prerequisite of empirical analysis. This thesis established and proved a four-dimension structure for CKM.

2. Figure out the structural dimension of IC in combination with management practice of architectural design enterprises. As the other focus of this research, structural dimension of IC is a major problem in this thesis. Due to diversity of business and management mode, researches on IC has different focuses in different enterprises. Therefore, to figure out the structural dimension of IC, management practice must be studied. This thesis established and proved a four-dimension structure for IC.

3. Figure out the relationship between CKM and IC. This research focused on empirical analysis of the influence of CKM on IC and found out the critical factors influencing IC. Through targeted reformation and innovation, the CKM and competition ability of enterprises will be improved.

1.5.2 Outline of the Research

This research is mainly divide into five parts:

Chapter I is introduction to the thesis. This chapter mainly introduces the background of this thesis and problems to be solved. This chapter will also put forward the purpose and methods of this research and else rote the logical framework and technology procedures of this thesis.

Chapter II is literature review. This chapter mainly elaborates theoretical basis of CKM and IC as well as existing research methods and their application in architectural design enterprises, on the basis of which the relationship between CKM and IC will be discussed.

Chapter III is presumption study and model construction. On the basis of Chapter II, in combination with management, this chapter put forward presumptions on the relationship between CKM and IC and set up a theoretical model for this research. What's more, this chapter introduces design ideas of this thesis which include questionnaires, data sourcing and related data processing methods.

Chapter IV is empirical study and statistical analysis. This chapter will carry out preliminary analysis including descriptive statistical analysis, validity and reliable analysis of survey data with statistical methods and SPSS, making sure that the data studied is reliable and valid. With Amos, structural equation model is used to analysis research data to figure out the relationships between variables. Then in combination with interviews with chief executives, this chapter will come to conclusions by discussing analyzing results.

Chapter V is conclusions and expectations. According to discussions in chapter IV, improvement suggestions and related solutions will be put forward. Also, limitations of this thesis and expectations for further research will be elaborated.

1.6 Definitions

This section introduces the basic concepts and related terminologies, which are used in this study; in such the following concepts and terminologies are explained:

1. Knowledge Management (KM)

Knowledge management gets the knowledge about the customer, constantly improves it and shares it
through the organization (Hoffmann, Loser, Walter, & Herrmann, 1999).

2. Customer Relationship Management (CRM)

CRM consists of guidelines, procedures, processes and strategies which provide organizations the ability to merge customer interactions and also keep track of all customer-related information (Srivastava, Shervani, & Fahey, 1999).

3. Customer Knowledge Management (CKM)

CKM refers to the source and application of customer knowledge, and how to apply information technology in building more profitable customer relationships, which leverages information and experience in the process of acquiring, developing and maintaining profitable customer mix (Wayland & Cole, 1998).

4. Innovation Capability (IC)

IC refers to the ability required for enterprises to search, identify and acquire external knowledge, or to discover new combinations and application of existing knowledge in order to generate endogenous knowledge that can create market value (Chen et al., 2012).

5. Likert Scale

Likert scales are a common rating format for surveys that rank quality from high to low or best to worst using five or seven levels (Robinson, 2014).

6. Structural Equation Modeling (SEM)

SEM aims to analyze the interconnected relationships among a set of constructs simultaneously (Cheng & Fu, 2013).

1.7 Limitations

1. The problem of sampling distribution. Due to limitation of time, energy and survey’s feasibility, samples of this research are mainly distributed in Beijing, Tianjin and Shanghai. The number of samples fulfills the requirement for statistical analysis and the models and presumptions are proved to be valid. But considering the purpose of this study—from the perspective of management practice of Chinese architectural design enterprises, coverage of this area is not wide enough to present the practical features of this industry, so it stills requires further test on the results to see if is universally applicable.

2. Data in this research was collected through questionnaire. Since every questionnaire can be finished by only one employee, common variance may occur. Further researches can try to use multiple methods to collect information.

3. The development of enterprise is dynamic. Only persistent follow-up survey can discover the development law between CKM and IC. Due to limitation of personnel, material and time, this research adopted cross-sectional study whose results are naturally reflect the relationship between variables. But to get more rigorous results, longitudinal study is necessary. In further researches, follow-up researches will be taken on representative enterprises to provide more valuable suggestions for enterprises.

1.8 Summary

This chapter introduces what problems this thesis has discussed as well as the background and theoretical underpinning, content, and significance of this research. Also, it briefly introduces research procedures and generalize the structure and layout of the thesis.
II Literature Review

2.1 Knowledge Management

Nowadays we have entered into the age of new economy. Whether you call it the “new” economy, the “digital” economy or the “knowledge” economy, it is just the same economy with different labels (Hamel, 1998). In a world where markets, products, technologies, competitors, regulations and even societies change rapidly, continuous innovation and the knowledge that enables such innovation have become important sources of sustainable competitive advantages. Hence, management scholars today consider knowledge and the capability to create and utilize knowledge to be the most important source of a firm’s sustainable competitive advantages (Nonaka, Toyama, & Konno, 2000). Knowledge-based resources have emerged as an important factor of production in maintaining a company’s competitive advantages, and have displaced traditional production inputs such as land and physical capital in the classical economic models, especially in service-oriented industries (Chan, Chu, & Wu, 2012). The most valuable asset of a 20th-century company was its production equipment. The most valuable asset of a 21st-century institution (whether business or non-business) will be its knowledge workers and their productivity (Peter F. Drucker, 1999; Peter F Drucker, 1999).

Duffy divides knowledge management (KM) into two research branches – information technology field and humanities field (Duffy, 2001). Information technology mainly refers to managing explicit knowledge. It is easier to be encode, store and share explicit knowledge through computer science and information system. The information technology field can continuously acquire and store knowledge, and express it in a more flexible way, raising its use value. Meanwhile, in the field of technology, knowledge is acquired and stored in forms of coding, computer programs and electronic documents. Hence, Duffy emphasized that information technology treated knowledge as an object to be processed (Duffy, 2001). Many scholars acknowledge the important value of information technology in the field of KM (Alavi & Leidner, 1999; Duffy, 2001). Duffy argues that information technology provides a seamless channel for the flow of explicit knowledge (Duffy, 2001). Alavi and Leidner regard information technology as a key factor in the success of knowledge management, which can solve problems and improve employee productivity. At the same time, the role of information technology in the field of KM can be reflected in different aspects (Alavi & Leidner, 2001).

In the field of humanities, the emphasis is placed on the management of people. Many scholars emphasize the most valuable resource in creativity and innovation is human skills, experience and interpersonal relationships, and that KM is to use this capital to create value for the enterprise (Thomas H. Davenport & Beers, 2015; Drucker, 1993; Duffy, 2001; David J. Skyrme & Amidon, 1998). The humanities field of KM is to evaluate, reform and promote employee skills and behaviors through training and professional development, which constantly maximizes employee competence. At the same time, corporate culture should pay more attention to the establishment of the senses of trust and belonging among employee, so as to promote employee loyalty and encourage employees to continually contribute their skills and professions to the enterprise.

KM is a complex and multi-faceted research field, so there are different research perspectives and classifications. Knowledge can be divided into explicit knowledge and tacit knowledge, which can either be managed or be used for a management process. Knowledge can exist in the human brain, and it can also be stored in the computer. There is no universally accepted approach in the field of KM.

2.1.1 Concept of Knowledge Management

Since 1990s, KM has begun to draw wide attention among scholars. The concept of KM has also
aroused diverse thinking. Some scholars believe that KM is about “how to benefit from managing knowledge, and viewing knowledge as a business asset”, which was first clearly put forward by Professor Wigg, a management consultant and the founder of AL, at the Swiss International Labor Conference (Wiig, 1997). And some believe that the concept of KM is to describe “the process of enterprise knowledge activities” which was proposed by management guru Peter F Drucker in the 1980s (J. Rowley, 1999).

The concept of KM can be roughly divided into three categories. The first category mainly refers to the promotion of organizational value. Sveiby considers KM as “the art of creating value from intangible assets” (Sveiby, 1996). Nermati, Steiger, Iyer et al regards “the application of KM is considered a feasible solution for problems that emerge in knowledge distribution within an organization.” (Nermati, Steiger, Iyer, & Herschel, 2002). Schwabe has a broader definition of KM – “We understand KM as an administrative function that enables information work.” (Schwabe, 1999).

The above definitions focus on the organization and view KM as a process of increasing organizational value, but fail to elaborate on how to enhance organizational value. Therefore, the second category revises the definition of KM and defines it as a series of knowledge activities. Ives, Torrey and Gordon argue that “KM makes sure that knowledge can leverage at the right time, in the right place and on the right subject in order to improve both staff performance and organizational efficiency.” (Ives, Torrey, & Gordon, 1997). Davenport and Beers think that “KM is a process of gathering, distribution and effectively application of knowledge.” (Thomas H. Davenport & Beers, 2015). Gandhi and Rowley describe KM as “organization’s endeavor to acquiring, sharing crucial knowledge, and focusing on enriching organizational memory, in order to formulate better supportive strategies and improve productivity and organizational innovation capability.” (Gandhi, 2004).

The third category is mainly about Knowledge Management System (KMS). Alavi and Leidner define KMS as “a process of knowledge creation, externalization and transfer based on information technology.” (Alavi & Leidner, 2001). Hoffmann, Loser, Water et al also consider that “KMS is a subsystem of knowledge preservation, dissemination and reorganization involving new knowledge development toward an organization, society or technology.” (Hoffmann et al., 1999).

Chinese scholars also hold varied views on KM. Ding Wei points out that “enterprise knowledge management can have two different understandings. First is a broad-sense understanding that KM is a new management model, a knowledge-based management activity that emphasizes business leaders’ and employees’ understanding and learning of all kinds of knowledge in the enterprise, and takes it as the basis of all aspects of the enterprise. It forms the consciousness of innovation in people’s minds in order to meet the demands of the knowledge economy era on enterprise developments. So KM is the specific embodiment of the knowledge economy in business management. Second is a narrow-sense understanding that KM is a part of modern business management, that is, to set knowledge manager and utilize modern information technology to manage staff training and the knowledge of various aspects inside the enterprise so that make full use of all kinds of knowledge and transform it into greater productivity.” (Ding, 2000).

Feng Junwen considers, “The so-called enterprise knowledge management, based and focusing on enterprise knowledge, refers to managing the knowledge on which an enterprise depends, as well as the process of the collection, organization, innovation, diffusion, use and development of this knowledge. It is also the continuous process management of various knowledge so as to meet the current and future demands of the enterprise, confirm and exploit existing and acquired knowledge assets, and explore new opportunities.” (Feng, 2000). It follows that KM can also be seen as a new management thought and management theory.

In addition, Taiwan economist Liu Changyong argues, “On the one hand, KM is the inventory, assessment, supervision, planning, acquisition, learning, circulation, integration, protection and innovation of the knowledge, and it manages knowledge as assets. Any activity that can effectively promote the value
of knowledge assets belongs to KM. On the other hand, KM integrates individuals into groups, turning individual knowledge to group knowledge and tacit knowledge to explicit knowledge. It combines the internal and the external, turning external knowledge to internal knowledge and organizational knowledge to product knowledge.” (Liu et al., 2002).

In short, domestic scholars’ understanding of the concept of KM can be divided into two stages – definition description stage and classification & summary stage. In the former stage, domestic and foreign experts and scholars give their definitions of KM from the strategic height and perspectives of technology and cybernetics. In the latter stage, faced with a variety of definitions of KM, domestic scholars try to make a summary and classification.

There are many reasons that contribute to the complexity of the definition of KM, mainly as follows:

First, KM is a multidisciplinary integrated inter-discipline, whose theoretical basis derives from a variety of disciplines, even including information. It is not limited to the artificial intelligence, library technology, information technology, document management, relationship databases and simulations, but also organizational theory (Barclay & Murray).

Second, different scholars define KM from their own research field and research interest. Scholars who study management theories tend to view KM as a series of management processes based on personal and organizational skills, such as techniques. Scholars who study Management Information System are more inclined to define KM as a thing that can be organized and controlled through computer information system. For example, Bailey and Clarke define KM as an approach to creating, communicating and developing knowledge for the benefits of individuals and the organization from the perspective of management theories (C. Bailey & Clarke, 2000). Here the benefit of the organization refers to “promoting the effectiveness of organizational strategies.”

Third, KM is a new thing, whose connotation and extension are still not clear and they will be in constant development with the socio-economic and technological development.

Although scholars have varied views on the definition of KM, there are still a lot of consensus, mainly on the creation, acquisition and sharing of knowledge and thus improving effectiveness. At the same time, knowledge is a very important kind of enterprise capital, which requires good management, that is, to transfer the right knowledge in the right form at the right time to the right person. In addition, with the development of KM, people have begun to realize that the focus of KM to center on people and to base on knowledge. The purpose is to seek the best combination of information processing capacity and human beings’ capability of knowledge innovation, maximize the dissemination and sharing of knowledge in the management process, and ultimately improve organizational innovation capability and strain capacity, realizing organizational development strategy.

2.1.2 Theoretical Background of Knowledge Management

Scholars Nonaka and Takeuchi put forwards that the origin of KM can be traced back to the ancient Greek philosophy. Plato and Aristotle are the originators of knowledge theories. Various ancient knowledge theories have contributed to the development of modern knowledge management. In fact, KM theories cover three major categories – economic theories, organizational management theories and philosophy theories. Enterprise competence theory is most highly regarded among those theories (Nonaka & Takeuchi, 1995).

Theories of enterprise competence are developed on the basis of enterprise internal growth theory, whose origin can be traced back to the labor division theory of Adam Smith, the classical economist. Subsequently, Marshall, Penrose and Richardson developed the theory of enterprise competence. At present, enterprise competence theory has formed four mainstream schools: Wernerfelt’s “Resource-based Theory of Firm”, Prahalad and Hamel’s “Firm’s Core Competence Theory”, Teece, Pisano and Shuen’s “Enterprise
Dynamic Capability Theory” and Harold Demsetz’s “the Knowledge-based Theory of Firm.” (García-Murillo & Annabi, 2002).

Theories of enterprise core competence are developed along with the development of enterprise strategic management theory. In the late 1980s and early 1990s, the development of strategic management theory entered a new stage. School of Firm’s Core Competence Theory, represented by Prahalad and Hamel, became the new mainstream school of strategic management theory. The landmark event was Prahalad and Hamel’s The Core Competence of the Corporation published at the Harvard Business Review in 1990 (Prahalad & Hamel, 2006). This school points out that the focus of enterprise strategic management theory should be placed on the matching of the internal and external environment. Enterprise should pay attention to the cultivation of internal resources and capabilities. Enterprise’s competitive advantages originate from the capabilities that rivals cannot imitate, which are based on enterprise internal resources. Hamel argues that competence is the accumulation of knowledge inside the organization, especially on how to coordinate different production skills and integrate a variety of knowledge. From the surface, the basic elements of an enterprise include two types. One is tangible material resources and the other is intangible rule resources. In fact, for an enterprise, both of these are superficial and carrier-nature elements. Only the capacity hidden behind these elements is the nature of an enterprise. The value of material resources and rule resources lies in their own hidden capacities.

Further study on competence theory makes more and more scholars realize the key that lies in the enterprise competence and determines enterprise’s competitive advantages is the knowledge of enterprise and the cognitive learning closely related to knowledge. Drucker argues that the economic resources of post-capitalist societies will be knowledge rather than capital or natural resources, whereas the core activity of creating wealth will no longer be the capital and labor; the creation of economic value will be productivity and innovation, both of which apply knowledge to work (Drucker, 1993). Actually, Prahalad and Hamel have defined the knowledge quality of enterprise competence at the very beginning, and they have emphasized learning, highlighting the dynamic nature of knowledge (Prahalad & Hamel, 2006).

In fact, both “Core Competence Theory” and “Resource-based Theory of Firm” emphasize that enterprise competence derives from enterprise “unique resources.” Here, the concept of resources is very broad, including knowledge as well as material, financial, tangible, and intangible resources. However, these resources have different degrees of importance. In the era of knowledge economy, knowledge is undoubtedly the most strategic resource and asset. Therefore, the unique resources mentioned by the Competence School is knowledge. Enterprise knowledge is highly contextual, with the characteristics of tacit nature and discrete distribution. The tacit nature of knowledge means knowledge cannot be fully expressed, and that the usage of knowledge highly depends on enterprise internal environment. The discrete distribution characteristic of knowledge means that enterprises cannot exist with a centralized form in a single mind. Instead, it can only be distributed by individuals or teams in a particular situation. The tacit nature and discrete distribution feature of enterprise knowledge make it difficult to be transferred and imitated. They also determine the heterogeneity of an enterprise, and thus constitute the source of competitive advantages (García-Murillo & Annabi, 2002).

Furthermore, differences in the extent to which the utility of various kinds of resources within an enterprise is exerted, that is, differences in innovation capability, are determined by enterprise’s stock of existing knowledge. Behind the competence difference are actually differences in knowledge stocks. Competence is the explicit manifestation of knowledge stocks. Without knowledge as the support, competence would become weak and feeble. As Peter F Drucker once pointed out, the only unique resource owned by an enterprise is knowledge (Peter F. Drucker, 1999).

In addition, a key point of the competence view based on “knowledge” should be correctly understood: the core competence of an enterprise is a dynamic knowledge system, emphasizing the learning ability of
the enterprise which is the root to open up new competitive advantages. Cognitive learning ability, which is closely related to enterprise knowledge, determines the knowledge accumulation of an enterprise, and thus determines the competitive advantages of the enterprise. The external environment faced by different enterprises is objectively the same, but since the knowledge structure and cognitive capability of enterprises are different, the market opportunity found by them are also different. With different knowledge stocks, enterprises also have different capabilities to absorb knowledge (Prahalad & Hamel, 2006).

In short, the core competence theory finds its source and basis in “knowledge”, and the KM theory must also focus its development on “competitiveness.” Therefore, these two theories are consistent in nature. Both the internal and external environment of an enterprise are an ocean of knowledge. How to effectively carry out KM is the key and fundamental to forming the core competitiveness of enterprises.

In addition to the theory of enterprise competence, the development of other branches of organizational theories, such as cultural theory, competition theory and learning theory, have also played an indispensable role in the generation and development of KM theory.

2.1.3 Summary

This section reviews the concept and theory of KM and introduces relevant theory of enterprise management, which provides basic background theories for this research.

2.2 Customer Relationship Management

The initial customer relationship management (CRM) can be traced back to the relationship management (RM). RM is an integrated effort to identify, build up and maintain a network with individual customers for the mutual benefit of both sides. RM is of largely strategic character and lacks a holistic view on business processes, although they are regarded as important. As a business management concept, CRM originated from “contact management” proposed in the early 1980s in the United States, that is, to specifically collect and collate all the contact information between customers and the company (Ling & Yen, 2016; Xu, Yen, Lin, & Chou, 2002). In the early 1990s, it evolved into customer service including telephone service center and support data analysis. After 1996, some companies combined sales force automation system and customer service system together with sales and on-site service, forming a call center that integrated sales and service, and gradually improved CRM. At that time, enterprises, big or small, were actively implementing CRM in order to manage their relationship with customers more effectively. Later, Gartner Group formally put forward the concept of CRM, which accelerated the development of CRM. In recent years, with the maturing of KM theory and the improving of technical approaches such as knowledge discovery and business intelligence, CRM has been more integrated into the concept of KM.

CRM is often considered a technological innovation. Many companies believe that once they build a CRM system, it can help improve customer loyalty, customer retention and corporate earnings (Badgett, Ballou, & LaValle, 2004; Peterson, 1999; Schultz & Bailey, 2000). In recent years, people have come to realize that CRM is not only a kind of computer software that combines marketing, sales and customer service, but it covers a broader sense and reaches a higher level of the enterprise. As a result, technology is only a necessary part in the development of CRM.

2.2.1 Concept of Customer Relationship Management

At present, the academia has not yet reached an agreement on the definition of CRM. Varied views are mainly as follows.

(1) Strategic View (Adebanjo, 2003; Kracklauer, Passenheim, & Seifert, 2001). The representative definition of CRM, proposed by Verhoeft and Donkers in 2001, is that “companies can invest in the
customers that are potentially valuable for the company, but also minimize their investments in non-valuable customers.” This view emphasizes that the allocation of resources for an enterprise to build and sustain the relationship should be based on the customer’s life-cycle value to the enterprise (Verhoef & Donkers, 2001). Scholars who hold a strategic view believe that customers are of different value to an enterprise. Hence, in order to maximize profits, companies need to constantly assess their customers to determine whether they can establish a long-term and profitable relationship with these customers (Kracklauer et al., 2001; X. Tan, Yen, & Fang, 2002).

Meanwhile, the strategic view of CRM emphasizes that enterprise should establish an appropriate relationship with its customers. In other words, different customer demands bring enterprise different value. Enterprises not only are concerned with positively establishing a good relationship with customers, but also need to ensure that this is a correct relationship. Only in this way can it have a positive impact on business performance.

(2) Philosophical View (Hasan, 2003; Piccoli, Connor, Capaccioli, & Alvarez, 2003). The representative definition, put forward by Hasan in 2003, is that “CRM is not a decentralized enterprise project, but a corporate philosophy, whose purpose is to achieve customer-oriented business concept.” (Hasan, 2003). In recent years, research on CRM has found that there is a significant positive correlation between customer loyalty and corporate profitability. From the philosophical view, CRM is a management approach to gaining customer loyalty by actively building and maintaining a long-term relationship with customers. As a kind of corporate philosophy, CRM is inseparable from the notion of marketing, emphasizing that in order to establish a good, long-term and profitable relationship with customers, the enterprise should actively organize and respond to the changes in customer needs (A. K. Kohli & Jaworski, 1990).

(3) Competence View (Peppers, Rogers, & Dorf, 1999). The representative definition, proposed by Pepper et al in 1990, is that “CRM is to constantly change enterprise behavior based on the knowledge of customers in order to adapt to the changes in customer needs.” The competence view emphasizes that CRM must invest in the development and acquisition of a resource to help enterprise continually adjust and improve its behavior in order to meet the needs of individual and group customers (Peppers et al., 1999). Although the competence view has not been fully accepted in the theoretical circle, it points out a series of resources and capabilities that enterprise must obtain in order to build a good relationship with customers. Subsequent supporters of Competence View continue to put forward what an enterprise should be capable of, including: 1) obtaining the information of existing and potential customers (Campbell, 2003; Crosby & Johnson, 2000); 2) using this information to standardize corporate behavior (Bradshaw & Brash, 2001; Hirschowitz, 2001).

(4) Technological Tools (Gefen & Ridings, 2002; Shoemaker, 2013). The representative definition was proposed by Shoemaker, that is, “CRM is an information system that promotes sales, marketing and service, and thus builds better relationships with customers.” (Shoemaker, 2013). Although Technological View has pushed the development of CRM, so far few scholars believe that CRM is a simple information technology. Most failures in the implementation of CRM are due to simply regarding it as an enterprise information system, failing to recognize its nature. However, it is still necessary to admit that information technology plays an essential role in the development of CRM, for it promotes the collection, storage and sharing of market knowledge, which are key to effective CRM (Crosby & Johnson, 2000; Hirschowitz, 2001).

(5) Process View (Day, Christophe, & Institute, 2002; Galbreath & Rogers, 1999; Grönroos, 2000; Reimartz & Kumar, 2003). The representative definition, proposed by Srivastava, Shervani and Fahey, was that “CRM is concerned with how an organization constructs and develops relationships with external entities, especially relationships with customers.” (Srivastava et al., 1999). Corporate processes are a series of activities that can transform an enterprise's input into its output (T. H Davenport, 1989; Hammer, 1996).
As for what kind of process CRM is, scholars have varied opinions. For example, Srivastava et al argue that CRM is a kind of corporate macro process that encompasses all the activities of an enterprise to build long-term, profitable and win-win customer relationships, and that it can also be further divided into many subprocesses, such as foreground confirmation and customer knowledge creation. But some scholars have a relatively narrower definition of CRM, considering CRM as the activities that manage the communication and interaction with customers (Day et al., 2002; Galbreath & Rogers, 1999; R. Kohli et al., 2001).

2.2.2 Theoretical Development of Customer Relationship Management

CRM is a developing research concept and application area (Gummesson, 2002). Through the review of the definition of CRM, we can see that CRM can exist in the enterprise without information technology and information systems. However, in order to effectively build and maintain customer relationships, enterprises need to integrate CRM software into enterprise information system. The development of CRM has gone through four stages: Non IT-assisted CRM, IT-assisted CRM, IT-automated CRM and integrated-CRM. This development process is divided according to the use of information technology and the integration of CRM and enterprise information system. The higher degree they are, the more effective CRM an enterprise has. And thus, enterprise can expand its customer base and improve corporate profits.

The first stage, Non IT-assisted CRM, is the primary stage of CRM. Organizations at this stage have not yet reached the extent to which they use information technology to support their basic operations. However, these organizations have begun to actively pay attention to relationship marketing management, starting to use some KM tools related to customers, such as customer satisfaction or complaint records and processing manuals (Swift, 2001).

The second stage, IT-assisted CRM, which began around 1998, is to use information technology to improve the relationship between customers and enterprise and meanwhile analyze customer data. The collection of customer data is almost dependent on employees’ manual work, but data recording and analysis can be completed by electronic forms, databases and analysis software. The greatest hope of enterprises at this stage is the emergence of the Internet, which can help manage customer satisfaction behavior and customer complaint behavior more effectively (Swift, 2001).

The third stage, IT-automated CRM, mainly emphasizes promoting the interaction and communication with customers through a variety of information technological means. Access to individual customer characteristics, tracking customer buying behavior and trends and targeted customer service can all be achieved through the use of advanced information technology. At this stage, most organizations use Internet technology, electronic data exchange technology and e-commerce technology, any many enterprises also implement ERP. Thus they can better optimize business process and promote sales automation. At this stage, management of customer accounts and feedback to customer needs and orders become more timely and professional, reaching a higher level of effectiveness (Swift, 2001).

The fourth stage, integrated-CRM, can achieve a higher level of customer customization, customer service and customer satisfaction. At this stage, enterprises use a more mature CRM system to improve the integration of the front-end work system and back-end work system. A mature CRM system can make a highly sensitive respond to the changes in customer demand (Chattopadhyay, 2001), and dynamically analyze and control customer preferences. Supply chain optimization and analysis functions can also be achieved through decision support system at this stage. This requires not only sharing information inside the enterprise, but also delivering customer-related information to any decision-maker in the enterprise and sharing information with customers and partners outside the enterprise, so as to achieve customer satisfaction, process efficiency and minimum cost.

Similar to information technology innovation, CRM is not only driven by technology. Instead, it should be the broadest innovation encountered in the enterprise development, because the implementation
of CRM techniques involves a customer-centered corporate strategy, a redesign of enterprise’s basic specifications and work process reengineering (S. Nelson & Berg, 2000). Corresponding to the integration development of CRM and information technology, Hahnke proposes the concept of CRM lifecycle, and defines the development process of CRM from another perspective, which includes three stages: integration, analysis and action (Hahnke).

2.2.3 Summary

This section reviews the concept and theory of CRM, which to some extent can be viewed as the predecessor of CKM. Research on the concept and theory of CRM lays foundation for understanding CKM theory, developing research method and building research model.

2.3 Customer Knowledge Management

By the early knowledge economy era, KM had already attracted scholars to invest a lot of resources to study the process of knowledge acquisition and sharing. Most of their research results focused on the KM implementation among employees inside the organization, while they mentioned little about customers outside the organization. Therefore, in another research field – CRM, the concept of customer knowledge management (CKM) is gradually being recognized and valued.

Wayland and Cole argue that enterprise’s growth requires focus on customers, and that CKM emphasizes the effective acquisition, sharing and spread of customer knowledge, as CRM will determine the enterprise’s value (Wayland & Cole, 1998). García-Murillo and Annabi consider that the most important source of knowledge for an enterprise is its customers, so it is necessary to actively communicate with customers to acquire customer knowledge so that enterprise can understand the reasons for customers to make purchase decisions (García-Murillo & Annabi, 2002). Fan Weixiang believes that customer knowledge plays a very important role in the enterprise operation, but that even if enterprise has customer information, it cannot guarantee the successful implementation of CKM. The accumulation of knowledge is just the first step in building CKM, while effective knowledge analysis and application can help enterprise retain customers and create value (Fan, 2001).

2.3.1 Customer Knowledge

As the theoretical circle and enterprises pay much attention to customers and knowledge, customer knowledge (CK) has gradually established its strategic position as one of the core resources in the organization. In order to better understand CKM, it is necessary to review the object of CKM, that is, CK.

Some researchers proceed from data, information and knowledge – three related things but with different concepts – and distinguish customer data, customer information and CK (Li & Dong, 2007). Customer data refers to the fact related to customers that is stored in the organization database and employees’ mind. When customer data is placed in some meaningful contexts, it becomes customer information. When customer information is used and disseminated among people in the form of document or interaction, it becomes CK. Among the definitions of data, information and knowledge, we can see that the definition of knowledge is the most complex. It is precisely because of its complexity that knowledge can bring greater benefits to companies than data and information. As Benjamin Franklin said. “Investing in knowledge can produce the most profits (Thomas H Davenport & Prusak, 1998).” Looking back at Russell Ackoff’s knowledge pyramid model, when we apply CK fully into enterprise management (that is, CKM), it will eventually be refined into enterprise management wisdom (Ackoff, 1967).

For enterprise, knowledge is an important resource. Wilson argues that enterprise knowledge chain can be divided into two categories, namely the business knowledge chain and technical knowledge chain. Business knowledge chain includes supplier knowledge chain and CK chain (Wilson & Shi, 2000). Some
scholars simply divide enterprise knowledge into two parts: professional knowledge and CK. Some multinational companies divide enterprise knowledge into four parts during the KM practice, namely CK, business competitive intelligence, business operation knowledge and product information. We can see that CK is an important component of enterprise knowledge no matter what kind of classification we use.

Based on previous research results, different scholars have defined CK from different perspectives. Alan Cooper defines CK as the degree of customer satisfaction of the products and services organizations provide and the complexity of communication between customers and organizations (Swift, 2001). Marcus Blosch considers CK as a dynamic combination of experience, value, and insight information which is needed, created and absorbed during the process of transaction and exchange between the customers and enterprises (Blosch, 2015). Gibbert describes CK as customer information (Gibbert, Leibold, & Probst, 2002). According to Scott Paquette, CK is the integration of customer knowledge, supply chain knowledge and corporate proprietary knowledge (Paquette & Wiseman, 2006). See more definitions of CK in Table II-1.

Table II-1: Definition of CK Provided by Different Scholars

<table>
<thead>
<tr>
<th>Scholars</th>
<th>Definition of CK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alan Cooper (2000)</td>
<td>The knowledge of how products and services meet customer demands, the specific customer needs and desires, the ease or complexity of the interaction between enterprise and customers, and even how customers respond to life stress.</td>
</tr>
<tr>
<td>Marcus Blosch (2000)</td>
<td>An organic combination of experience, value, context information and professional insights which are needed, created and perceived during the process of transaction and exchange between customers and enterprises</td>
</tr>
<tr>
<td>Tiwana (2001)</td>
<td>Customer-related concepts, rules, patterns, laws, constraints, etc</td>
</tr>
<tr>
<td>Campbell (2003)</td>
<td>CK is created through the sorting and analysis of a series of systematic customer-related data along with the customer data of the interactions between customers and enterprise.</td>
</tr>
<tr>
<td>Scott Paquette (2006)</td>
<td>The integration of customer knowledge, supply chain knowledge and corporate proprietary knowledge</td>
</tr>
<tr>
<td>Wei Nanyang (2001)</td>
<td>CK is not simple customer information, but also includes the records and interaction process of the contacts between company and customers. (Emphasizing the tacit nature and explicit nature of CK)</td>
</tr>
<tr>
<td>Fan Zhiping (2005)</td>
<td>From an organizational point of view, CK is the organization’s knowledge of customers which is valuable to the organization.</td>
</tr>
<tr>
<td>Yang Yi, Dong Dahai (2005)</td>
<td>CK is the combination of experience, values and insights closely related to the object provided by enterprise, which are formed during the interaction between customers and enterprise. It can self-renew in the course of constantly evaluating and absorbing new experiences and information. (Emphasizing the dynamic nature, interactive nature and tacit nature of CK)</td>
</tr>
</tbody>
</table>

From the definition of CK and the distinctions among customer data, customer information and CK, we can see that although different scholars have different definitions of CK, there still exists a lot of consensus, mainly as follows:

(1) CK is a relatively wide concept. It encompasses not only the knowledge of customer demand, but also the knowledge of rivals held by customers, other related knowledge of the industry, and other
knowledge that may be useful to the enterprise. This knowledge is of high value and great significance to the development of new products, costs reduce, service improvement, and profit rate increase, but usually enterprises cannot acquire this knowledge on their own (Bloesch, 2015).

(2) CK is different from customer information and customer data. Customer data, customer information and CK are at different levels in the information value chain. Customer information is the raw material of CK, which is easy to transfer and can be copied. By contrast, CK is the solution, based on information analysis, to specific customer needs and problems. It can only be transferred through learning, and cannot be copied. Only when information is organized in a meaningful form, can information become knowledge. From customer data to customer information, it is mainly about establishing correlation among customer data, which makes it ordered and structured, and analyzing, comparing, synthesizing and generalizing customer information according to customer demand, from which enterprise discovers the essence and core of problems and forecasts its development trend. Japanese scholars Nonaka and Takeuchi consider that there is a clear distinction between information and knowledge. Knowledge is about action, which will always “target a certain goal.” Compared with customer information, CK and customer demand are highly correlated, which directly serve the development of decision-making and action plans (Nonaka, 2015).

(3) The knowledge assets of an enterprise can be divided into human asset, relationship asset and the customer relationship asset existing in customer relationship. Similarly, from the perspective of knowledge and KM, CK can be considered as an important asset of enterprise development and the cornerstone in the construction of enterprise core competitive competence. At the same time, it is also an intangible asset of the enterprise, which can continue to increase in value so as to create greater value and more profits for the enterprise (J. Rowley, 1999).

For many enterprises, it is a big challenge to build an integrated customer database, since customer data is often distributed inside the enterprise – in different departments, databases, employees' notebooks, and even employees' minds. In addition, employees are not willing to share their customer information with others. Thus, Ballantyne, Massey, Montoya, Weiss and Holcom argue that the key to the definition of information and knowledge is to understand who owns and who uses (Ballantyne, 2004; Massey, Montoya-Weiss, & Holcom, 2001).

2.3.2 Classification of Customer Knowledge

Jennifer divides CK into two types: (1) knowledge about customers, including knowledge of potential customer segments and individual customers; (2) knowledge possessed by customers, including new product demand preferences and expectations, improvement direction of existing products, effectiveness and service environment of products, and the target market of the products (J. E. Rowley, 2002).

Gebert(2003), Gelb(1998), and Brenner(2003) divide CK into three types based on the KM perspective of CRM process: (1) knowledge for customers, that is, the knowledge prepared by enterprises to meet customer demand so as to help customers better understand their products and service, including knowledge about the market, products and suppliers; (2) knowledge about customers, that is, the knowledge that companies collect to understand customers’ motivation, including customers’ records, background, demands, expectations, etc., which help enterprises accurately analyze and locate customer resources, understand customer demand, and accordingly develop personalized marketing strategy for customers; (3) knowledge from customers, referring to the idea, information, future needs and product improvement suggestions that organizations get from customers, which help enterprises timely respond to changes in customer demand and adjust their marketing strategies accordingly (Gebert, Geib, Kolbe, & Brenner, 2003).

Rainer argues that CK can be divided into the following four aspects. Compared with the above three
dimensions of CK, he separates the basic knowledge of customers, which is the focus of CRM. This kind of classification seems beneficial to the connection between CKM and CRM. (1) Knowledge of customers: Who are customers? What do customers need? Knowledge and views of customer environment, and customers’ relationship network; (2) Knowledge about customers: customers’ characteristics, difficulties, opinions, transaction history, and returning potential, which is mainly about understanding customer needs and trying to meet the needs; (3) Knowledge for customers: knowledge about enterprise products and service that enterprise provides for its customers; (4) Knowledge from customers: customers’ respond to the information and knowledge provided by enterprise, and the evaluation that customers make for enterprise products and service (Alt, 2003).

From a physical perspective, Ronald S. Swift divides customers into four categories: consumer, business, channel, and internal. (1) Consumer: customers who buy the final products or service; (2) Business: customers who buy products or service for resale or value-adding; (3) Channel: individuals or companies that are in the indirect agent of your products or service, without direct commercial relationship; (4) Internal: the internal staff or departments that purchase products or service, which is often overlooked (Swift, 2001).

Based on CRM experience, Zhang Shaojie proposes 10 data indexes of customer classification, namely customer ID number, age, gender, annual income, occupation, address, marital status, benefit, transaction time and marginal contribution to the enterprise. However, these indexes are only applicable to individual customers instead of corporate customers. Zhang Shaojie (2004) also puts forward four levels of customers, namely high-value customers, the most potential customers, ordinary customers and non-value customers. Since the market information of architectural design enterprises often originates from customers, the most important value of customers may not be the value of a specific project, but their market influence (Zhang & Wang, 2004).

Huang Yixiao et al propose customer classification methods based on customer value, including two aspects – customer life-cycle stages and customer development potential (Huang & Shao, 2006). Customer life-cycle phase can be classified according to customer sales volume, customer profit and customer share. For example, in architectural design enterprises, it is classified according to customer contract amount, contract profit and the share of this customer contract in enterprise total contracts. Customer development potential can be classified according to the development potential of customers, and the effect elasticity, strategic elasticity and innovation elasticity of customer market. In architectural design enterprises, it is classified according to customer growth potential and whether this customer contributes to opening up a new market, reaching strategic objectives and innovating products in the design enterprise. According to this point of view, he divides corporate customers into 6 categories:

(1) Category 1: The relationship between customers and enterprise is in the initial stage (entering stage) and low development potential period. These customers bring few profits to the enterprise, thus known as unimportant, and enterprise does not need to focus too much on them.

(2) Category 2: The relationship between customers and enterprise is in the middle stage (stable stage) and low development potential period. These customers, who are satisfied with and loyal to the enterprise, bring high yield, but they have low development potential since what they bring to the enterprise is at the peak. Enterprise should maintain the relationship with these customers, preventing from losing them to rivals. But meanwhile, it is unnecessary to put in more resources.

(3) Category 3: The relationship between customers and enterprise is in the later stage (decline stage) and low development potential period. Volume of business begin to drop. In the future, these customers can no longer bring much profits to the enterprise. Faced with the risk of losing customers, enterprise should investigate the causes. Let the customers go if it is non-enterprise reason, while take actions and avoid the detrimental effect if it was the enterprise that caused customer complaint.
(4) Category 4: The relationship between customers and enterprise is in the initial stage (entering stage), but these customers have high development potential, who will become much more important in the future relation. But at this stage, customers have low trust and dependence on the enterprise, so enterprise should focus on these customers.

(5) Category 5: The relationship between customers and enterprise is in the middle stage (stable stage), and these customers are of high development potential. Enterprise should design one-to-one marketing strategy and provide quality service for these customers.

(6) Category 6: These customers have high development potential, but their relationship with the enterprise has been deteriorated due to factors of demission of contact person, leadership change of the customer and customer address change. Enterprise should never give up these customers, and try to win them back.

From an integrated perspective of customer loyalty, customer value and customer potential, Zhang Jianlin divides corporate customers into five levels (Hu & Zhang, 2004):

1. End-customer: The demand side of the supply-demand relationship is called the customer. However, customers do not necessarily use the products or enjoy the service. Take intermediate customers and dealers as an example, they do not consume the final products. Those who buy and use the products or enjoy the service are called end-customer. End-customer is a part of customer whole, who draw the real attention of enterprise.

2. Loyal-customer: the end-customer who buys enterprise products or service in a long or lifelong term.

3. Valuable-loyal-customer: Customer who brings or creates value to enterprise—the long-term value created by the word-of-mouth effect of loyal-customers—and grows with enterprise.

4. Internal-loyal-customer and External-loyal-customer: Internal-loyal-customer, extension of loyal-customer, refers to the internal staff who has a strong sense of responsibility and a high spirit of devotion, dedicated to the development and expansion of the enterprise with a master attitude. External-loyal-customer refers to the loyal customer outside the enterprise who buys enterprise products or enjoys the service.

5. Latent-customer and Explicit-customer: Latent-customer refers to the customer who has not purchased or possessed enterprise products but will probably buy in the future. Explicit-customer refers to the customer who has already purchased the products.

Yao Shanjii considers that CK consists of explicit customer knowledge and tacit customer knowledge. Similar to the differences between explicit knowledge and tacit knowledge, tacit customer knowledge has higher value than explicit customer knowledge, but it has the characteristics of uncertainty and hard to obtain (Yao & Wei, 2007). Yao Shanjii proffers that tacit customer knowledge contains four parts.

1. The undefinable technical know-how of customers: The technical know-how itself means tacit knowledge. In reality, lots of technical know-how can hardly be explained literally. It can only be understood by repetitive practices, from which you feel, experience, and give feedback.

2. Customer mental model: Mental model refers to the assumptions, prejudice, values, beliefs, images and impressions that are rooted in the minds of customers and influence them in knowing the world and taking actions. Customers usually think about problems subconsciously in the mental model.

3. The ways customers deal with problems: As to the same problem, different customers, influenced by how they dealt with issues in the past, often have different ideas and actions.

4. Customer group convention: Convention refers to the code of conduct with implied experience formed through repeated interaction by the behavior, which is an organizational skill. Group members not only are unaware of the detailed knowledge about operability, but also feel it is difficult or impossible to explain it all in words.
2.3.3 The Concept of Customer Knowledge Management

CKM is a new management idea, which studies and analyzes customer management issues from a new perspective. It is still in development and perfection, having not yet formed a complete theoretical system. In recent years, many scholars and groups put forward the concept of CKM from different perspectives. Representative ones are as follows:

Wayland and Cole first put forward the complete concept of CKM, “CKM refers to the source and application of customer knowledge, and how to apply information technology in building more profitable customer relationships, which leverages information and experience in the process of acquiring, developing and maintaining profitable customer mix.” (Wayland & Cole, 1998). This definition emphasizes that CKM is the process of customer management, focusing on how to use advanced information technology to access, store, share, and apply CK so as to create profits for the enterprise. They argue that the lack of a CK base in an organization’s CKM will limit the value of providing services to customers, and that enterprise will still lose opportunities if it cannot classify its abundant CK. Therefore, enterprises must focus their growth on customers, and organize, analyze and understand CK, turning it into organization’s wisdom and practical actions so as to enhance organization’s performance. In the 21st century, the era of knowledge economy, only the real use of KM can truly implement and achieve the goals and vision of corporate strategy.

Alan points out that CKM is the process in which enterprise uses advanced information technology to interact with customers, helping customers find out problems and solutions so that they can adapt to the environment. By CKM, customer demand process and enterprise marketing process are integrated in a favorable way, and “customized” service is implemented (Cooper, 2004). This definition, in contrast to the one proposed by Wayland and Cole, emphasizes that CKM is a process of managing the enterprise by taking advantage of CK, and that the focus is on how to use CK to help enterprise’s marketing decision-making.

Gibbert, Leibold et al (2002) argue that CKM is a strategic project that transforms customers to knowledge partners, which involves acquiring, sharing and diffusing knowledge from customers. Through adequate operation, CKM can benefit the company as well as customers. They divide CKM into five types, namely prosumerism, team-based co-learning, mutual innovation, communities of creation, and joint IP/ownership. This classification lays the foundation for the practical application of CKM (Gibbert et al., 2002).

Gebert, Geib, Kolbe et al (2003) define CKM from the differences between KM and CRM. Compared with CRM, CKM emphasizes CK as the main connotation of the relationship between enterprise and customers. Compared with KM, CKM focuses the object of KM on customer knowledge, and gains profits by narrowing the broad range of enterprise KM to the operation management of CK (Gebert et al., 2003).

Domestic research on CKM started late. Representative studies are as follows. According to Li Jianguo, CKM is to effectively acquire, develop and maintain the experience and knowledge that is beneficial to customer mix. In order to obtain the maximum value as far as possible, “customer”, “knowledge” and “management” must be in a closed circulation system. And CKM is the action that enterprises use the CK from that circulation system to gain the maximum benefit from customer relationship (Qi, 2001). Guo Qing, Fan Zhiping, Zheng Miaoj et al bases on the practice of e-commerce and puts forward the definition and implementation process of CKM based on ECRM (Guo et al., 2004). Jiang Yuejin explains the differences between CKM and CRM, based on which he puts forward the idea of CKM (Jiang & Liang, 2004). Yang Yi and Dong Dahai regards CKM as a strategy that enterprise uses to gain the competitive advantages in the era of knowledge economy, which combines traditional technology and information with network technology to acquire CK, expands the breadth and depth of corporate CK through the dissemination and sharing of knowledge, and improves enterprise knowledge structure and business-to-customer cognitive ability through the use and innovation of knowledge, so as to effectively manage the relationship between
enterprise and customers, deliver excellent customer value, and maximize corporate profits (Yang et al., 2005).

Taiwan scholar Fan Weixiang considers that the co-called CKM is to effectively obtain, apply, transfer, practice and maintain the knowledge and experience that is beneficial to the establishment of customer relationship (Fan, 2001). Taiwan scholar He Yongqing, Fan Weixiang and Chen Zhensui (2003) define CKM as follows: Through organizational learning, organizational members provide customer information, consulting or contact experience to the organization to effectively use and expand the breadth and depth of CK. Through effective management, the organization turns CK into its wisdom and thus improve its competitive advantages (He et al., 2003).

As for the definitions of CKM mentioned above, different scholars have elaborated their ideas from different perspectives. This study divides the definitions of CKM into three categories: objective/process view, synthesis/integration view, and technology/procedure view. Major representative scholars and viewpoints are listed in Table II-2. This study takes objective/process view, considering that CKM is composed of a series of CK activities, and that it will influence the performance and competitive competence of the enterprise.
<table>
<thead>
<tr>
<th>Classification</th>
<th>Representative Scholars</th>
<th>Representative Viewpoints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective/process View</td>
<td>Wayland and Cole (1997), Alan (2000), Wu Jinhong (2005), Fan Weixiang (2001), Yang Yi and Dong Dahai (2005), etc.</td>
<td>Wayland and Cole (1997) consider that CKM refers to the source and application of customer knowledge, and how to apply information technology in building more profitable customer relationships, which leverages information and experience in the process of acquiring, developing and maintaining profitable customer mix. Yang Yi and Dong Dahai (2005) regards CKM as a strategy that enterprise uses to gain the competitive advantages in the era of knowledge economy, which combines traditional technology and information with network technology to acquire CK, expands the breadth and depth of corporate CK through the dissemination and sharing of knowledge, and improves enterprise knowledge structure and business-to-customer cognitive ability through the use and innovation of knowledge.</td>
</tr>
</tbody>
</table>
2.3.4 Summary

This section reviews and classifies the concept and theory of CKM. With the comparison of the definitions and viewpoints of CKM made by different scholars from different research perspectives, this research will base its study and conceptual model on the concept and viewpoints of process theory. This section not only lays the theoretical foundation for the research issue, but also provides the basic concept and theoretical background for research method and model selection.

2.4 The Differences and Connections among CKM, CRM and KM

In recent years, CRM and KM are two hot fields in the theoretical circle and the physical world. Although they are independent of each other, they are still interrelated and inseparable. Research on CRM probably began in the 1980s. Some scholars believe that CRM is a sort of comprehensive enterprise strategy, which can increase value for shareholders and provide value for customers through corporate behavior such as customer segmentation and customer behavior prediction. Gebert, Beib, Kolbe et al (2003) consider that CRM includes three major areas – marketing, business and service, and is composed by six related business process – campaign management, lead management, offer management, contract management, complaint management, and service management (Gebert et al., 2003).

In the information age, CRM is more recognized as a management tool. Through the investigation of enterprises that have previously implemented CRM, Snyder and Davidson find that 80 percent of these enterprises have failed and thus the scholar circle has begun to doubt the effectiveness of CRM (Snyder & Davidson, 2003). More scholars believe that one major cause of the high failure rate is that CRM, as the business strategy of the enterprise, is not integrated with the concept of KM in the implementation (Thomas H. Davenport & Beers, 2015; Ling & Yen, 2016). Therefore, the key step of CRM is to understand customers based on KM. In other words, the process of CRM contains KM elements. As a management tool, KM cannot be independent of enterprise business process, and CRM precisely provides a good application platform for it.

Due to the high failure rate of CRM and the increasing research on KM, CKM has emerged as a cross filed between CRM and KM, and meanwhile it is also an independent research field.

2.4.1 CKM and CRM

According to the insights and opinions of various scholars, the relationship between CRM and CKM can be summarized as follows.

1) CKM is the objective of CRM. CRM focuses on the establishment and maintenance of the long-term relationship between enterprise and customers, while the objective of CKM is to help enterprise acquire and accumulate CK, and apply this knowledge to all the areas of the enterprise, such as production, marketing, and customer service, so as to enhance customer satisfaction and loyalty, reduce the costs of production, sales and service, and increase corporate profitability.

2) CKM is the essence of CRM. CRM uses information technology to provide new methods and techniques for the accumulation, usage and management of CK. The essence of CRM is to encode and manage the information and knowledge generated in the interaction with customers, dig CK, and batch customer categories, so as to provide more personalized service for valuable customers.

3) CKM is a reasonable extension and development of CRM. CKM connects all kinds of resources in the enterprise with CK to create and improve sustainable competitive advantages and corporate capability of customer service, so as to further optimize enterprise value chain (Huang Yixiao and Shao Peiji, 2006). CRM can be divided into CK platform, customer interaction platform and enterprise production platform. CKM involves one of the three platforms of CRM: CK platform. CRM can also be divided from another
perspective into operational CRM, analytical CRM and collaborative CRM. In a sense, the analytical CRM system has lifted the original customer information management system to the higher level of CKM.

(4) Customer satisfaction is the mutual standard in measuring the implementation effect of CKM and CRM. CRM locks customers by timely meeting customers’ individual needs and engaging in a variety of customer loyalty programs, and thus improves customer satisfaction. By contrast, CKM emphasizes enhancing customer satisfaction by developing customer capabilities and improving customer experience value. The premise of developing customer capabilities is the integration of CK and corporate knowledge. Enterprise not only needs to acquire CK, but also has to take advantage of CK and provide an innovation platform.

There is a natural link between CKM and CRM, but the differences between them are also obvious.

(1) Different management objects. The CK of CRM is the knowledge related to customers. Gibbert and Leibold argue that CKM refers to the management of the knowledge from customers and the knowledge that enterprise provides for customers (Gibbert et al., 2002). Garcia-Murillo and Annabi further point out that the CK of CKM refers to the knowledge that exists in customers. In other words, CKM pay more attention on tacit CK, while CRM focuses more on explicit CK, or customer information and customer data (García-Murillo & Annabi, 2002).

(2) Different incentive objects. The incentive object of CRM is the customers. By establishing the customer database, CRM uses data mining technology to analyze customer preference, predict customer life value, and make customer classification. According to different customer categories, it develops different customer loyalty programs, thereby locking customers. The incentive object of CKM is not only the customers, but also the employees. CKM system is based on the interaction between customers and employees. Through the interaction with customers, employees accumulate knowledge and improve their capabilities; through the interaction with employees, customers enhance their experience and become satisfied. In order to convert employees from selfish knowledge hoarders to selfless knowledge sharers, they must be incented.

(3) Different ways of communication with customers. CRM is a one-way communication, while CKM focuses on the two-way communication between enterprise and customers, in which enterprise and customers are equal in the knowledge transfer and sharing activities. To be more precisely, Gibbert and Leibold consider CKM as a strategic project that enterprise gets rid of the old notion that treats customers as passive recipients of products or service, and empowers them to become knowledge partners of the enterprise. This project includes the acquisition, sharing and expansion of the knowledge stored in customers. Through adequate operation, it can benefit the company as well as customers (Gibbert et al., 2002).

(4) Different management objectives. The main purpose of CRM is customer segmentation based on customer profitability, while CKM is to understand the customers and communicate with them in a personalized way, and its goal is to learn from customers and understand their knowledge needs. What is more important to CRM is to gain corporate competitive advantages through customer loyalty. There is a very famous management theory in this field that gaining a new customer costs five times as much as keeping an old one. Reicheld and Sasser also point out that 5% increase in customer loyalty can bring the increase in the average industrial profit rate by 25% to 85% (Reichheld & Jr, 1990). On the contrary, CKM considers that it has become increasingly difficult for enterprise to maintain customers as customer purchase behavior becomes mature in today's market environment of high-speed competition. Therefore, CKM is less concerned about maintain customers. Instead, it cares about how to enhance corporate competitive competence by gaining new customers and engaging in value-creating activities with customers. Corporate competitive advantages are improved through customer innovation and development. This kind of innovation and development capability cannot be imitated or copied, and thus is a core
competitiveness of the enterprise (Rollins & Halinen, 2005).

(5) Different means. The rise of CRM is due to the popularity and development of information technology, especially e-commerce technology and WEB technology, which make it possible for enterprise to collect customer data and information through online trading and thus contribute to the extensive application of CRM. Hence, information technology is the key to the development and practice of CRM. By contrast, the research object of CKM is more of tacit CK. Wayland and Cole propose that acquiring tacit knowledge relies mainly on psychological theory, which includes three types: dialogue, observation and prediction. Therefore, CKM emphasizes the direct interaction and communication with customers, while information technology is only a necessary aid (Wayland & Cole, 1998).

2.4.2 CKM and KM

KM is a science of systematic management of institutional information and knowledge resources. Generally speaking, knowledge refers to the useful information obtained from filtering, refining and processing related information. In the field of business, knowledge is the valuable information related to the key elements of business operation and management (market, customer, competitor, technology, product, employee, supplier, partner, shareholder, business process, and management process). Enterprise management of its customers is an important part of enterprise external knowledge network. The core of it is to clarify the scope of the external knowledge which is beneficial to the enterprise, and then systematically organize it, effectively use it, and internalize the knowledge into enterprise knowledge base as much as possible, so as to achieve the systematicness, unity and continuity of enterprise’s internal and external knowledge. Thus, CK is the fertile ground for KM, and KM is the process of creating, exchanging and applying knowledge in the interaction with customers in order to increase enterprise value and maintain competitive advantages. CKM is one of the specific work of KM. CKM is the extension of enterprise KM (Rollins & Halinen, 2005).

Gibbert and Leibold argue that CKM incorporates the principles of KM and CRM. CKM expands KM and CRM by extending the “original epistemology” of KM and introducing KM tools in CRM, elevating them to a higher level of “creating co-value.” In other words, customers transform from the traditional sense of passive information source and role of product and service recipient to the active knowledge partner of the enterprise, jointly creating value with the enterprise (Gibbert et al., 2002). It can be seen that CKM is the inheritance, innovation and development of CRM and KM, which achieves the goal of the better management of customer relationship through the organic combination of KM tools and CRM functions. However, KM is more extensive than CKM, including products and service, industrial knowledge, competitor knowledge, methods and process knowledge, and environmental knowledge. Thus, Rollins and Halinen argue that CKM system can be seen as a key area of KM system (Rollins & Halinen, 2005).

Rollins and Halinen (2005), Garcia-Murillo and Annabi (2002), and Gibbert and Leibold (2002) have made an elaborate analysis and comparison of CKM and KM at the specific level. For example, the corporate task in KM is to encourage employees to share knowledge, while the corporate task in CKM is to turn customers from passive product recipient to the active value creator (García-Murillo & Annabi, 2002; Gibbert et al., 2002; Rollins & Halinen, 2005).

To further illustrate the differences and connection between CKM and KM, we can divide KM into two types: One is to find the connection between customer behavior and property and the experience or other knowledge gained from the interaction with customers. The process of spreading and applying this knowledge to create value for enterprise can be called “inward” KM. The other is the process of collating and developing the knowledge about enterprise products, and then spreading them to the specific customers, so as to exert favorable influence on customers, which can be called “outward” KM. Obviously, CKM is a
kind of “inward” KM. The core of “inward” KM is to obtain knowledge from customers, which is also the task of CKM.

CKM is proposed under the background of the updated concept of knowledge economy and marketing management. According to the prediction of CRM technology trend by AMT, the future CRM system will integrate part of the idea of KM and competitive intelligence, and become a powerful tool of KM and competitive intelligence. In this sense, the integration of KM and CRM will lead to CKM. In addition, this trend can also be seen from the development of KM. KM has gone through a series of transformation, from SFA to CSS. With the development of information technology, the concept of CRM was proposed. Since 1999, with the rise of e-commerce, CRM has developed towards e-CRM. The famous research company Forrester points out in the report “Business Integration Rules” that enterprise can improve its competitiveness through the effective integration of e-commerce and enterprise management model. It also finds that previously most enterprises ignored “liquidity integration” in their e-commerce, that is, ignoring the full coordination of information, knowledge and traditional business. The KM system, which is the foundation of enterprise e-commerce, uses the combination of information technology and human beings to establish and manage the knowledge chain linking customers, enterprise and suppliers, and thus completes the “liquidity integration” of the enterprise. Therefore, it can be seen from the analysis that CKM is the inevitable result of the development of e-CRM.

Since the integration of KM and CRM leads to CKM, we can see CKM as the extension and development of CRM.

There is an intersection in the functions of CKM and CRM. The content of CRM contains the concept of CKM, and CKM has clearly stressed to use the idea of KM to further deepen CRM functions. As it were, CKM is the integration of KM and customer management. CKM links together the two essential resources in the enterprise and today’s economy – knowledge and relationship. On the one hand, enterprise establishes a closer and more valuable cooperative relationship with customers. On the other hand, enterprise furthest embeds the knowledge and professional experience obtained from the interaction with customers into products and service, in order to lay the sustainable solid foundation of enterprise sustainable competitive advantages. CRM and CKM are both the branch content of customer management, but CKM is also the important component of KM. Hence, CKM has not only the characteristics of KM, but also the idea of customer management.

The concepts of CRM and CKM are closely related, but the two are also largely different from each other. The theoretical basis of CRM is customer management while CKM is based on KM and customer management. CRM views customers as its core asset while CKM views knowledge and customers as its core assets. The organization implementing CRM is “information processing” mechanism, which obtains information from the outside and then processes it to solve customers’ problems. However, this cannot adapt to the changing environment. The organization implementing KM is of high efficiency, which promotes the knowledge exchange among employees and different departments through the establishment of intranet and knowledge map, and improves the efficiency of problem-solving through employee knowledge sharing. The organization implementing CKM is an innovative organization which acquires and creates new knowledge inside and outside the organization, and on this basis identifies key issues and solves the problems, taking the initiative to create an environment suitable for its existence and development. In addition, differences between CKM and CRM also include the aspects of management model, corporate culture, competitive mode, and functional roles.
Table II-3: The Connections and Differences among CKM, CRM and KM

<table>
<thead>
<tr>
<th>Source of Knowledge</th>
<th>KM</th>
<th>CRM</th>
<th>CKM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees, teams, organizations, network</td>
<td>customer database</td>
<td>customer experience, customer innovation</td>
<td></td>
</tr>
<tr>
<td>Baic Principle</td>
<td>“as long as we know what we know”</td>
<td>“Retaining old customers is more rewarding than gaining new customers”</td>
<td>“as long as we know what customers know”</td>
</tr>
<tr>
<td>Objective</td>
<td>To share knowledge inside the enterprise</td>
<td>To mine the knowledge about customers</td>
<td>To acquire, share, innovate, and apply CK</td>
</tr>
<tr>
<td>Role of Customers</td>
<td>Passive product recipient</td>
<td>Passive connector of enterprise relationships</td>
<td>Active knowledge creator and sharer</td>
</tr>
<tr>
<td>Role of Enterprise</td>
<td>Collect the knowledge stored in employees</td>
<td>Establish a long-term relationship with customers</td>
<td>Turn customers into partners of enterprise in knowledge creating and sharing</td>
</tr>
<tr>
<td>Effect Measurement</td>
<td>Customer retention</td>
<td>Customer satisfaction</td>
<td>Achieve better performance than competitors in growth and innovation</td>
</tr>
<tr>
<td>Focus</td>
<td>Knowledge</td>
<td>Customer relationship</td>
<td>CK</td>
</tr>
</tbody>
</table>

2.4.3 Summary

This section compares the concepts and theories of CKM, CRM and KM, which further clarifies the research focus of CKM and provides a theoretical basis for the factors that need to be considered in the research method and model selection.

To sum up, CKM is the development of CRM and the integration of CRM and KM. The content of CRM contains the concept of CKM, and CKM has clearly stressed to use the idea of KM to further deepen CRM functions. CRM and CKM are both the branch content of customer management, but CKM is also the important component of KM. Hence, CKM has not only the characteristics of KM, but also the idea of customer management. See the connections and differences among CKM, CRM and KM in Table II-3.

The application and research of CKM can be divided into two levels:

First, management of CK. CKM develops the leverage function of CK to select and manage customers through the acquisition, sharing, innovation and application of CK, so as to constantly optimize customer value.

Second, management by CK. CKM connects other resource elements in the enterprise with CK in specific ways and systems, so as to create and improve sustainable competitive advantages and corporate capability of customer service, and further optimize enterprise value chain.

2.5 Literature of Customer Knowledge Management: Research Gap Identification

2.5.1 Literature of CKM

Definition of CKM and other related concepts. CKM is a newly-rising research filed. Although its development over the past 20 years has not yet reached a universally accepted definition, scholars have defined and analyzed its source of CK, CK characteristics and CKM objectives from different research perspectives, which lays the foundation for the development of CKM and determines its further research direction.

What is CK? What is the content of CK? These questions have always been the hot issues in the field
of CKM. Scholars have made a detailed distinction among CK, customer information and customer data, as elaborated in Chapter II. The classification of CK proposed by Gebert, Geib and Kolbe (2002) and Buerend, Schierholz, Kolbe et al (2004) is widely accepted, including knowledge for customers, knowledge about customers and knowledge from customers (Bueren, Schierholz, Kolbe, & Brenner, 2004; Gebert et al., 2003). On this basis, scholars Zou Nongji and Feng Junwen (2006) put forward a new idea of CK – knowledge-co-creation, that is, the knowledge co-created by enterprise and customers. Studies show that CK itself is owned and co-created by enterprise and customers. Without enterprise, CK loses carrier as well as its practical significance; without customers, CK loses its source (Zou & Feng, 2006). Therefore, co-creation is implied in the three kinds of knowledge. This study uses the classification of CK proposed by Gebert et al. Polanyi divides knowledge into tacit knowledge and explicit knowledge (Polanyi, 1967), based on which many scholars believe that CK can also be divided into tacit CK and explicit CK. They consider that knowledge for customers and knowledge about customers mainly belong to explicit CK while knowledge from customers mainly belongs to tacit CK (Ling & Yen, 2016; Norman, 2004).

Previous studies have discussed CKM from perspectives of process and CK activities. For instance, Wayland and Cole emphasize that CKM is a closed-loop model, including segments of planning, focusing, generation, classification, sharing and upgrading (Wayland & Cole, 1998). The CKM model proposed by Tiwana contains three kinds of knowledge activities – acquisition, sharing and application of CK (A. W. Tiwana, Miles, 2000). Garcia-Murillo (2002), Dervin (1983), Kuhlthau (1998), Yoon and Nilan (2000), Chinese scholars Guoqing and Fan Zhiping, Yang Yi and Dong Dahai, and Taiwan scholar Fan Weixiang have described the cyclic process of CK in the enterprise, and have defined different CK activities according to the research results (Dervin, 1983; Garcia-Murillo & Annabi, 2002; Kuhlthau, 2004; Yoon & Nilan, 1999; Fan, 2001; Guo et al., 2004; Yang et al., 2005). Scholars have recognized that the CKM of an enterprise is not only a kind of strategy, but also the practical tactics, an in-depth business process, which has greatly promoted the implementation of CKM in enterprises and have provided a clearer direction for the development of CKM theory.

Previous studies have clearly pointed out the connections and distinctions among CKM, CRM and KM. Most scholars consider that CKM is the development and extension of CRM and KM, which learns from the CRM theory and KM tools. The CKM model proposed by Swiss scholar Gebert integrates the six parts of CRM (campaign management, lead management, offer management, contract management, complaint management, and service management) and the four aspects of KM (knowledge encoding, knowledge exchange and knowledge integration) (Gebert et al., 2003). Yang Yi and Dong Dahai also propose a similar CKM model (Yang et al., 2005). As we can see, scholars have a clear positioning and planning of CKM, which lays the foundation for its future development in theory and practice.

Scholars have also clearly pointed out the relationship between CKM and enterprise performance – the implementation of CKM can enhance enterprise performance (tangible performance and intangible performance). Davenport and Klahr argue that the implementation of CKM can enhance enterprise performance from the following aspects: improve the quality and consistency of solutions, and improve employee and customer satisfaction; reduce the costs of each answer to the questions and the costs of technical service; increase the knowledge of general service personnel and reduce customer complaints; integrate the generation, access and sharing of knowledge into the work of employees; reduce the costs of answering questions by professionals and cultivate customer-oriented front desk service staff (Thomas H. Davenport & Klahr, 1998). Taiwan scholar Lin, Su and Chien have demonstrated through an empirical study that corporate CKM has a significant positive impact on the improvement of enterprise performance. The impact on performance will help to promote the implementation of CKM in enterprises (Y. Lin, Su, & Chien, 2006).
Scholars have discussed the factors influencing the implementation of CKM. Campbell puts forward the concept of CK capability, and considers that marketing and information interface, support from top managers, employee reward system, and CK process are four key elements in the formation of enterprise CK capability (Campbell, 2003). Some scholars believe that CKM is the product of market-oriented development. Hence, the factors proposed by Kohli and Jaworsld (1993), such as market chaos, technology chaos, market competition and market growth, will all affect the development of CKM (A. K. Kohli & Jaworski, 1990). In addition, organizational structure and corporate culture are also important factors mentioned by different scholars that will influence the implementation of CKM in enterprises.

2.5.2 Gap Identification

(1) Integration of concepts. CKM is in the transition stage from conceptual exploration to in-depth study of the theoretical framework. General agreement has been reached on the type of CKM. Some foreign companies have already practiced CKM and achieved favorable results. However, there is still no set definition of CKM. Varied definitions and the lack of theoretical framework make it difficult for enterprises to master and understand CKM, let alone implement it. Therefore, the definition of CKM and the integration of research framework should be two important research issues (Bhat & Darzi, 2016).

(2) Lack of empirical research. Most of the relevant research on CKM is based on the theoretical discussion, whether about the model construction or the influence on enterprise performance. Even in a limited empirical study, scholars discuss CKM as a single-dimension variable (Jayachandran, Hewett, & Kaufman, 2004). Then, how does CKM contribute to the improvement of enterprise performance? Direct influence or indirect influence? With mediators or moderators? Only a few Taiwan scholars have conducted related empirical studies. For example, Fan Weixiang has discussed the relationship among CKM, market orientation and marketing performance (Fan, 2001); Lin, Su and Chien have verified the direct relationship between CKM and enterprise performance (Y. Lin et al., 2006) [102]; Alton Y.K Chua and Snehasish Banerjee use the survey data of Starbucks to analyze the role of social media in CKM (Chua & Banerjee, 2013); Wu Jiebing et al use the survey data of a Chinese telecom company to analyze the positive effect of CKM on the business model based on information technology (Wu, Guo, & Shi, 2013). These simple empirical studies are far from enough. Therefore, the field of empirical research on CKM should be further expanded.

(3) Although scholars who are concerned about the business process of CKM have recognized that CKM is a kind of corporate tactics, a kind of process, and that the integration of CKM and KM can produce huge synergetic effect, they have shown great differences in the classification of CKM because they have different research perspectives of CKM and different understandings of its connotation. So far, there has not yet formed a mature understanding of CKM structure (Taherparvar, Esmaeilpour, & Dostar, 2014).

(4) Lack of the integration with other management theories. Many scholars regard CKM as the extension and development of CRM and KM. However, if CKM is discussed as a business process, it will have an inseparable relationship with the theories like enterprise process management and organizational learning. Meanwhile, as to the problem of CK sharing, the “human” factor will be a difficulty as well as the blind spot of current research. Hence, the integration with organizational theory and relationship theory is also necessary (Taherparvar et al., 2014).

2.5.3 Summary

This section reviews the current literature of CKM, including the current literature of CKM conceptual model, related research on CKM and enterprise performance, and empirical studies of enterprise CKM. The review and analysis of CKM conceptual model lays foundation for the establishment of research model, while the empirical studies of enterprise CKM in other industries provides a reference for the research methods of this research.
2.6 Literature of Enterprise’s Innovation Capability: Research Gap Identification

2.6.1 Theories of Enterprise Innovation

2.6.1.1 Schumpeter’s Innovation Theory

In 1912, American-Austrian economist Schumpeter groundbreaking put forward “innovative thinking” in his book “Economic Development Theory,” pointing out that “innovation” is the fundamental phenomenon of economic development and the process of “creative destruction.” (Schumpeter, 1935). According to his definition, innovation is to set up a new production function, that is, to introduce into production system a “new combination” of production factors and production conditions. It includes the following five situations: (1) introduce a new product or attach a new feature to the product; (2) introduce a new production method, mainly reflected as adopting new technologies or new production organizational modes in the production process; (3) open up a new market; (4) acquire new supply sources of raw materials and semi-finished products; (5) establish a new industrial organization (Schumpeter et al., 2015).

The five types of innovation described by Schumpeter can be roughly divided into three categories. The first category is technological innovation, including developing new products, transforming old products, adopting new production mode, acquiring new supply sources, and using new raw materials. The second category is market innovation, including expanding the original market share and opening up new markets. The third category is organizational innovation, including the transformation of the original organization mode and the establishment of a new business organization.

Two points in Schumpeter’s innovation theory have a profound impact on the subsequent research. One is the view of dynamic change, and the other is the attention to the role of technology in the development of economic system. Schumpeter’s innovation theory attaches great importance to entrepreneurship. He argues that innovation originates from entrepreneurship. After Schumpeter, many scholars have followed these two traditions to develop innovation theory. As a phenomenon with multiple characteristics, innovation has following features: (1) As an economic phenomenon, innovation is determined in part by the market or market demand factors, including actual, perceptual and potential economic or non-economic demand; (2) Innovation is determined in part by technical factors and the characteristics of the technology itself, which form the innovation possibility frontier; (3) There is an interdependent and restrictive relationship between the economic characteristics and the technical characteristics of innovation; (4) Innovation is partly determined by non-technical factors, such as personal, social, political and economic influence, and a crucial one is the institutional arrangement of innovation; (5) Innovation is a dynamic process, which will change with the impact of relevant factors over time (Guo & Cai, 2001).

2.6.1.2 Theories of Technological Innovation and Institutional Innovation: Innovation Research Following Schumpeter

After Schumpeter, innovation theory has developed into two directions. One is the technological innovation school represented by Mansfield and Schwartz, which has formed some representative theories through thorough research on technological innovation from the perspective of the relationship between the innovation and the imitation, promotion, and transfer of technology. The other is the institutional innovation school represented by North, which combines innovation and system to study the relationship among institutional factors, enterprise technological innovation and economic benefits. It emphasizes the importance of institutional arrangement and institutional environment to economic development (Ding, 2002).

Many scholars have conducted massive research on innovation theory and practice, which pushes the
development of innovation theory. These studies mainly focus on the meaning of technological innovation, innovation process and innovation system (DODGSON, GANN, & SALTER, 2011; Mao, 2005).

(1) The meaning of technological innovation. G.Lynn defines technological innovation from the perspective of the time-series process of innovation, regarding technological innovation as “the whole process that begins with the recognition of the commercial potential of technology and finally transforms it entirely into commercialized products.” (Wang & Cao, 2012). J.M.Utterback argues in Innovation in Industry and the Diffusion of Technology, “Innovation, as distinct from an invention or technical prototype, refers to technology actually being used or applied for the first time.” (Utterback, Hollomon, Sirbu, & Allen, 1976). S.Myers and D.G.Marquis define innovation as the gathering of technological changes in “Successful Industrial Innovation.” “Innovation is a complex process, which starts with new ideas and new concepts and through solving various problems finally puts a new program with economic and social value into actual practice successfully.” (Myers & Marquis, 1969). R.Mueser argues that “technological innovation is a meaningful consisting event characterized by novelty and successful implementation.” (Mueser, 1985). Chinese scholar Fu Jiaji defines technological innovation in Science of Technological Innovation as follows: Entrepreneurs seize the potential profit chance in the market, and reorganize production conditions and elements with business interests as the goal, establishing a production and operation system with higher efficiency, higher effects and lower costs, so as to promote new products, new technology and new production methods, open up a new market, and acquire new supply sources of raw materials or semi-finished products, or establish a new enterprise organization. It is a comprehensive process of a series of activities including science, organization, commerce and finance (Fu, 1998).

The essential meaning of technological innovation is: 1) It emphasizes the market-oriented behavior based on factor combination. 2) It emphasizes the integration of technology and market. Technological innovation cannot only consider technology. Instead, it has to combine technological knowledge and market demand. 3) It emphasizes the effective integration of R&D department, manufacturing department and marketing department. Generally, enterprise need to organize these three departments systematically, and focus on strengthening the link among them (Chen, 2001).

(2) Five generations of innovation process models emerged from the 1950s to the 1990s. These innovation process models try to explain enterprise technological innovation process from different perspectives.

The first generation, from the 1950s to the early 1960s, is a simple, linear and “technology-driven” innovation process model, in which technological innovation is a technology-oriented linear and spontaneous transformation process while the market only passively accepts technological achievements, manifested as a technology-driven process (Mansfield, 1968). In this model, research and development is the main source of innovative ideas. A new discovery leads to a series of events, and finally the invention is put into actual practice, bringing new products or technology to the market.

The second generation, from the mid-1960s to the early 1970s, is a simple, linear and “demand-driven” innovation process model (Kamien & Schwartz, 1982). This innovation process model emphasizes that the market is the source of innovation ideas. Market demand, which provides opportunities for products and technology, plays a key role in the innovation.

The third generation, from the late 1970s to the early 1980s, is an “interaction-based” innovation process model (Rothwell & Zegveld, 1985; Steinmueller, 2000), which emphasizes that the whole process of innovation is triggered by the interaction between technology and market demand. The driving force of technology and demand has different roles in different stages of the product cycle and innovation process. According to the internationally renowned innovation economist Roswell, this model divides the innovation process into different stages, which interact but also are independent on each other. These stages are not necessarily continuous in the process, but are logically connected. The overall pattern of the
innovation process can be viewed as a complex internal and external communication network, which links different internal functional departments and connects the enterprise to broader scientific and technical groups and the market. In other words, the innovation process represents the fusion of the market demand and the technological capabilities of the innovation organization. It is obvious that incremental innovation can be easily introduced into the existing structure and process of the enterprise. The fundamental technological innovation, to achieve success, is often required for significant organizational and procedural adaptations. In other words, for the fundamental innovation with long-term strategic potential, organizations must have enough flexibility and willingness to make adaptive changes in order to meet the demands of innovation. The interaction model of innovation strengthens the link between marketing and technology in the technology-driven and demand-driven model. It also means that innovation management matches market demand and new technological capabilities. In this case, the feedback between marketing and R&D is a substantive link.

The fourth generation, from the late 1980s to the early 1990s, is a “chain-linked” innovation process model (S. J. Kline & Rosenberg, 1986), which emphasizes the integration of R&D and manufacturing interfaces as well as close collaboration with suppliers and leading users. It understands the process of technological innovation based on the interaction among market opportunities, enterprise knowledge base, organizational and institutional framework, and enterprise’s innovation capability, which organically combines the technical process, organizational process, institutional process and market process of the enterprise to a large extent. This model contains four functions, namely the identification and analysis of product strategy and market opportunities, engineering design, production engineering, and marketing. These four functions almost cover the most basic business activities, and each function contains a number of sub-processes, whose output is of high uncertainty. In order to overcome the difficulties in the development process, it is often required to return to the early stage, which means that there are feedback effects among all the sub-processes. Therefore, what determines the success of technological innovation is not only the simple technical or market aspect, but also the degree to which the enterprise can maintain an effective link among different innovation processes.

The fifth generation is the innovation model of “systems integration and network” in the 1990s (DODGSON et al., 2011), which considers the entire innovation process as a complex network of internal and external communication pathways in the organization. It not only links various internal functions of the enterprise, but also emphasizes the closer strategic link among cooperative enterprises and the link with the market. The successful operation of this model requires managerial and organizational flexibility, internal and external cooperation, and highlight of innovation strategy and technology strategy in the corporate strategies.

(3) The research of innovation system mainly includes: national innovation system (R. R. Nelson & Winter, 2009), regional innovation system (Mothe & Paquet, 1998) sectoral innovation system (Breschi & Malerba, 1997; Davies & Brady, 2000), technological innovation system, innovation networks (Belussi & Arcangeli, 1998; Edquist, 1997; Fleming, 2003; Freeman, 1991), complex products and systems integration (Davies & Brady, 2000).

The theory of institutional innovation is mainly represented by two schools: one is represented by Galbraith, Myrdal and Heilbroner. The school attacked the present institution and believed that the present institution should be fundamentally changed to promote innovation. Their theory was attacked and ridiculed by the mainstream economists for loosely structure, so it had little influence. The other one is the New Classical Economics School represented by Coase, North. The school used the method of New Classical Economics to research institution, which was accepted by mainstream economic school. Coase won the 1991 Nobel Prize in Economics. Since then, Douglas, North also won the Nobel Prize in Economics. In the academic community occupies a pivotal position. They use the general static equilibrium
and comparative static equilibrium method in New Classical Economics, which is mainstream in western economics, to carry out institutional analysis so that New Classical Economics obtains a new explanation of real economic problems and this greatly expanded the application areas of New Classical Economics. This had a significant impact in the academic community. The school has 4 basic ideas: because of the transaction costs, the institution will affect the efficiency of resource allocation; there exists market failure, and the key to solve market failure lies in the institutional arrangements; the performance of economic growth is technological innovation and progress, but the source of economic growth is efficient institutional arrangements; institution is endogenous and scarce in the process of economic operation, the key to economic growth is the institutional factors (Williamson, 2000).

2.6.1.3 The Literature of Innovation Management Theory in China

The theoretical research of technological innovation originates from the West, and Chinese scholars start from the introduction of western research results. With the continuous expansion of research, the research work in China has quickly turned from the simple translation and introduction of western technological innovation theory and research methodology to the empirical study of the technological innovation activities in Chinese enterprises. With the support of the National Natural Science Foundation of China, the academia has conducted research on the levels, mechanism and pattern of technological innovation, diffusion and transfer, innovation and entrepreneurial behavior, technological progress and technological innovation, and management innovation and organizational innovation. On this basis, China’s theoretical system of technological innovation is formed, which directly promotes the implementation of national technological innovation projects (Shao et al., 2002).

Gao Jian and Fu Jiaji analyze the innovation status of Chinese enterprises and the incentives and barriers to enterprise innovation through the investigation and research of technological innovation (Fu, 1998). Some scholars have studied on the process and model of technological innovation (Shan, 2010; Hu & Hu, 2009; Wang, 2004; Zhang, 2004; Zhang et al., 2007). And some scholars have discussed the problems and solutions of enterprise technological innovation (Cheng, 2003; Liu, 2003; Zhang & Liu, 2003).

Scholars like Xu Qingrui has conducted systematical research on the theoretical framework, mechanism and model of combinatorial innovation and the total innovation management (Guo et al., 1997). Research on technological innovation has gone beyond the technological field into a wider area including organization and culture. Xu Qingrui and other scholars bring organizational and cultural factors into the theoretical research field of technological innovation, put forward the model of combinatorial innovation, and conduct in-depth theoretical and empirical research on it. In the early days of this stage, research focuses on how to improve enterprise’s innovation capability through technology, organization and combinatorial innovation; in the later days of this stage, the core-competence-based innovation portfolio model is put forward, and research focuses on how to cultivate and enhance enterprise core competence through the combinatorial innovation of technology, organization, culture and institution (Guo & Xu, 1997; Xu et al., 2002; Zheng, 1997). Through case analysis and theoretical research of typical innovation management in the domestic and foreign enterprises, Xu Qingrui puts forward the law of total innovation. The central task of this law is to cultivate and enhance the technological innovation capability of the enterprise, and finally to form the core technical competence. Its purpose is to enable enterprise to adapt to environmental changes and meet users’ demands. To achieve this central task, enterprise must continually carry out the total innovation focusing on technological innovation (Xu, 2001). Furthermore, Xu Qingrui and other scholars have studied the total innovation management system including elements of technology, culture, strategy, management, organization and institution (Xu, 2007; Xu et al., 2003). Figure II-1 illustrates the basic framework of total innovation management.
The connotation of total innovation is to strive to achieve innovation of everyone, everything, every time and everywhere through effective innovation management mechanism, which is strategy-oriented, targeting at value increase and focusing on cultivating and enhancing core competence and improving core competitiveness by means of collaborative innovation of all the innovation elements (such as technology, organization, market, strategy, management, culture, institution, etc.).

The internal factor dimensions of total innovation are: (1) technological innovation – key; (2) strategic innovation – direction; (3) market innovation – path; (4) management innovation – basis; (5) organizational innovation – guarantee; (6) cultural innovation – precursor; (7) institutional innovation – driving force; and (8) collaborative innovation – means.

There are three points in the meaning of total innovation management: First, it refers to the all-round innovation of all the innovation factors inside enterprises that focus on technological innovation, including organization, culture, institution, process, market, etc. Second, it refers to the all-involvement innovation covering all the departments and staff, as well as the three-dimensional all-round sustainable innovation including full-time innovation, whole-value-chain innovation, etc. Third, it refers to the collaborative innovation among each innovation factors (Xu, 2001).
The concept of total innovation is largely different from the concept of traditional innovation, for it breaks through the old pattern that R&D department carries on innovation alone as well as greatly expands the innovation factors and the time-space scope, which is embodied in the all-involve innovation, full-time innovation and all-round innovation (including whole-process, global and whole-value-chain innovation). The essence and goal of total innovation can be summed up as follows: First, to achieve sustainable competitive advantages (value creation/increase); second, to emphasize the accumulation and development of core competence. With appropriate mechanisms and tools, total innovation management enables innovation to be carried out smoothly throughout the organization, and that is, to achieve all-involve, full-time, and all-round innovation (Xu, 2001).

Some scholars have analyzed and discussed enterprise innovation management model from the views of system and integration. For example, Li Yuan and liao Weijie have constructed a framework of enterprise innovation system based on value management, and have analyzed its six components (strategic innovation, organizational innovation, cultural innovation, marketing innovation, product innovation and technological innovation) and their interrelations (Li & Qiao, 2002). Zhang Huasheng and Xue Lan have studied the paradigm of integrated innovation from the perspective of technological innovation, and have analyzed the integration object, integration body, integration platform, integrated system structure and organizational capability, integrated innovation network, and the implementation mode of integrated innovation (Zhang & Xue, 2002). Guan Jiancheng and Zhang Aijun have found some rules about the relationship among organization, technology and innovation performance with O-T map tool according to the questionnaire investigation and data analysis of 213 manufacturing innovative enterprises in Beijing. Research shows that the effective integration of technology and organization plays a decisive role in the success of technological innovation (Guan & Zhang, 2002). Chen Jin proposes that integrated innovation is composed of technology integration, knowledge integration and organization integration (Chen, 2002).

2.6.2 Enterprise Competence Theory

The theory of enterprise competence is developed along with the discussion about the root of enterprise’s competitive advantages concerning enterprise strategic management theory. Since the 1980s, strategic management theory has discussed the root of enterprise’s competitive advantages from different perspectives. Relevant theoretical research can be divided into two categories: One is the exogenous theory of enterprise’s competitive advantages represented by Porter’s industrial analysis theory; the other is the endogenous theory of enterprise’s competitive advantages represented by competence theory. Focusing on the crucial question that how can enterprise achieve and maintain sustainable competitive advantages in a turbulent environment, resource-based enterprise theory, enterprise competence theory, enterprise core competence theory, enterprise dynamic capability theory and knowledge-based enterprise theory have made different explanations, forming a basic framework of the generalized enterprise competence theory. All the above-mentioned theories have in common that the discussion on the source of enterprise’s competitive advantages has shifted from the outside to the inside of the enterprise. They all consider the internal conditions have decisive effects on the enterprise’s competitive advantages, compared with the external conditions of the enterprise, and that the key to achieving excess earnings and maintaining competitive advantages is the accumulation of enterprise’s internal resources and capabilities (Li, 2003).

The current development of enterprise competence theory is mainly about seeking the source of enterprise’s competitive advantages so as to define the extension of enterprises. As Foss puts it, today strategic management researchers are still keen to consider the special resources and capabilities of the enterprise as key factors influencing the enterprise’s long-term competitive advantages. Hence, this theory has sprung into the theme of the theoretical research on enterprise strategic management. Enterprise competence theory not only illustrates the sufficient conditions for the existence of an enterprise, but also
makes a reasonable explanation for enterprise’s heterogeneity and the decision of enterprise boundaries (Foss & Knudsen, 1996).

### 2.6.2.1 The Evolution of Enterprise Competence Theory

Since the 1980s, researchers have shifted their focus on the exploration of competitive advantages to the inside of the enterprise, which results in a system of competence theory including resource-based theory, competence-based theory, core competence theory, dynamic capability theory and enterprise knowledge theory. From the emergence and development of enterprise competence theory, it has gone through four stages: division of labor theory, enterprise internal growth theory, enterprise resource-based theory and enterprise core competence theory. Enterprise competence theory dates back to the classical economist Adam Smith’s theory of division of labor (Smith et al., 2003).

In “Wealth of Nations”, Adam Smith puts forward that the division of labor inside the enterprise determines enterprise’s labor productivity, thereby affecting enterprise's growth. He believes that the division of labor means some enterprises specializing in a particular industry or in the production and sales of a particular product forms stronger capabilities in such aspects. He suggests that the division of labor can improve productivity from three aspects: First, workers can improve their productivity by repeating similar work; second, the conversion cost that occurs when workers convert from one task to another is largely reduced by dividing the complex work into many simple operation processes; third, that a worker specializes in one simple task is beneficial to replace manual work by machine production, thereby enhancing production efficiency (Smith et al., 2003). It can be seen that the division of labor inside the enterprise determines enterprise labor productivity and affects enterprise's growth. Subsequently, Alfred Marshall, Sarnico, Penrose and George Richardson have further developed enterprise competence theory (Li, 2003). The evolution of enterprise competence theory is shown in Figure II-2.
2.6.2.2 Enterprise Resource-based Theory

The resource-based view of firm can be briefly referred to as the “resource-based theory,” which grew up in the rebellion against the mainstream strategic theory. Its basic goal is to deconstruct enterprise, the “black box”, which is regarded as a production function by the economists, and dismantle it into more basic elements in order to find the root of enterprise’s competitive advantages. The resource-based theory emerged in 1984, marked by the classic paper *A Resource-Based Theory of Firm* written by B.Wernerfelt (Barney, 1996). Later, some scholars have enriched and improved the theory, such as D.J.Teece, G.Pisano and A.Shuen, J.R.Pandian, and M.A.Peteraf. The core idea of this theory is that enterprise is a combination of a series of resource bundles, and its competitive advantages originate from the resources it owns, especially some heterogeneous resources. External market structure and market opportunities will have an impact on enterprise’s competitive advantages, but they are not decisive factors (Yu, 2002).

2.6.2.3 Enterprise Core Competence Theory and Dynamic Capability Theory

There are many resources in the enterprise, but not all of them can become enterprise’s competitive advantages or the source of high profits. Take material resources as an example, some can be bought directly in the market. And in a competitive market, their prices tend to be consistent with their value, so it is impossible to generate rent. A company that uses a kind of advanced equipment to obtain a certain degree of advantage will soon lose it due to the popularization of this advanced equipment. From the perspective of rent and long-term advantage, such resources are of no value. This reveals a principle that there is no
causal relationship between excess profits and long-term competitive advantages and the resources that most companies have, because such resources are either adequately supplied so that no firm can obtain rent from these resources, or scarcely supplied mainly because competitions for such resources lead to the situation that firms cannot acquire the resources at a price below the value. In any case above, enterprises cannot obtain sustainable excess profits or competitive advantages with such resources. Based on this consideration, some scholars critically inherited and developed the resource-based theory, forming enterprise competence theory, that is, the capability-based view of firm. Although the researchers gathering under the banner of enterprise competence theory stand for different concepts and use different analytical frameworks and perspectives, their basic idea is the same (Prahalad & Hamel, 2006). The concept of corporation’s core competence put forward by Hamel and Prahalad has gradually taken the leading position in the theoretical development. Core competence is “a kind of accumulative knowledge that can coordinate different kinds of manufacturing skills and integrate organically various of technical genres” (Prahalad & Hamel, 2006). Teece, Pisano and Shuen propose a framework of dynamic capabilities by combining the enterprise model of evolutionary economics with the resource-based theory. The dynamic capability refers to an enterprise’s ability to integrate, build and reconstruct competences in response to the rapidly changing environment (D. J. Teece, Pisano, & Shuen, 2009).

Hamel and Prahalad have pointed out, the capability that determines enterprise’s competitive advantages is the organic combination of various resources, technologies and different skills instead of mere enterprise’s resources. Thus, in the process of exploring the source of enterprise’s competitive advantages, we have made a further step in the understanding. The root of enterprise’s competitive advantages has changed from concrete and objective resources to the ability of resource allocation, exploitation and protection (Yu, 2002).

Compared with enterprise absorptive capacity, dynamic capability focuses on the ability of enterprises to self-renew their strategies and organizational capabilities. It enables enterprises to accumulate technical knowledge in change and gain profits through innovation (D. Teece, 1994). In the process of innovation, dynamic capability helps enterprises to achieve the collaboration, evolution, matching and updating inside and among the enterprises and between enterprises and sources of institutional pressure, resources and conventional abilities, so as to maintain long-run competitive advantages.

2.6.2.4 The Comprehensive View of Enterprise Competence Theory

Enterprise is essentially a combination of the resources and capabilities it possesses, which are gradually formed and accumulated in the development of the enterprise. This accumulation process is not repeatable. Enterprise’s competence comes from its resources, which ultimately is enterprise’s knowledge. Compared with external conditions, the internal factors of the enterprise have more decisive effects on enterprise's competitive advantages. The accumulation of internal resources, capabilities and knowledge is the key factor for enterprise to obtain excess profits and maintain competitive advantages (Li, 2003).

The modern theory of enterprise competence is concerned about the knowledge hidden behind the competence, which is completely different from the contract theory. Business organization is regarded as the carrier of knowledge. In particular, a lot of knowledge can only be effectively used in enterprises, and it has business uniqueness. In other words, it is hard to cut out a fragment of an enterprise’s specific, implicit and social organizational knowledge and successfully apply it to another enterprise. An enterprise exists because this implicit, social and path-dependent knowledge can be effectively learnt, produced and commercially applied in the enterprise. And the ability to learn, produce and apply this knowledge is exactly the core of organizational competence (Yu, 2001).

Since an enterprise is the combination of knowledge, its knowledge stock determines its capability of innovation activities such as resource allocation, and ultimately reflects competitive advantages in the
enterprise output and market forces. Meanwhile, knowledge is difficult to be imitated, for it is acquired through path-dependent accumulation processes. Knowledge plays an important role in determining the future knowledge accumulation so that enterprise can have sustainable competitive advantages. And the enterprise cognitive learning ability determined by enterprise knowledge is the inexhaustible source for enterprise to exploit new competitive advantages. As Hayek points out, an enterprise, as a combination of knowledge, is a distributed knowledge system, which acquires knowledge through path-dependent accumulation processes and enables knowledge to function. New knowledge gradually blends into the formal and informal organizations of the enterprise, becoming an important influence factor in determining the future knowledge accumulation of the enterprise. The knowledge stock and cognitive structure of an enterprise further determine its ability to allocate, exploit and protect resources, ultimately reflecting its competitive advantages in the enterprise output and market forces. The knowledge-based theory of firm inherits and develops “the resource-based view of firm” and “the capability-based view of firm”, identifying the essential factor of enterprise’s competitive advantages as enterprise’s reified knowledge, which provides a workable concept for cultivating enterprise’s competitive advantages. To sum up, the knowledge-based theory of firm discovers the core element that determines the firm’s strength, and establishes the core concepts of its theoretical analysis. Therefore, it develops into two aspects (Yu, 2005).

Chen Litian et al consider enterprise core competence as the “collective learning in the organization.” The competition of core competence is not about products or the market, but the “future capability”, that is, the long-term competitive advantages (Chen et al., 2012; Xu et al., 2012, 2013). The following three key characteristics distinguish core competence from non-core competence:

1. Core competence can greatly increase enterprise’s use value for customers;
2. Core competence brings enterprise much better products and service than its rivals, making enterprise significantly different from rivals;
3. Core competence is the ladder to new markets.

2.6.3 Theories of Enterprise’s Innovation Capability

2.6.3.1 Theories of Technological Innovation Capability

Research on enterprise core competence is gradually combined with enterprise innovation theory, and the core competence includes the content of technological innovation capability. According to the research on core competence, technological innovation capability has gradually become the main competitive advantage of an enterprise. The research on technological innovation capability, which originates from the study of technological capability, considers technology as “all the activities related to the realization of the process from input to output.” However, technological capability and technology are two different concepts. Technological capability must include the following seven elements: (1) the ability to find reliable and selectable technologies and determine the most appropriate imported technology; (2) the transformative ability to convert the imported technology from input to output; (3) the ability to improve technologies in order to adapt to the local production conditions; (4) the ability to adapt the imported technology to the local production conditions; (5) the ability to make a progressive innovative development in the technology adoption; (6) the ability to achieve important innovation and breakthrough through institutional research on the basis of R&D; (7) the ability to develop basic research plans and further improve technologies (†, Bessant, & Phelps, 2006). These include several aspects of technological innovation, such as the innovation of the introduction of technology, innovation of technology adoption and radical innovation. And technological innovation capability is defined as “the ability of an organization to effectively absorb, master and improve existing technologies and create the skills and knowledge needed for new technologies.”

In addition, we can see from the definition and measure of innovation capability (IC) that most
research regard IC as technological innovation capability. These two concepts are not distinguished, and technological innovation capability is defined as “enterprise’s potential to create and innovate output.” The measures of IC include the number of patents, the number of innovations, the sales ratio of new products, and the ratio of innovation expenditure. Some research analyzes IC with innovation input capability, innovation operation capability and innovation output capability, and uses the number of new ideas adopted by the organization as an index for measuring organizational IC. Zhang Guoliang and Chen Hongmin have studied the definition, measurement and conceptual framework of IC, and argue to measure IC from four aspect: innovation quantity – output capacity, innovation effect – the ability of added value, innovation efficiency – the utilization ratio of resources (input-output ratio), and innovation speed – the speed of innovation adoption.

The above-mentioned measures of IC mainly analyze from the perspective of the input and output of innovation. With the development of relevant research, many scholars begin to study IC by dividing it into R&D capability, marketing capability and innovation management capability, gradually shifting their focus to the aspect of organizational management. Burgelman, R.T. Konsnik and M Van de Poel (1988) establish the examination framework of organizational IC, including five aspects: first, the availability and distribution of resources; second, the ability to understand competitors’ strategies and the innovations in the industry; third, the ability to understand the technological development in the industry; fourth, the business structure and culture that influences innovation; fifth, the strategic ability to deal with innovation activities (Burgelman, Konsnik, & Poel, 1988).

Benn Lawson and Danny Samson propose that innovation management can be viewed as a form of organizational capability. Excellent companies invest and nurture this capability, from which they execute effective innovation processes, leading to innovations in new products, service and processes. They also propose an IC construct with seven elements: vision and strategy, harnessing the competence base, organizational intelligence, creativity and idea management, organizational structures and systems, culture and climate, and management of technology (LAWSON & SAMSON, 2001, 2003).

Chen Haiqiu has proved by non-parametric statistical method that the technological innovation resources owned by the enterprise along with its management level jointly determine the technological innovation capability. In this case, technological innovation management includes organizational structure, innovation atmosphere and interface management (Chen, 2004).

In summary, with the development of research on core competence, dynamic capability and technological innovation capability, IC and innovation management capability have become the key content of these capabilities. Innovation theory and competence theory are gradually integrated, and enterprise’s technological innovation capability and IC gradually converge with enterprise’s core competence. Especially for high-tech enterprises, the core competitive advantage is exactly the IC of innovation activities and projects. And thus, the innovation management capability within IC has gradually become a very important research field.

2.6.3.2 Theories of Innovation Management Capability

With the increasing importance of innovation management activities in the innovation activities and the further development of research on enterprise’s technological innovation capability, much research has divided technological innovation capability into the ability related to technology system and the ability related to management system. Some have studied the constitution of technological innovation capability. They divide it into manufacturing capability, marketing capability and R&D capability according to organizational functions, but pay less attention to the ability of resource allocation in specific innovation activities, such as knowledge accumulation and factors of management process. Technological innovation capability focuses on the results and functions of innovation, while innovation management capability
focuses on the process of innovation. Innovation management is the process of the coordination, integration and allocation of innovation resources. Therefore, innovation management capability is the integration and allocation ability of innovation resources, which is a kind of regulation and behavior formed in the process of innovation management. Research on technological innovation capability and IC has begun to focus on innovation management. Research on enterprise’s innovation management capability has become crucial to IC. And research on IC has also begun to pay attention to the key activities in the process of innovation management († et al., 2006).

1. Tidd: Core Competence of Innovation Management

J. Tidd, J. Bessant and K. Pavit have studied innovation management and the core abilities in managing innovation from the perspective of integrating technical, market and organizational change (Tidd et al., 2004). They consider the key issues in the process of management innovation mainly include:

First, establish routines and timely break old ones. Establishing a set of new routines is closely related to the successful innovation management, and it can also create firm-specific competitiveness. The constant establishment of new routines is consistent with the research on the routines that need to be established in the firm’s dynamic core competence. The ability to manage innovation is a part of dynamic core competence (Tidd et al., 2004).

Second, manage innovation by an integrated management method. They consider it necessary to manage the whole process of innovation and cultivate integrated innovation management capability. They argue that in the context of innovation management there is a hierarchical relationship in developing capability. Basic skills are behaviors associated with things like planning and managing projects or understanding customer needs. These simple routines need to be integrated into broader abilities which taken together make up an organization’s capability in managing innovation. Table II-4 shows the content of the core abilities in managing innovation (Tidd et al., 2004).
### Table II-4: Core Abilities in Managing Innovation

<table>
<thead>
<tr>
<th>Basic ability</th>
<th>Contributing routines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recognizing</td>
<td>Searching the environment for technical and economic clues to trigger the process of change</td>
</tr>
<tr>
<td>Aligning</td>
<td>Ensuring a good fit between the overall business strategy and the proposed change – not innovating because it is fashionable or as a knee-jerk response to a competitor</td>
</tr>
<tr>
<td>Acquiring</td>
<td>Recognizing the limitations of the company’s own technology base and being able to connect to external sources of knowledge, information, equipment, etc. Transferring technology from various outside sources and connecting it to the relevant internal points in the organization</td>
</tr>
<tr>
<td>Generating</td>
<td>Having the ability to create some aspects of technology in-house – through R&amp;D, internal engineering groups, etc.</td>
</tr>
<tr>
<td>Choosing</td>
<td>Exploring and selecting the most suitable response to the environmental triggers which fit the strategy and the internal resource base/external technology network</td>
</tr>
<tr>
<td>Executing</td>
<td>Managing development projects for new products or processes from initial idea through to final launch. Monitoring and controlling such projects</td>
</tr>
<tr>
<td>Implementing</td>
<td>Managing the introduction of change – technical and otherwise – in the organization to ensure acceptance and effective use of innovation</td>
</tr>
<tr>
<td>Learning</td>
<td>Having the ability to evaluate and reflect upon the innovation process and identify lessons for improvement in the management routines</td>
</tr>
<tr>
<td>Developing the organization</td>
<td>Embedding effective routines in place – in structures, processes, underlying behaviors, etc.</td>
</tr>
</tbody>
</table>

Source:

In addition, they propose five questions to examine the innovation management capability of the organization. (1) Does the organization have an innovation strategy? (2) Has the organization established effective external linkages? (3) Does the organization have effective implementation mechanisms? (4) Does the organization have supportive organizational context? (5) Is it a learning organization related to innovation management? They also propose some assessment criteria for the process of innovation activities, including assessment on strategy, innovation output, quality and costs of operation and process, and customer satisfaction (Tidd et al., 2004).

Tidd et al have paid attention to the factors of the organizational level as well as the project level in their study of innovation management. However, although they have studied innovation management capability, they have not illustrated its constitution and dimension.
2. Mao Wuxing: Total Innovation Management Competence

Dr. Mao Wuxing from Zhejiang University has studied the total innovation management competence, and has established a framework for it. He considers the total innovation management competence consists of strategic management capability, technological innovation management capability, market demand management capability and basic management capability. He also studies the relationship between innovation management competence and enterprise performance (Mao, 2006).

Figure II-3: The conceptual model of the framework of firm’s total innovation management competence and the correlation of innovation performance

Source:
Mao Wuxing, *Total Innovation Management Competence of Firms: Case Study on China Electronic Information Industry*, Hangzhou: Zhejiang University, 2006

Mao’s research analyzes the relationship between the innovation management competence and enterprise performance in the electronic information industry by using the structural equation model. Basic management capability and strategic management capability have the greatest impact on enterprise innovation performance, followed by technological innovation management capability and market demand management capability. He also conducts a case study of Chinese enterprises on the construction process of total innovation management competence and analyzes the formation mechanism of total innovation management competence.

However, his research has not study the ability of project process management, which is part of innovation management competence. It lacks an in-depth study on the factors of innovation project management from perspective of innovation project. It also lacks an in-depth analysis of how to enhance total innovation management competence.

3. Dimensions of Innovation Management Capability

The research on the dimension of innovation management capability mainly includes research on the dimension of the IC related to innovation activities, research on the dimension of technological innovation capability, and measurement and auditing research on the variables of innovation management.
Yeung points out that IC is mainly reflected in the following aspects: response time, innovation cycle, willingness to conduct exploratory testing and whether enjoy the reputation as an industry innovator (Yeung et al., 1999).

Wheeler identifies four sequenced constructs of business innovation: choosing new IT, matching with economic opportunities, executing business innovation for growth, and assessing customer value. Correspondingly, there are four capabilities in the innovation activities, which are choosing capability, matching capability, execution capability and assessing capability (Wheeler, 2002).

Richard Adams et al construct an integrated framework for measurement of innovation management, including seven areas – inputs (people, physical and financial resources, tools), knowledge management (idea generation, knowledge repository, information flows), innovation strategy (strategic orientation, strategic leadership), organization and culture (culture, structure), portfolio management (risk/return balance, optimization tool use), project management (project efficiency, tools, communications, collaboration) and commercialization (market research, market testing, marketing and sales). They have also summarized and defined the measurement of each variable († et al., 2006). Their research provides a basis for the exploitation of the variable measurement of innovation management capability and the development of the empirical studies on innovation management capability.

Through the analysis of the relevant research, a summary of the research on innovation management and the measurement of innovation management capability is made as shown in Table II-5:

<table>
<thead>
<tr>
<th>Source</th>
<th>product innovation</th>
<th>process innovation</th>
<th>management innovation</th>
<th>technological innovation</th>
<th>market innovation</th>
<th>institutional innovation</th>
<th>business model innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lin Ruhai &amp; Peng Weixiang, 2009</td>
<td>√</td>
<td></td>
<td>√</td>
<td></td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xie Hongming et al., 2007</td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qin Peiheng et al., 2014</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rao Yangde, 2008</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Su Jinqin et al., 2013</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wei Jiang et al., 2008</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>Prajogo &amp; Ahmed, 2006</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crossan &amp; Apaydin, 2010</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>Damanpour, 1991</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Becheikh, Landry, &amp; Amara, 2006</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.6.3.3 Literature of Enterprise’s Innovation Capability

From an integrated perspective of innovation content and process, Chen Litian et al. base on theories of resource-based view, knowledge-based view, absorptive capacity view and dynamic capability view, defining IC as: a series of strategies, organizations, technologies and market routines that are required for enterprises to search, identify and acquire external knowledge, or to discover new combinations and application of existing knowledge in order to generate endogenous knowledge that can create market value (Chen et al., 2012).

The definition of IC contains two points: (1) The goal of IC is to enhance enterprise innovation performance and maintain sustainable competitive advantages; (2) The essence of IC is multi-dimensional process routine.

The forming process of the concept of IC draws the nutrient from the resource-based view, absorptive capacity view and dynamic capability view, but it is not the same as these theories. First, IC is different from resources. It constitutes the decisive factor of enterprise innovation performance along with enterprise’s resources (including internal and external resources). Resource is an explicit decisive factor of enterprise innovation performance while IC is a tacit decisive factor. IC makes constant improvement on the stock of existing resources and knowledge. In the process of transforming the resources into the innovation goal, new resource increment is generated, which lays the foundation for the accumulation of IC. Second, the dimension of IC is broader than absorptive capacity. Third, apart from dynamic capabilities, IC also includes conventional capabilities. Dynamic capabilities include perception, formation, seizing opportunities, and maintaining competitive advantages by re-allocating resources. Conventional capabilities include operation capabilities, such as technical capability and the ability to perceive market orientation and customers’ potential demands.

Now scholars’ research on IC is mainly concentrated on the following three aspects:

(1) “Innovativeness”. It emphasizes the novelty of innovation and innovation culture (Calantone, Cavusgil, & Zhao, 2002; Hurley, 1998). This kind of research studies IC from a one-dimensional perspective, neglecting the rich connotation of IC to some extent.

(2) Degree of innovation. For example, transformational and radical innovation, continuous and imitative innovation (Subramaniam & Youndt, 2005; Wu et al., 2007). This research mainly emphasizes the novelty and degree of innovation, but has limits in areas of innovation content and the enhancement of IC.

(3) Content of IC. It covers the areas of technology, marketing, product and process (R. J. Lin, Chen, & Chiu, 2010; Lyu & Su, 2009).

Obviously, at present the relatively scattered research on IC has diverse classifications and varied measuring methods, which is not conducive to a unified understanding of IC. It restricts the development of scientific and effective empirical studies in this field, and effective measurement on IC can hardly be conducted, thereby failing to effectively guide the practices of innovation management in the enterprise. There is no exception in the architectural design industry. Therefore, it is necessary to have a systematic study and discussion on IC around the situation of architectural design.

2.6.4 Summary

This section reviews the concept and theories of IC. After comparing different scholars’ definition and viewpoints of IC from different research perspectives, this research will measure IC from a multi-dimensional perspective combined with industrial characteristics. This section not only provides a theoretical basis for the research questions, but also provides the basic concept and theoretical background for the research methods and model selection. The research method of this research can draw lessons from the empirical studies on the IC in other industries.
2.7 Literature of CKM and IC about Chinese Architectural Design Enterprises: Research Gap Identification

2.7.1 Analysis of the Development Status of Foreign Architectural Design Enterprises

2.7.1.1 The Emergence and Evolution of Foreign Architectural Design Industry

During the Renaissance, on the one hand, the architectural scale was increasing and the process became more sophisticated, with the progress of science and technology and the development of productivity. Thus, “master builders” were required, who had not only rich design knowledge and superb skills, but also strong ability of organization and coordination. On the other hand, the newly-rising urban nobles, represented by the Medicis, and the wealthy merchant class turned capital into land and houses, and began to encourage new and luxurious architectural styles for political and economic needs. Hence, they looked for talented craftsmen who had received design training, had workshop experience and could express their wishes. However, constrained by their social status, craftsmen could hardly possess all those abilities. Therefore, architectural design gradually fell from craftsmen into the hands of those with cultural and artistic accomplishment, who were called “architects.” The emergence of architectural design profession distinguished architects from traditional builders, and developed architectural design discipline based on the art theory. Architects must receive specialized education. At the same time, as the first artists closed to the ruling class, architects gained middle-class social status that craftsmen could never get. In this superior condition, architects summarized the building experience of ancient craftsmen, and applied the scientific and technological achievements to the practices of architectural creation, enriching architectural types and styles.

The formation of architectural design discipline was marked by the emergence of industry associations. In 1834, the Builders Society was established in the UK, which distinguished architects from others in the architecture industry. In 1834, the Royal Institute of British Architects (RIBA) was founded. It obtained the qualification of Royal Society in 1837. In 1857, American Institute of Architects (AIA) was founded. Through industry associations, architects established their unique position and further refined the college education system. An architect was cultivated by going through the apprenticeship and granted diploma and university degree.

With the strengthening of the professionalism of architectural design, industry associations represented by RIBA clearly defined the professional status of the architects. That is, the industrial activities other than designing and monitoring were prohibited. In other words, architects were separated from the products they created – architectures, and they were only responsible for proprietors in designing and supervising the construction process. The clarity of the scope of the architects’ practice showed that the architectural design industry became more mature, making the architectural design market more standardized. Architects’ sole principal, in the form of firms, got rapid development. By the late 19th century, with the increasing monopoly of various industries and the expanding scale of production, the corresponding construction projects had also been developing towards the direction of large scale and high costs. In response, architects’ firms began to expand, gathering and organizing all the relevant professionals in the architecture industry. Among them, architects took the primary leading position.

The progress of science and technology propelled architectures toward a complex and diversified direction. Accordingly, architectural design also stepped onto a specialized road. Over the years, domestic and international architectural design industry had been continuing the “customer – architectural design enterprise – contractor” three-party model. Architectural design enterprise and contractor, known as Party B, respectively signed design and construction contracts with the customer, known as Party A. Since the 1980s, the reform of architectural design industry has developed into a new direction. The “customer – construction project manager” two-party model emerged. Architectural design enterprises have developed
from simple project designing into all the stages of the whole industry chain including project planning, construction and even operation. The expansion of the business scope of design enterprises leads to an increasingly urgent need of scientific management.

For architects, the project management model puts forward a new challenge beyond doubt. In the process of professionalization which began from the mid-nineteenth century, it seems that architects have only achieved the professional status in the formal level. The actual projects require architects to understand other professions and to play the role of “team leader” as well as “proprietor agent” in the construction process. However, the project management model brings an unprecedented challenge to the architects, for their traditional status is threatened by the professional architectural design project managers. Moreover, structural engineers, quantity surveyors and other professionals also begin to play a more important role inside the architecture industry. The scope of architects’ practice has shrunk again. The reform of architectural design industry begins to develop into a new direction.

2.7.1.2 The Characteristics of Foreign Architectural Design Enterprises

Generally speaking, the international architectural design enterprises represented by developed countries have the following characteristics (Yi, 2008):

1. Unique Market Positioning

Uniqueness is the market positioning of a design company, mainly manifesting as its strengths in designing certain types of architecture in the industry. For example, the characteristic business of the well-known SOM design firm is office and scientific research building; HOK is medical and sports architecture; Perkins & Will is school and R&D building. In the design bidding and entrustment of a certain type of project, the proprietor will first think of those firms that have formed their brand characteristics in this field.

The cultivation of uniqueness requires strategic vision. That means enterprises have to overcome fickleness, give up short term interest, analyze market trends with strategic thinking, and select business areas according to its technological resources and actual conditions. Different from domestic design companies that insist to “do everything,” some outstanding international design companies do what they specialize in. When there is no business, these companies would rather have a “rest” and take time to do some relevant basic studies and experience analysis than deviate from its best business. In the market operation, foreign design companies attach great importance to market research and make adequate technical preparation.

2. Professionalized Design Field

Professionalization means that an architectural design company integrates its technology and expertise in a certain field. Professionalization and uniqueness supplement each other. Many design companies start from uniqueness and finally succeed in its professionalization. Without professionalization, uniqueness can hardly achieve success. For instance, the design of large-scale sports building is not only about the form, but also about the operation. Therefore, the connotation of sports building design contains architectural form, structure, costs and beauty as well as some other professional factors that designers must take into consideration. The mechanism of foreign architectural design market is “professionalized division of labor and socialized collaboration.” When the design of architectural form is completed, professionalized companies will collaborate in finishing the structural system, air conditioning system, and intelligent system as well as the use and operation after the completion of the architecture.

3. Small-Scale Organizational Structure

In the highly market-oriented regions such as the United States, the mainstream group of architectural design market practice is numerous small-scale professional design institutions. Since architectural design consulting agencies are often hard to form their proprietary intellectual property and their competitiveness
is largely dependent on architects’ never-ending design innovation, which is hard to copy, the expansion of the scale and business areas does not have significant help to the improvement of enterprise’s competitiveness. Instead, it may be distracting, preventing enterprises from focusing on the enhancement of core design capability. Therefore, professionalized architectural design institutions tend to be small-scale. One by-product of small scale is a large number of independent design institutions, thus forming the pattern of completely free competition. However, the current situation shows that with the economic globalization and the world-wide integration of construction market, some powerful architectural design enterprises are expanding and have become a member of multinational corporations.

4. Native Business Market

There are still some controversies in the theoretical cycle about whether the architectural design industry has the characteristics of regionalism or nativeness. However, at present the number of foreign design institutions that are practicing in China is only about 5% of the total number of Chinese practice institutions. According to the 1997 US economic census data, the number of the organizations involved in overseas business in the US architectural design industry only accounts for 5.1%, and the gross output of overseas business accounts for 5.7% of that of the whole industry (Yi, 2008). This reflects that architectural design is a native industry. For a country’s domestic market, native designers obviously have more advantages than foreign designers in the understanding of the national conditions, traditional culture, geographical meteorology, environment, and conditions of technology implementation, especially in considering all the stages of architectural design consulting service, including architectural programming, plan design, preliminary design, construction drawing design and follow-up service design. Except for plan design, native designers have more advantages in other stages. For example, as for the factor of costs, native design enterprises can save the expensive travel expenses. Moreover, cultural background and cultural differences also make it difficult for foreign designers to grasp local thinking habits.

5. Flexible Practice Structure

Market changes, policy changes, individuality and mobility of freelancers, and a variety of requirements from proprietors together determine that design institutions must be flexible enough. For the response to the market, small design companies have advantages of quick response and flexible business adaptations. Since architecture industry is cyclical, design companies need to maintain a high degree of flexibility when take actions. Architects are freelancers. Design teams in many cases are formed by projects. Designers can form a team to cooperate with each other when they are needed by the market or the project. When a project is over, designers return to the state of freelancers. One advantage of this practice structure is that it can reduce the survival difficulties caused by the surplus of “fixed employees” in the declining market. The 1997 US Economic Yearbook statistics showed that about 19% enterprises in the US architectural design industry were closed, not doing business. But it is interesting that although these 19% enterprises were not actually doing business, they still contributed about 2% output value to the whole industry as a result of the successful asset management. The income of asset management helped these enterprises survive the difficult time without business. Other data showed that the average employment during the period of closure was 1.2, indicating that most enterprises dismissed their employees when stop doing business (Zhang, 2003).

2.7.1.3 The Operation Model of Foreign Architectural Design Industry

According to the system of diversified property rights, foreign architectural design enterprises can be divided into individual architectural design firms, partnership architectural design firms, architectural design companies, and subordinate architectural design institutions of government departments and real estate companies. From the perspective of diversified market demand and professionalized social division of labor, foreign architectural design institutions can also be divided into special service, multiple service
and integrated service according to operation model (Li, 2004).

1. Special Service Institution

The so-called special service institution is the organization that provides only one or just a few services in the operation of architectural design projects, which is the product of the development of professionalized division of labor in architectural design. For example, companies or firms that are engaged in architectural design (narrow sense), interior design, landscape design, engineering design, equipment design and rendering (model) production provide services merely limited to the “basic service” range of architectural design. These types of institutions are in large numbers. They are very unstable at the bottom of the pyramid. With the economic fluctuation, they have a high elimination rate. Only a very small number can pass the market test and grow up. This is the initial state of architectural design institution, which can be further classified into the following four types: (1) the service institutions that provide designs for particular architectural professions. These institutions limit their scope of business to a specific field and provide service of particular architectural designs, such as interior design companies, engineering design companies, structural design companies and equipment design companies. (2) the service institutions that provide designs for particular architectural types. These institutions generally provide design service for those have special requirements and contain high technology, such as medical buildings, sports buildings, air-raid shelters and industrial architectures. (3) the institutions that provide personalized architectural design service. These institutions target at those customers who seek individuality. These customers need architects to provide comprehensive and attentive service as well as unique and artistic final architectural products. To provide particular products for particular customers is the best explanation for this type of design institutions. (4) the institutions that provide narrow-sense architectural design service. These institutions mainly provide the basic service of architectural design. Large and medium size design companies are also engaged in interior design, urban design and regional planning, whose members are mainly architects. This type of architectural design institutions has the largest number. Companies of this type are mainly committed to innovating design philosophy and skills and studying different architectural types and construction methods, which is beneficial to the improvement of design professional standards.

2. Multiple Service Institutions

Multiple service institutions provide a variety of design services in the operation of architectural design projects. They position at the large and medium-sized projects as their target market, and their characteristic is to provide customers with comprehensive, stable, reliable, efficient, long-term and high-quality service. Different from special service institutions, they do not focus on the innovation and uniqueness of design, but on how to provide products and service that satisfy customers with the lowest costs. This kind of institutions is generally of large scale. In terms of staff composition, multiple service institutions employ not only architects, but also development programming designers, negotiators, planners, economists, structural and equipment engineers, and the architects engaged in professional research. This makes the professionalized collaboration system inside the institution well developed. Inside the institutions, the production is organized according to the working procedures and different types of work. The project manager takes the whole situation into account and plan accordingly. Division of labor is clear and specific. Different from the general view, these institutions also rely on the collaboration with external professional companies. Many well-known large-scale design companies belong to this type, such as Nikken Sekkei, NBBJ, RTKL and HOK, and most have developed into giant multinational companies. The organizational form of their subsidiary companies is quite complex. Each has its own characteristics. The most common situation is the decentralized management of subsidiary companies. The head office establishes a complete management system, by which subsidiary companies collaborate and contact with each other, forming an organized combo. Subsidiary companies share their achievements but conduct economic accounting independently.
3. Integrated Service Institutions

Integrated service institution is a relatively new type of architectural design institution, whose scope of services covers almost all aspects of engineering construction procedures. According to the different operation models of architectural design projects in the developed countries, this kind of institution can be further divided into the following three types:

(1) Design Consulting Institutions

The service provided by design consulting institutions mainly covers all the technical information fields in the engineering construction process, such as the preliminary research of architectural design, information collection and analysis, architectural inner space planning and design, equipment planning, information communication planning, furniture configuration, building assessment, etc. Of course, architectural design is also included. In addition to drawings, products also include copy write, forms, research reports and even related books. Their function in the market is to ensure that design practices are based on customers' interests and constantly explore new ideas and procedures. In other words, they do not focus on the development of innovative structures and design skills, but try to establish organic connections between customer needs and design goals.

(2) Project Management Institutions

This is entirely different from traditional engineering construction program – project management dominates. This kind of institutions have unmatched advantage in ensuring that customers can quickly and efficiently access to quality and cheap architectures. In fact, project management institution is not the simple sense of architectural design institution. In addition to architects, its professionals also include assessors, project engineers and structural engineers, who constitute the larger proportion and play a more important role than architects. This operation model provides customers with a detailed description of the architecture, a budget and the schedule, and ensures accurate implementation. The working process of this kind of institutions is roughly like this: In the conceptual stage, the institution draws up the space plan (providing the scheme and effect picture) and the unilateral cost, and discusses with the proprietor until the total price is determined. Then the institution hires a design team, including architects and other relevant professionals, to work out the design outline and sketch plan (including detailed task specification and bill of quantities) and prepare the package subcontracts. Next, the institution begins bidding work. The design work of the follow-up stages is also on the bid list. The institution has the final say. At last, it chooses multiple contractors. Companies that win the bid will complete the remaining work including design development, construction documents, construction management, and the work in the latter stages. Project management institutions are responsible for checking the quality, progress and budget control, and ensuring that proprietors can get the products that conform with the contract within the set time.

(3) Design-build Institutions

Design-build institutions are generally large integrated companies, the so-called “design-build” associates. These companies, which are well-funded and have strong technical force, include design firms, construction enterprises, prefabrication factories, and research institutes, and provide services of the planning, development and consulting of new projects. The technical staff of a giant company is more than 10,000 people, and a large company has over several thousands. These are “knowledge-intensive enterprises.” This kind of architectural design institution caters to the rise of BOT (Build – Operate – Transfer), liberating architecture industry from the small circle of construction and turning it to the role of main contractor which undertakes engineering management, design and technical equipment supply. It organizes and arranges the whole project, including the whole process of the earlier and later stages of the architectural design project. The profits not only comes from labor and construction, but also include the feasibility study, planning and design, consulting, material supply and the operation after completion, which makes contractors change the operation model of waiting for bid and take the initiative to provide
advance service for government, proprietors and financial groups.

2.7.1.4 The Development Trend of Foreign Architectural Design Industry

1. Widely-used Information Technology

Information technology drives the progress of architectural technology, which is mainly reflected in improving the design efficiency and generating new technical means. The informatization process of architectural design enterprises gives birth to a series of new technologies, which in turn has greatly promoted the development of enterprise informatization. These two complement and promote each other. At present, the information technology which is being applied and paid close attention to in the field of architectural design mainly involves 3D CAD technology, collaborative design technology, constructional engineering design database, virtual simulation technology and network technology.

The emergence of the Internet has also provided new support for the development of foreign architectural design enterprises, which is mainly reflected in two aspects: One is that the Internet has become the information source of market research and the background research of specific programs. When a design institution is ready for the bidding work of a certain design project, it can conveniently acquire the relevant information of the target customers through the network, which is an important supplement to the traditional approach. The other is that the Internet has become an important channel for architectural design enterprises to publish information, provide service and promote themselves toward the outside world. The most typical way is to build their own website. Generally, websites of European and American architectural design institutions can be roughly divided into the following parts: (1) general situation of the design institution, including its development history, design concept and staff composition; (2) news events of the design institution; (3) brief introduction of the architectural design projects completed by the design institution; (4) award-winning projects of the design institution; (5) market profile of the design institution, that is, the acceptable project types; (6) contact information of the design institution; and (7) employment information of the design institution. The network also provides customers with search service for architectural design institutions, enabling proprietors to get aware of all the design institutions that meet requirements in the shortest time. They can have an in-depth understanding through the network and then make the choice.

2. Expanding Size of Organizations


World Architecture has studied this trend based on the world’s top 300 architectural design institutions in 2003. By comparing the size and composition of the top 300 architectural design institutions in 1998 and 2003, it discovers that in 1998 firms with fewer than 200 employees accounted for 65%, but in 2003 they reduced to nearly 50%. In 1998, none of the institutions had more than 800 architects, but in 2003, 6% of the design institutions had more than 800 people (Zhang, 2004).

3. Developing Towards Internationalized Multinational Organization

The economic globalization and the support of emerging technologies enable the architectural design institutions in the developed countries of Europe and America to make use of their advantages in technology, management, capital and talents to expand towards the developing countries and economic hotspots. Take America’s HOK as an example. Its branches cover around the world, including the Europe, Latin America, the Pacific Rim and the Middle East. In 2003, it had 1600 employees, including 845 architectural designers, most of whom were local design talents. The company’s general income in 2003
was USD 215 million, of which USD 156 million was from North America, USD 24.77 from Western Europe, and USD 5 million from others (Zhang, 2004). HOK’s branches in London, Berlin and Amsterdam have formed strategic alliances with Altipla in Brussels, Novotny Mahner Assozierte in Frankfurt, Arte Charpentier et associés in Paris, Progetto CMR in Milan and Rome, and Studio Quadra in Warsaw, forming a powerful multinational design group. Others, such as America’s Perkins & Will, RTKL, NBBJ and SOM, Australia’s HBO+EMTB and Cox Group, and Britain’s Aedas and BDP, have also become large multinational design institutions and are still developing.

2.7.2 The Development Overview of Chinese Architectural Design Enterprises

2.7.2.1 The Emergence and Initial Development of Chinese Architectural Design Industry

After the Opium War, China was forced to open its door to western powers. The arrival of western architectural designers and land agents not only brought some advanced technologies, but also brought a new operation model of architecture industry, which stimulated the development of Chinese architecture industry.

The increase of foreign capital and the rapid development of national industry caused the market demand to change and had higher requirements on architectural design. At that time, China had no architect team of its own. Hence, foreign architects and civil engineers monopolized domestic architectural design market and opened a number of large firms, such as Atkinson & Dallas, Stewardson & Spence, Becker & Baeedecker, Hazzard, Leonard & Veysseyre, and Palmer & Turner. The development of architectural design industry led to the development of trade associations. In 1901, “China Engineering Association” set up in Shanghai, absorbing almost all the foreign engineers and architects in Shanghai. In 1910, this association recruited the first Chinese engineers. In 1917, Chinese students in the United States founded “Engineer Institute of Chinese Nation.” After the first batch of engineers returned to China in 1992, they moved the headquarters to Shanghai. In 1923, they set up “Chinese Institute of Engineers” along with the Chinese members of China Engineering Association. Over the next several years, architects continued to join this institute.

The period from the 1920s to the late 1930s witnessed the boom of Chinese architectural industry. The first generation of architects in China, represented by Lyu Yanzhi, Yang Tingbao, Liu Dunzhen, Tong and Chen Zhi, stepped onto the stage of history. Many of them showed their talents while they were studying abroad.

The rising prosperity of the architecture industry in China also contributed to the development of building societies, architectural journals and architectural education. In the winter of 1927, Zhuang Jun and Fan Weizhao gathered the Chinese architects in Shanghai and established the Architectural Society of Shanghai China. The name was changed to the Architectural Society of China the following year. By 1931, it had 39 members, which developed to 55 by 1933. In 1932, it stated the academic publication Chinese Architecture. In 1931, the Architectural Association of Shanghai was established and it launched Architecture Monthly in 1932. Moreover, many talented and responsible architects also devoted themselves to architectural education, which laid the foundation for Chinese architectural education. For example, in 1923, architects Liu Shiying and Liu Dunzhen came back from Japan, and set up the architecture discipline in Suzhou Industrial College. Later in 1927, it was incorporated into National Fourth Zhongshan University and the Architecture Department was established. In 1928, Liang Sicheng and Lin Huiyin set up the Architecture Department in the Institute of Engineering of Northeastern University. In 1934, Zhuang Jun et al set up the Architecture Department in University of Shanghai. At that time, most teachers also worked in firms, which also formed the educational pattern combining teaching and practices and cultivated a large number of talents for the country.
2.7.2.2 The Exploration and New Development of Chinese Architectural Design Enterprises

After the founding of the People’s Republic of China, the Ministry of Construction for PRC was established in August 1952. State-run architectural companies and architectural design institutions were founded successively in Beijing, Shanghai, Tianjin, Nanjing, Wuhan and Chongqing. At that time, the national registration was fewer than 200 people. In 1955, China completed the socialist transformation of all the private architectural firms. In 1951, Liang Sicheng and other celebrities in the architecture circle initiated the preparation of the Architectural Society of China, which was formally established in October 1955. It joined the International Union of Architects in July 1955 and joined the Architects Regional Council Asia in October 1989. During the ten chaotic years (from 1966 to 1976), it was forced to suspend all the activities. It partially resumed in 1972 and fully recovered in 1977.

1953-1957 is the period of China’s first Five Year Plan. The scale of construction was unprecedented in Chinese history. At that time, a large number of Soviet experts came to China. China carried out a campaign to learn architecture from Soviet experience. The production and management system of China’s current architectural design institutions exactly originated from this period. The firm model was abolished, replaced by architectural design institute and architectural design firm. To meet the demands of large-scale industrial construction, the design institutes affiliated with the Ministry of Construction were changed to industrial architectural design institutes. Architectural design completed the transformation to the industrial system. Chinese design institutes (firms) have three levels, that is, subordinate design institute, design institutes of provinces, autonomous regions and municipalities, and regional and county design firms. The size ranges from thousands to dozens of people. The scope of business is generally civil or industrial architectural design, and some institutes are also engaged in design consulting, feasibility study, exploration survey and design technical examination. Institutes with different scales many have a similar production and management system. This model continues to this day without any fundamental changes.

After the Third Plenary Session of the Eleventh Central Committee of the Communist Party of China in December 1978, China entered a new period of building a socialist modernized country. In the ensuing early 1980s, institutes began to explore new design systems. On the basis of the implementation of design fees, design institutes carried out enterprise management and economic contract responsibility system, developing from public institutions toward enterprises and socialization. C-level design units appeared in large numbers. Administration, reorganization and merger were carried out in order to maintain the order of the architecture market. A-level and B-level architectural design institutions in Beijing were more than 140, and the competition was fierce. A small number of different types of architectural design institutions appeared. In the late 1980s, the embryonic form of architectural design firm emerged, such as Solution Design Development and Zhongjing, led by famous architects. But they were not essentially difference from state-run architectural design institutes in the production and management system.

In 1992, Deng Xiaoping’s talk given during the inspection tour in the south started the construction of Chinese socialist market economic system. In the market economy, consumers had the right to make independent choices of consumer goods in the market. Hence, different consumer demands on consumer goods were generated. For architectural design – an artistic special commodity, differences in consumer demands brought by personal factors were even more obvious, which resulted in a variety of architectural design market demands. At the same time, this diversification of architectural design market demands also determined that architectural design institutions would develop towards diversification. In 1993, the Ministry of Construction printed and distributed Trail Measures for Private Design Firms. After the further revision and improvement of the trail measures in 1995, private design firms approved by the Ministry of Construction reached 16 throughout the country. Meanwhile, there appeared a number of special service companies in China, such as the companies that specially undertook tasks of interior design, perspective rendering and model making. National laws and regulations had no special limitation on this kind of
companies, so long as they complied with Company Law and Commercial Law. Therefore, this kind of companies followed market demand and grew up rapidly. However, the establishment of architectural design companies or firms was faced with strict limits, especially the qualification level system, which largely limited the development of architectural design institutions.

On November 11, 2001, China became a member of the World Trade Organization (WTO), which brought another major change of design market and talent management to Chinese design industry. Engineering survey and design consultation belongs to the field of trade in services, while trade in services is included in the General Agreement on Multilateral Trade. All the member states must accept the General Agreement on Trade in Services (GATS). The GATS of the WTO established four modes of international trade in services, which are related to architectural design activities except consumption abroad. Cross-border supply: the supply of a service from the territory of one Member into the territory of any other Member (referring to providing project design at present stage); Consumption abroad: the supply of a service in the territory of one Member to the service consumer of any other Member (for example, traveling abroad). Generally this does not exist in the architectural design industry; Commercial presence: the supply of a service by a service supplier of one Member, through commercial presence in the territory of any other Member, such as establishing partnership, cooperative institution, affiliated agencies or branches; Presence of natural persons: the supply of a service by a service supplier of one Member, through presence of natural persons of a Member in the territory of any other Member. For example, architects, engineers or consulting engineers provide services through cooperative design in another country. Chinese government made a “commitment and concession table” related to architectural design consultation in the negotiations of accession to the WTO. According to the basic principles of “market access, national treatment and transparency,” foreign architectural firms would flood into China after China’s accession to the WTO. With advanced technology and management and superb financing capability, foreign architectural firms would impact on domestic engineering consultation and design market, competing for Chinese talents. In order to survive and develop in such a more intense market competition, Chinese architectural design institutions began a new round of institutional reform.

1. Merger and reorganization of large state-run architectural design institutions

In March 1998, East China Architectural Design & Research Institute and Shanghai Institute of Architectural Design & Research jointly set up Shanghai Xian Dai Architectural Design (Group) Co., Ltd., marking that large architectural design institutes made the first step in changing from public institutions to enterprises. At that time, there was no other large architectural design companies in China like Shanghai Xian Dai Architectural Design Group, so there was no mature experience it could learn from. In that case, it investigated and studied the market, management system, property rights structure, production models, technology management and technical equipment of some world-famous design companies as a reference for system reform.

On April 6, 2000, China Architecture Design & Research Group (CAG) was formally established. It was formed by the former Architectural Design Institute of Ministry of Construction and China Academy of Building Technology, with North China Municipal Engineering Design & Research Institute and China Urban Construction Design & Research Institute as subordinate units. In July 2001, it completed the industrial and commercial registration. On October 18, 2001, it formally opened, becoming one of the largest state-run scientific and technological design enterprises in China. On July 18, 2003, CAG made some “adjustments” on the business structure of its headquarter, canceling the original nine integrated design firms and all the operating, production and scientific research departments, restructuring China National Engineering Research Center For Human Settlements and establishing “five institutes, one center and three studios.” Among them, one was “Architectural Design Project Management Center”, mainly contracting design projects and coordinating design progress. The idea of these adjustments was to change
the original vertical parallel structure to a horizontal parallel structure, and comprehensiveness to professionalization, by forming a complete design industry chain of consultation, planning, construction, interior, landscape, electrical intelligence and real estate. And the management and coordination of the adjusted projects was arranged by the management center. The three expert studios were self-financed production and scientific research units.

In theory, these adjustments were line with the development trend of the international architectural design companies. But the market was accustomed to the old model which had practiced for 50 years, so it would take some time to accept the new approach. The reform of Shanghai Xian Dai Architectural Design Group and CAG can be viewed as exercises of connecting to internal thinking. Certainly, only after the exercises will the operability and effectiveness of “operation plan” be verified.

2. Privatization of small and medium architectural design institutions

After China’s accession to the WTO, domestic economic structure began to change. State-run enterprises, private enterprises and listed companies became the three major forms. Small and medium architectural design institutions could not become listed companies due to their own characteristics, and there was no need to become state-run enterprises. So the best way was one step into the ranks of private enterprises. The restructuring methods were different in the small and medium architectural design institutions across the country, mainly as follows: (1) According to the local preferential policies in the institutional reform of survey and design units, the institution can be restructured to a pure private enterprise or a diversified modern enterprise, if employees invest to buy state-owned net assets. (2) The survey and design units with great asset inventory and poor employee purchasing ability can solve the fund problem through credit loan by introducing financial institutions. (3) The third party directly buys state-owned net assets, agreed by all the employees of the survey and design unit. On the premise of the relative stability of major technical capabilities, the overall sales plan is determined after the assessment of state-owned assets. Approved by the competent department, the institution looks for a one-time buyout.

For the enterprises that have finished reorganization, there are several models of stock distribution: whole employee stock ownership, distributed stocks; whole employee stock ownership, concentrated stocks; major operator stock ownership; employee and major customers stock ownership; the pluralistic structure of state-owned capital, enterprise entity capital and natural person capital; changed to solely state-owned enterprise, personnel and assets remaining unchanged. There are both advantages and disadvantages in the above models, which need constant exploration in the practice.

3. Lifting the restrictions on private architectural design firms

With the development of China’s market economy, small and medium-sized, small-sized, and mini companies, enterprises and individual business workshops spring up. In the field of architecture, correspondingly, there are numbers of small-scale and ultra-small-scale projects. However, due to the constraints of operating costs, large design institutes rarely undertake small and medium-sized design projects, let alone small-scale and ultra-small-scale design projects. Similarly, medium-sized design institutes are committed to large and medium design projects. Small design institutes are also required to be equipped with all types of workers due to qualification standards. Hence, the tasks that can be completed by only two or three designers cannot be included in the work plan of the design institutes. Therefore, since the traditional comprehensive design institutes with qualification levels have no significant differences in design fee rate and they are all subjected to the scale constraints, almost all the design institutes are competing for large and medium-sized design projects. But in developed countries, many design masters bounded into fame on small works.

Out of the above consideration, China accelerated the pace of private architectural firm reform. In January 1993, the Ministry of Construction issued the Trail Measures for Private Design Firms. In 1994, 16 private architectural firms were approved in China. On December 13, 2000, the Ministry of
Construction issued the *Management Measures for Architectural Engineering Firms*. From October 12, 2001 when the Ministry of Construction approved the first batch of construction projects of design firms to February 27, 2003 when the third batch list was announced, the number of architectural engineering design firms approved by the Ministry of Construction reached 79, accounting for 1.1% of the total number of architectural design enterprises. The Ministry of Construction planned to develop 150 to 200 private architectural engineering design firms throughout the country in 2004.

At present, Chinese private architectural firms are established mainly through the following three ways:

First, in December 2000, the Ministry of Construction issued the *Management Measures for Architectural Engineering Design Firms*, which explicitly approved the establishment of comprehensive design firms and professional design firms (architectural design firms, structural design firms and mechanical and electrical design firms) and set limits for the number.

Second, separated from large or medium-sized design institute/company/firm. Supported by national policy, some “design departments” separate from their parent companies and develop their own brands on the premise of the development of relevant professional companies.

Third, developed from small and medium-sized design institute. After the reform and opening up, small and medium-sized design institutes were faced with the cruelty of market competitions earlier than large design institutes, which forced them to deepen reform. Meanwhile, they have relatively lighter historical burden and less thinking confinement. Under the circumstances of increasing professional firms, they are likely to ease the burden and reduce the scale, divided into several small professional companies. In turn, this also increases the number of professional firms.

The kind of design institution approved to set up in China is only one operation model of the design institutions in developed countries, that is, “partnership.” Certainly, this model should be encouraged, but it is by no means the only direction of development. Only a variety of models can meet the different needs of the market.

### 2.7.2.3 Gap between Chinese and Foreign Architectural Design Enterprises

#### 1. Business and Organization

After China joined WTO, foreign architectural design firms have entered Chinese market, whose focus was on some large public construction projects. Directly affected are large and medium-sized state-run design units. The inherent factors of foreign-funded architectural design enterprises, such as design philosophy, design techniques and methods, and abundant capital, have a strong impact on the Chinese architectural design market. For example, B+H, Lee Timchula Architects and Australia Peddle Thorp Architects Group have obvious advantages in designing public buildings and villas for they have advanced operational and management mechanism and design idea, strong technical capabilities, and experience in large-scale projects. The most critical factor of success is their economic and efficient competition patterns formed in the mature market competition mechanism. Whether divided by business type or organizational form, foreign construction projects are driven by architectural design firms, which play an important role in terms of design-build, PM or CM, starting from the project commission, and they can have good communications with proprietors through social intermediary service organizations (such as general contractor, PM and CM).

According to the current situation of Chinese architectural design market, there is a lack of intermediary institutions similar to those from overseas architectural design markets. Besides, Chinese architectural design enterprises have no proper market position. They are directly responsible for proprietors and have little freedom in creation. These are the consequences caused by the imperfect market
mechanism. Abnormal market phenomena exist that proprietors compress design cycle and reduce design fees.

2. Business Scope and Characteristics

The operating characteristics of foreign design institutions are highly professionalization and attention to design features. According to the regulations and international routines of the WTO, the work of an architect is defined as construction service, which is the service of the whole construction process needed by the client, including consulting, pre-design service, architectural design service and project contract management service. It emphasizes technical advice, design, management and service, and it has a broad sense of concept and a wide range of business scope. In the practice of foreign architects, proprietors usually require architects to take overall responsibility of the whole project design and consulting work, and then to form a design consulting consortium with structural, mechanical and electrical, and other corresponding professional design firms. Architects are responsible for the project design and construction process. Architects are responsible to the proprietor while the subcontractor is responsible to the architects, which takes the advantage of the division of labor on the basis of specialization in the architectural design process. Small design firms attach great importance to professionalization. They achieve constant breakthroughs and innovations in their professional skills with the intent of establishing their own comparative advantages which is beneficial for market competitions. This forms the competition model of the overall contract and professional subcontract of the design project. At the same time, the fierce competition of the foreign design market and the inherent operating risks of different forms, such as joint-stock companies and privatization, force architectural design companies and firms to pay much attention to the technological innovation and breakthroughs of architectural design so as to form their own characteristics.

The work of architectural design in China is mainly defined as the completion of architectural design and planning work, which emphasizes technical design and completing production tasks instead of providing engineering consulting service of the whole process for the proprietor. Due to the factors in aspects such as traditional management system and market competition, the design feature is not as outstanding as that of foreign famous enterprises.

3. Design Techniques and Methods

There are many reasons for the backwardness of technology in Chinese architectural design enterprises, mainly in two aspects:

One is that the differences in organizational structures of architectural design enterprises make foreign design enterprises focus more on technology. Design companies that are integrated with design, scientific research and construction are able to take full advantage of their own research departments. Comprehensive and professional architectural design firms make full use of the convenience offered by the mature market economic system, clearly define their business division of labor, and focus their superior resources on their own design, so as to innovate new techniques and methods. Compared with domestic architectural design enterprises, overseas design enterprises have very obvious advantage in their technologies, especially in some high-standard and high-tech design projects.

The other is that the perfection of market economy shifts the focus of foreign architectural design firms to the innovation of design idea. The famous architects and architectural design firms in western developed countries continually pursue the high technology and high quality of architectural design, which is satisfied by abundant time and high design fees so that in the architectural design they can devote more
businesses and enthusiasm to studying the utilization of architectural culture, functional environment, new technologies and new products in the construction. By contrast, the architectural design market in China is still in the initial stage. The market order is far from stable, and competition situation is in chaos. Faced with the harsh competition environment of low design fees and short design cycles, Chinese architectural design units have no option but to give priority to profits, the basic level of business survival. Their concern and research are limited on issues of architectural culture, design philosophy and new technologies and methods. As a result, once a lucrative and high-tech design project appears in the market, domestic architectural design enterprises are at a disadvantage compared with foreign design enterprises.

4. Income Level

The reasons for the low income level certainly include the difficulties in getting rid of the years of influence of the economic system and slow enterprise transformation. The design fee system also matters. A perfect market mechanism sets a clear standard for the design fees, which is beneficial to the healthy development of design enterprises. Compared with foreign design enterprises, Chinese architectural design units are undergoing hardship under the conditions of low design fees, short design time and other harsh market environment. Therefore, there exist an obvious gap between domestic and foreign designers in the design accuracy and the grasp of building function. The perfection of market mechanism has resulted in a set of complete design fee system established by overseas design firms, forming a stable industrial standard. By contrast, the market economy has just started in China and the market mechanism is far from perfect. There is still a long way to go before the current design fee system reaches marketization. The design fees are suppressed by owners’ units, which impedes the long-term development of Chinese architectural design enterprises.

5. Brand Image

Design brand and features can bring an enterprise more business projects and economic benefits. For example, RTKL focuses on the architectural design of shopping malls, which designed Beijing apm and the famous Los Angeles business center. KPF and SOM are characterized by high-rise buildings. KPF participated in the design of Shanghai Financial Center whose height is over 460 meters. Pakings & Wills has expertise in educational building design. These have formed their brand features.

Some domestic proprietors choose a foreign design company only based on its reputation, even though they know little about it, including its size and type (professional or integrated), because proprietors have a psychological expectation that even if it is a professional architectural design firm, it should have the ability to organize outstanding structural engineers and equipment engineers to fulfill the task in view of the mature foreign market mechanism. Domestic architectural design market has no such mechanism. Most architectural design enterprises in China, large or small, are integrated type, whose division of labor is not specialized enough. This results in overbroad profession but failing of expertise, which is not avail to building brand image.

2.7.3 Literature of CKM and IC in Chinese Architectural Design Industry

Before the reform and opening up, there were few research literature on Chinese architectural design enterprises, only a few each year and even interrupted during the Cultural Revolution. The research during the 30 years of reform and opening up can be roughly divided into three stages. The first 10 years belong to the initial stage of research, during which the research literature was less than 100 each year. The second 10 years added up to over 100 each year. The last 10 years entered into the active period of research, when relevant literature increased to over 1000 each year. Explosive growth began in 2014, and recently nearly
3000 papers are published each year. However, most of the literature is still confined to the research on the professional skills and traditional management of architectural design, while studies on the innovation management of architectural design enterprises remains few. In recent years, there is a growing recognition of the importance of enterprise innovation management among the managers of Chinese architectural design enterprises. Design management innovation has become a hot word in the domestic design research, but its research object remains unclear and the studies are relatively superficial. The significance of design management innovation to Chinese design discipline has always been marginalized and the disciplinary boundaries are ambiguous (Xiong, 2015).

Domestic research literature on the management of architectural design enterprises can be divided into three types. The first type is traditional management literature, including the management of human resources, salary, budget, qualification, finance, quality, contract, etc. The second type is strategic management, including organizational structure, values, market competition, value chain analysis, brand building, sustainable development, architectural industrialization, etc. The third type is innovation management, including enterprise innovation, customer management, technical capability assessment, KM, etc. More and more research literature is concerned with studies on CKM and IC, but most of the literature remains in the conceptual research stage, which has not formed a mature system and lacks an in-depth study.

2.7.3.1 Literature of CKM in Chinese Architectural Design Enterprises

CKM theory is the combination and extension KM theory and CRM theory. Domestic research on KM in architectural design enterprises mainly focuses on personnel management and project management. From the aspect of personnel management, the architectural design enterprise is typical knowledge-intensive enterprise, whose core must be people. Yang Guohua et al propose three difficult problems in managing knowledge and staff for design enterprises, which are management of people, quantization of things and management of knowledge. To solve these three problems, Yang Guohua et al argue that customer knowledge culture that emphasizes customers should be established at first. It is very important to enable employees to actively cooperate with CKM process rather than passively execute the systems. Next is to establish a CKM reward system with regular commendation and reward, which is different from incentive piecework system. Then, emphasis should be laid on building the knowledge base and the trust relationship between customers and employees in order to make tacit knowledge explicit (Yang & Xie, 2011). Zhang Yong from China Architecture Design Group compares the management of Chinese and foreign architectural design enterprises, and concludes that foreign design enterprises maintain a more consistent design style and undertake design tasks with unified service while the domestic design enterprises tend to be more random since the quality of customer service depends more on the personal ability and willingness of the project leader (Zhang, 2003). From the perspective of project management, Hu Zishi considers that project management is the process in which the design unit collect, integrate, share, use and create CK. It is the process of knowledge movement, during which knowledge has been extended, applied and innovated (Hu, 2014). He also divides the project management process of architectural design enterprises into the following six stages:

(1) Project planning: It is the most important stage of communicating with customers and collecting CK. However, many design units often neglect or attach little importance to this stage, or consider that this stage should be completed by the project planning company or customers themselves. Enterprises that implement CKM will consciously strengthen the work of this stage to provide adequate design basis for the follow-up stages and to enhance project management efficiency. This stage is one of the key points in establishing differentiated competitive advantages of design enterprises.

(2) Plan design: It is one of the traditional design stages, whose emphases are the originality, economy
and applicability of the design plan.

(3) Preliminary design: It is one of the traditional design stages, whose emphasis is to control the feasibility of final professional plans and to control equipment selection and project cost.

(4) Construction drawing design: It is one of the traditional design stages, which is the completion stage of the design work. Its emphasis is to control the design quality.

(5) Coordinating construction: Most domestic design units coordinate with construction passively. They should change from passive to active after implementing CKM. This is the second key point in building differentiated competitive advantages.

(6) Project operation: The vast majority of domestic design units do not value this stage, regarding the project completion means all the work has been done. But in fact, project operation is the most important stage for design enterprises to obtain valuable CK, which is also the biggest gap between Chinese design enterprises and foreign top design companies. Project operation is the short slab of design enterprises. The knowledge gained at this stage directly contributes to the work of the first stage, forming the virtuous circle of architectural design and the knowledge spiral. This stage is the third key point in building differentiated competitive advantages (Hu, 2014).

Domestic research on CRM of architectural design enterprises mainly focuses on customer satisfaction. To achieve higher customer satisfaction is one of the objectives of CKM. Zhang Yong considers that customer satisfaction is determined by employee satisfaction, and what is more important is project manager satisfaction. The biggest difference between design enterprises and the traditional manufacturing industry is that customers participate in the whole process of production and service. Therefore, the quality of design service is affected by many external uncertainties. Design production is an open process. Customers, project leader and designers can control the direction of design production. Customer satisfaction comes from employees’ efforts, thus employee satisfaction is an important part of CKM. Employee satisfaction, first of all, depends on the division of labor. That means, make professional people do professional things. Foreign architectural design enterprises divide employees into three types: comprehensive, technical and labor [190]. Comprehensive talents are the ones with management ability and comprehensive abilities, who are the key talents in the CKM. Technical talents are responsible for design quality while labor-type talents take lighter responsibilities. These three kinds of talents perform their own duties and responsibilities, which is the basis for establishing employee satisfaction. Architectural design products are characterized by large amounts of capital, long-term disposable products, relatively flexible product testing standards and long after-sales service period, and most customers do not have construction experience. Hence, there exists a strong long-term information asymmetry between design enterprises and customers. As a result, customers will be very cautious when selecting design units. Therefore, to enhance customer satisfaction, it is crucial to collect market-related information and relevant information of that type of project as much as possible before the beginning of the project, summarize design experiences of design enterprises, make the estimates of project cost, and even give suggestions for project operation output and operation management, eliminating information asymmetry as soon as possible (Xie, 2009).

In the CKM process of architectural design enterprises, the externalization of tacit knowledge into explicit knowledge is the most difficult link. The difficulty may be caused by three factors. First, due to distrust or internal competition, employees are not willing to share their own core knowledge completely; second, since tacit knowledge is indescribable, employees cannot accurately or fully express their knowledge, let alone in words; third, due to privacy or confidentiality, knowledge employees cannot express their knowledge in public and form written records. However, the most difficult link is also the most valuable link in the CKM process. One solution might be building trust through establishing a learning organization and building strong enterprise culture. In addition, mentoring practices and the establishment of normal exchange and sharing mechanism may also help to solve the problem (Ji, 2006).
2.7.3.2 Literature of Chinese Architectural Design Enterprises’ IC

Architectural design industry itself is IC-oriented, requiring engineers to use their wisdom to bring customers a new experience in feeling, usage and comfort level. Domestic research on the IC of architectural design enterprises mainly includes two aspects: technological innovation capability and management innovation capability, which are the indispensable criteria to measure architectural design enterprises’ IC.

The major business of architectural design enterprises is technical service, so the TIC is one of the important indexes to achieve customer satisfaction. Wang Li et al from China Electronics Engineering Design Institute have conducted the research on the technical capability assessment system of Chinese architectural design enterprises through literature review and investigation of design enterprises. They put forward five categories including 26 assessment factors, in which building enterprise information platform, setting industrial or local design standards with customers in need, training managerial personnel of development-type and construction-type customers (those who have long-term construction demands) to learn knowledge about construction management, helping customers access to green buildings and intelligent building certification are all the embodiment of technological innovation capability (Wang & Shen, 2014).

Research on technological innovation capability mainly includes the technological progress in the aspects of design concept, design method, service mode and means, technical equipment and construction materials, construction accessories, building operations, architectural physics, building construction and building equipment (Chen & Cheng, 2009). However, at present Chinese architectural design enterprises are faced with the following problems in technological innovation:

(1) Most of the technical personnel do not have scientific research capabilities. Although the view has been deeply rooted that scientific and technological innovation enhances the core competitiveness of an enterprise, the technical personnel of most design institutes are not familiar with the project management process and necessary methods and tools of R&D. In addition, they also lack relevant guidance.

(2) Research funding and incentives are insufficient. A large number of experienced technical personnel, with R&D capabilities though, struggle to cope with specific design projects under the model that the performance is linked to output value, coupled with tight schedule and fast payment. As a result, it is hard to have adequate time, manpower and material resources for scientific research. Even though some design units have carried out some research and innovation work, they remain superficial.

(3) Patent protection is not easy in China. The reward of research result can hardly be guaranteed, since the technical achievements can easily be used for free by the market.

In the aspect of management innovation, the Chinese architectural design market is characterized by large space and good growth. But the market is not yet mature, the competitive structure is outdated, and enterprises lack management innovation capability, highlighted in the following five aspects (Ye & He, 2015).

(1) The organizational structure of the enterprise is not reasonable enough, with the serious phenomenon of “big but not strong, small but not specialized”. That is, large design enterprises do not have obvious scale and brand effects, failing to compete with large international design companies, while small design enterprises are in defect of advantages in features and specialization, difficult to participate in the competitions on the same platform.

(2) The design market has poor management normalization. The open, fair, and just competitive environment has not yet been formed, while relying on connection and black box operations are still serious. Design units, especially the large state-owned enterprise that are in the dominant position, are short of innovative impetus in management.

(3) It is a common situation that management innovation and technological innovation are separated
apart from each other.

(4) Generally, enterprises do not have a high management level, in lack of normalization, sequencing and scientification. Enterprises are weak in IC and the overall industrial technical level is low.

(5) The design industry does not have an ideal performance, with a huge gap in per capita output value between Chinese and foreign architectural design enterprises. Many domestic design enterprises have become the production units in the “pipeline” to solve the problems of social employment, with not energy left to implement management innovation.

Drawing on the abundant research on IC conducted by domestic and foreign scholars, Chinese architectural design enterprises should put more efforts in the following aspects (Chen, 2011):

(1) The development of innovation strategy should focus on several points, on specific issues, according to the specific circumstances of the enterprise and starting from a small strategy of solving specific problems.

(2) The innovation in the use of talents is the most important IC. Enterprise should use its best resources and innovation methods to solve the major issue of recruiting people, using people and keeping people, which troubles all the design enterprises.

(3) The biggest gap between domestic and foreign enterprises lays on the core technological capability.

(4) State-owned enterprises and private enterprises are the two systems in China. State-owned enterprises have the advantage of resources while private enterprises have the advantage of efficiency. The mechanism innovation that combines both of their advantages is of great importance.

(5) Specialization requires that customer-centered management innovation capability should focus on customers, and that enterprise should extend and broaden its management layout, organizational structure and management depth.

(6) Enterprises should build a construction project team with service of the whole life cycle and whole process, from planning, design, construction to operation.

(7) Implementation capability of national innovation policy.

2.7.4 Summary

This section reviews the development of Chinese architectural design enterprises and the research within the industry on CKM and IC. Looking back on the industrial development, we can see that nowadays Chinese architectural design enterprises have an increasingly higher demand for management. CKM is important to enterprises, but its application in Chinese architectural design industry is still at the initial stage and relevant studies are scarce. Hence, the research on the CKM of Chinese architectural design enterprises has great significance. In addition, architectural design industry is obviously an innovation-driven industry, so the research on corporate IC is also significant to architectural design industry. Based on these two points, this thesis will focus the research problem on the relationship between the CKM and IC of Chinese architectural design enterprises. This section provides an industrial basis for the research problem, industrial practice basis for research hypothesis, industrial background basis for the analysis and discussion of research results, as well as a background reference for the conclusion of this study.

2.8 Literature on Measurement Models of CKM and IC

2.8.1 Literature on Measurement Models of CKM Research

The quantitative research of CKM has been new and no agreement has been achieved in either its research methods or framework. Classic measurement models include:
Wayland and Cole were the first ones who gave an integrated definition of CKM, as well as a CKMC model which states “customer”, “knowledge” and “management” as three independent concepts. To obtain the whole value that CKM brings the enterprise, these three concepts must be integrated as an organic whole in a close and circulated environment, which means putting all efforts into acquiring target customers and proper knowledge and applying all CK in the best way so as to maximize the value of customer relations. The model of Wayland and Cole focuses on how an organization should make policies based on CK in a closed-loop system, how to take care of proper customers, hot to acquire CK in a best way and how to collect (Wayland & Cole, 1998), share and use CK. See Figure II-4.

Figure II-4: CKM Conceptual Model of Wayland and Cole


Tiwana (2001) analyzes the steps and conditions of CKM considering how information technology and CKM methods give impetus to CRM under the environment of electronic commerce, based on which he puts forward CKM research model (A. Tiwana & Ramesh, 2001) (see Figure II-5). This model divides CKM into three phases: acquisition, sharing and application. It analyzes implementation steps of CKM from the perspective of corporate macroeconomic performance and analyzes CKM from both KM and CR, realizing an effective integration of knowledge capital and relation capital. From the view of the overall operation environment and process, this research model analyzes the organization structure, human resources, organization cultures and other parts of corporate CKM, which offers sound suggestions to corporations on how to push through corporate CK in an efficient way, but this model fails to give ample details on specific KM methods or management process of CRM.

Garcia Murillo et al put forward their CKM model in 2002. Digging into the specific operation level and based on the inter-behavior of customer and corporate knowledge, this model considers CKM process a knowledge flow process which consists three steps. It fully unveils the circulated process of knowledge revealing, knowledge sorting and knowledge leveling during the whole CKM process. Meanwhile, it analyzes KM methods and technologies applied by corporations and customers when acquiring and sharing knowledge during the process (García-Murillo & Annabi, 2002).

Kamla Ali Al-Busaidi propose a 5-dimension model of knowledge share system within employees of an organization (Al-Busaidi, 2013), as shown in Figure II-6.

Individual Factors: including computer efficiency, individual innovative consciousness, knowledge efficiency and knowledge capability, etc.

Peers Factors: including peer attitude, trust relationship and communication level, etc.

Organization Factors: including management support, organization knowledge structure, incentive policy and technical competitiveness, etc.

Perceived System Factors: including usage perception, competitiveness perception and security perception, etc.

Sector Factors: including support, system, competitive pressure, standardization level, etc.
Taiwan scholars Lin, Su and Chien define CKM as a single-dimension variable. Their measurement verifies the direct relation between CKM and enterprise performance (Y. Lin et al., 2006). Jayachandran defines CKM as a single-dimension variable as well, and verifies the impact of CKM on customer response capabilities (Jayachandran et al., 2004). Taiwan scholar Xu Zhiyuan divides CKM into three dimensions — willingness to exchange knowledge, expectation to obtain values by exchanging knowledge and channels to exchange knowledge, and made the measurement, discussing the relation between the core factors of CKM and enterprise capital (Xu, 2004). Taiwan scholar Fan Weixiang classifies CKM into three dimensions — acquiring CK, transferring CK and implementing CK, and discusses the relation among CKM, market orientation and marketing performance (Fan, 2001).

Zou Nongji and Meng Qingliang believe CKMC should contain five key dimensions: 1 cooperation among functional departments; 2 organization system support; 3 collaborations with customers; 4 IT system support; 5 organization study support, knowledge sharing and customer-oriented organization culture (Zou et al., 2007).


Other relevant models proposed by scholars such as Garcia-Murillo, Schulze Anja, and Hoegl Martin, and Fan Weixiang will not be listed here (García-Murillo & Annabi, 2002; Schulze & Hoegl, 2006; Fan, 2001).

**2.8.2 Evaluations on Current Measurement Models of CKM**

By reviewing current CKM models, it would be fair to say that many scholars have realized how important a simple but comprehensive implementation framework could be in terms of the implementation of CKM, not to mention the development of CKM theories. Foreign studies concerning CKM models could be divided into two categories: research on CKM process and research on CKM driving factors.
In terms of the variety of research perspective, process-oriented research could be divided into research based on CRM business operation process and research based on KM business operation process.

1) Research based on CRM process

Research based on CRM process contains factors of KM in themselves and depends on the support and optimization of KM theories. For example, to further divide CRM core processes (marketing, sales and service) into six business operation processes (marketing campaign management, lead management, offer management, contract management, service management and complaint management) that intersect with each other in operation, four KM tools (substance, capacity, structure, cooperation) are introduced from the perspective of KKM epistemology and ontology and a CKM model is built thanks to their inner mechanism integration and coordination. The customer process circulation model put forward by Swift also focuses on improving the efficiency and efficacy of corporate CRM through CKM (Swift, 2001).

Though the earliest CKM model put forward by Wayland and Cole in 1997 is based on KM, it also states its basis on CKM process. It believes that without ample CK, enterprises will fail to get enough customer values through their CRM. If generous CK is not applied sensibly, enterprises may also suffer great loss in opportunities. Investment that only focuses on base structure and process but ignores the efficient combination of CKM process and CRM is also a waste of resources (Wayland & Cole, 1998). So to speak, Wayland and Cole believe that CKM and CRM are inseparable and CKM provides basis for CRM—CK.

To build a process-oriented CKM model is to offer enterprises feasible proposals. Based on various industries and enterprises, Walk and Kooge (2001), Massey, Montoya –Weiss and Holcom (2001) have separately proved the practicability of some CKM models (Massey et al., 2001; Walk & Kooge, 2001). However, research of this kind is mostly based on CRM process, in which case, many of their classifications of the process don’t agree with corporation business process, which decreases the practicability of those models. Meanwhile, most process-oriented CKM models are based on knowledge that is about customers and for customers, the so-called explicit CK. They fail to pay enough attention to tacit CK and human-oriented activities that transfer, share and create knowledge and the distinctions of CK categories mark one of the significant differences between CKM and CRM.

2) Research Based on KM Process

Research of this kind bases their theories on organizational epistemology and the understanding that customers co-create corporate values. They analyze CKM process through two perspectives: how to learn from customers through an organization and how to learn with customers through an organization. For example, Gibbert and Leibold propose a five-dimension CKM model which underlines the significance of KM and organizational learning and the transfer of customer roles: from passive recipients of products and services to cooperators with enterprises and co-creators of corporate values (Gibbert et al., 2002). To scholars like Gibbert, CKM will finally achieve a win-win situation between enterprises and customers. The closed-loop CKM process proposed by Wayland and Cole is also based on internal knowledge activities. It focuses on five CK activities namely planning, focusing, generation, classification, sharing and upgrading (Wayland & Cole, 1998). The model put forward by Bose and Sugumaran Srinivasan and Lilien puts even more efforts in highlighting the process of KM and knowledge learning. Moreover, Srinvasari and Lilien try to prove the value and meaning of their opinions through empirical method (Bose & Sugumaran, 2003; Srinivasan & Lilien, 2011). Knowledge management process-oriented research is all based on research of knowledge activities within corporations before they are expanded to research of CK activities between enterprises and customers so as to build theoretical models of CKM.

It could be concluded through the research process of this part that the role the customers play has gone through significant change. They shouldn’t be cornered as passive information sources and recipients of products and services; instead, they should be value creators of enterprises. Scholars concerning this part put their best attention on the tacit CK from customers, in which case they pay less attention on how to achieve knowledge innovation through knowledge transformation theory, which becomes one of the weak points of CRM process-oriented research. Besides, many corporate business processes of functionalized organization structure
are much loose. For example, the market research department is responsible for understanding customer needs, R&D department and production department producing products required by customers, marketing department persuading customers to buy products over and over again and service department improving customer satisfaction and loyalty. Therefore, how to realize an efficient CKM process has been one of the greatest obstacles for current CKM practices (Belkahla & Triki, 2011).

To those customer-oriented enterprises, an efficient management of CK innovation could accelerate the added value and capability development of corporate CK and ensure a steady rise in corporate customer satisfaction and loyalty so as to assure a continuous rise in corporate profits. As a result, CK innovation will be key to CKM and merits considerable attention and practices.

(2) Research on CKM Driving Factors

Many scholars believe that CKM is a latent variable that couldn’t be measured directly. Since there hasn’t been any process-oriented CKM framework generally accepted by enterprises, many scholars are devoted to studying factors that may influence the implementation of corporate CKM, which is what we call research on driving factors. Research on driving factors has their guiding significance in terms of improving corporate CKMC. Research of this part is mostly based on CKMC.

Li and Calantone believe that new product promotion will benefit from market knowledge capability. Market knowledge capability is the process to produce and integrate market knowledge. In terms of new product development, market knowledge capability is mainly made up by customer knowledge process, marketing and research and development interface and competitor knowledge process (Li & Calantone, 1998). Customer knowledge process refers to the process of producing customers, including customers’ needs on current and future new products. Competitor knowledge process is the knowledge process concerning competitors’ products and strategies. Marketing and research and development interface means the process where marketing department and R&D department communicate and work with each other. Of all these processes, customer knowledge process consists three continuous parts which are customer knowledge acquisition, customer knowledge interpretation and customer knowledge integration. Enterprises can acquire CK through their interaction with customers, then rank acquired knowledge with accordance to corporate analysis process and customer needs before testing whether their needs are appropriate. Finally, the analyzed information will be integrated into the design of new products. As a process in which external customer needs drive internal corporate activities, CK process helps enterprises increase the width of market requirements and decrease the risk of inapplicable products so as to allow enterprises to gain more profits from new products.

To extend what Li and Calantone have proposed, Campbell holds the idea that corporate CK capability is key to the success of CKM process (Campbell, 2003). Directed at special customers, CK capability is a process of producing and integrating customer information. From where enterprises stand, CK is a set of information concerning customers. Since the process of producing and integrating CK is not only related to corporate activities but also buried inside corporation, CK capability has become the core competence that could neither be imitated nor moved by forces outside the corporation. He considers that CK capability consists four organizational processes, including customer information process (also known as the process to produce CK), marketing and information technology interface, participation of top management and staff evaluation, compensation and benefit system. The producing and application of CK by an enterprise could achieve a maximum benefit only when these four processes interact with each other.

Based on organizational capability, Gold, Malhotra and Segars regard that the CKMC of an organization should be composed by two parts: infrastructure, with technology, structure and culture included and process management capability that includes knowledge acquisition process, knowledge transfer process, knowledge implementation process and knowledge protection process (Gold, Malhotra, & Segars, 2001).

Taking KM balance model as a platform and based on the CK capability analysis framework of Campbell, Liu Yezheng and Zhang Ting refine the customer information process in CL capability analysis framework into CKM process capability, which ascribes marketing and IT (information technology) interface, participation of top management and evaluation and reward system of employees to CK basic resources capability, and adds
CKM practical ability to the list (Liu & Zhang, 2004).

With a reference to the research listed, it would be clear that different from CK, CK capability and CKMC, stable as they are, are implied in the cognitive activities of an organization and unable to be observed from the outside, acquired from the market or imitated. Even so, it would be called bias if the driving factors of CKM implementation are discussed from the view of capability since CK capability and CKMC are both independent concepts. It could also be said that research on driving factors that is based on capability is dependent on CKM process itself and most scholars take driving factors only as cofactors of CKM, which lowers the depth of relevant research.

2.8.3 Literature and Evaluation on Measurement Models of IC

So far research on the connotation and quantitative measurement of IC remain scattered and inconsistent. As reviewed in chapter 2.6, multiple classifications of IC and relevantly scattered IC research have led to different quantitative measurements of IC. As a matter of fact, the main responsibility of IC is to promote and reflect the continuous innovation of enterprises and finally gain profits, so most measurements on IC now are built on the basis of research concerning innovation categories and innovation connotation. Representative researches on IC measurement methods based on innovation categories are listed in Table II-6.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lin Ruhai &amp; Peng Weixiang, 2009</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xie Hongming et al., 2007</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qin Peiheng et al., 2014</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rao Yangde, 2008</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Su Jinqin et al., 2013</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wei Jiang et al., 2008</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prajogo &amp; Ahmed, 2006</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crossa &amp; Apaydin, 2010</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Damanpour, 1991</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Becheikh et al., 2006</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As is shown in Table II-6, current research tends to divide innovation into product innovation, process innovation, management innovation, technological innovation, market innovation, institutional innovation and business model innovation. Product innovation is about introducing, improving and developing products or service (Becheikh et al., 2006; Qin et al., 2014). Process innovation is the improvement and creation of process like production, manufacture and operation (Damanpour, 1991; Prajogo & Ahmed, 2006). Management innovation is to improve and innovate the process of organizational structure and inter-enterprise management process, including improving and innovating recruitment process, finance, marketing regulation and working procedures (R. J. Lin et al., 2010; Xie et al., 2007). Technological
innovation refers to enterprise’s capacity to improve and innovate its technical methods including the innovation of information technology in products, process and operation and its input in research and development (Becheikh et al., 2006; Lin & Peng, 2009). Market innovation indicates the improvement and innovation conducted to deal with external customer relation and marketing strategies and explore new market (Rao, 2008; Wei et al., 2008). Institutional innovation refers to the improvement and substitution of current system so as to adjust to changes of enterprises themselves and external market (Lin & Peng, 2009). Business model innovation is to innovate the process in which enterprises create, promote and deliver values to their customers (Crossan & Apaydin, 2010).

With accordance to the research on references, most existing empirical research on IC operationalizes IC from perspectives of resource input (such as enterprise R&D intensity and research personnel number) and performance output (such as number and output value of new products, patent number or the level of novelty), among which the research measuring IC through innovation performance is in the majority. Previous research lays special stress on technological factors and fails to pay enough attention to the socialized characteristic of innovation, but now scholars have started keeping their eyes on non-R&D innovation factors of enterprise innovation.

Zhang Jun et al. conducted in-depth interview of 13 Chinese innovative textile enterprises from 2008 to 2009, including a 6-month site observation. They encoded and analyzed the mass first-hand information and observation date they obtained, exploring the connotation, structure and measurement of IC from enterprise organizational activities. Eventually, they defined four dimensions of corporate IC – innovation perception, information annotation, innovation decision and actualize implementation (Zhang, Xu, & Zhang, 2014).

With the aid of knowledge transfer theory, directing at service outsourcing industry, Wang Yonggui et al. make new use of “motivation, opportunity, ability” (MOA) framework. From perspectives of service contractor and service owner, they probed into and proved promotion mechanism of contractor’s IC. Their research proposed a model framework based one 174 paired questionnaires between service managers and strategy managers of contractors (Wang et al., 2015).

By means of questionnaires concerning corporate performance of 35 private banks in Iran, Nastaran Taherparvar et al. have studied the impact of CKM on sustainable IC, measuring IC from three dimensions which are innovation capability, innovation speed and innovation quality (Taherparvar et al., 2014).
III Research Methods

This chapter mainly discusses the research methods of the thesis. Firstly, it reviews existing quantitative measurement models of CKM and corporate IC, and builds a CKM and IC model based on knowledge process. Then, it proposes a theoretical framework, research hypotheses, as well as research methods including pretest and large sample test. After that, based on the definition of the core concept, it draws on the measurement scales of correlated scales in existing documents, combines the conception of this research with current situation of KM and CKM implementation of architectural design enterprises, and finally forms the items of the questionnaire by following basic principles of questionnaire design and methods.

3.1 Building Measurement Model of CKM Based on Knowledge Process

On account of analysis stated above, with a combination of practical situation of business management activities of architectural design, this thesis builds a CKM model based on knowledge process.

3.1.1 Determining CKM Process

Combining what Chapter II has done in reviewing the background of KM and CKM theories and on the way of determining a CKM process, it would be detected that KM ends up more mature than CKM whether in terms of theory research or real practices. Knowledge management, which cares more about how internal employees of an enterprise acquire, share and use knowledge, is penetrates in CKM itself. CKM is in a way the extension of KM research, which changes the KM within enterprises into a KM between enterprises and customers. Knowledge management is the research basis for CKM. Taking these into account, this thesis concludes not only the research process of CKM, but also the research process of KM.

Conclusions of this thesis are based on approximately 70 definitions and classifications of over 100 writers, letting aside more than 60 knowledge activity processes. It scrutinizes the contents and definitions of every knowledge activity and finally summarizes these 60-some knowledge activities into four categories, which are acquisition, integration, internalization and externalization. They are classified with accordance to what stated below:

(1) To store, accumulate, retrieve, reserve and access are basic functions of CK repository (customer database). As database tools, they are not identified as specific CK activities in the CKM model of this thesis.

(2) Creation is a knowledge activity with double meanings. It is firstly the acquisition of tacit knowledge. As Skyrme notes that the first step of KM process is to create knowledge, which is the tacit knowledge like working experiences and working skills they acquired in daily work. Also, it could mean innovation, mostly the generation of new knowledge (David J Skyrme, 2000). In the eight steps of KM put forward by Liebowitz and Beckman, the creation of knowledge is identified as the generation of new knowledge, also known as the innovation of knowledge. Since innovation management will be included in this thesis later, this part will only talk about the first meaning and creation is thus ascribed to the process of knowledge acquisition (Liebowitz & Beckman, 2000).

(3) Before acquired knowledge is transferred into corporate productivity, it should undergo the process of being classified, analyzed, mined, selected, explained, organized and systemized. Besides, with reference to definitions listed in relevant documents, knowledge intension and knowledge integration share
the same meaning. As a result, this thesis identifies “classification, analysis, mining, selection, explanation, organization and systemization” as integration. The detailed meaning of knowledge integration and CK integration will be explained later (Rollins & Halinen, 2005).

(4) Knowledge transfer, knowledge spreading, knowledge sharing, knowledge diffusion and distribution all belong to knowledge sharing. This thesis regards knowledge sharing as a part of the knowledge internalization of corporate organization. What merits special note here is that the knowledge internalization in this CKM model puts more attention to the management of tacit CK and the bidirectional flow of CK between enterprises and customers (García-Murillo & Annabi, 2002).

(5) Evaluation, assessment and measurement is used to compare the performance before the KM or CKM is conducted to the performance after. It should not be included in the knowledge process of CKM, so it isn’t part of this model (Rollins & Halinen, 2005).

(6) Wayland and Cole propose the closed-loop model of CKM, believing that CKM includes six types of CK activities, namely planning, focusing, extension, codifying, sharing and implementation (Wayland & Cole, 1998). Planning, which means to assure target customers and management objectives, belongs to the corporate strategy level, but CKM is not a corporate strategy. Instead, it is more of a management tactic. So planning is the management activity prior CKM. Focusing and extension refer to the process of knowledge acquisition, the former of which is more about the acquisition of explicit CK while the other tacit CK. According to Davenport, dialogue, observation and prediction are three approaches to acquiring tacit knowledge (Thomas H Davenport & Prusak, 1998). Codifying highlights the process of knowledge integration. Sharing and implementation echo with the internalization and externalization of classifying CKM activities.

3.1.2 Building CKM Model

After concluding and analyzing current CKM process and KM process, this thesis divides CKM process into four parts which are customer knowledge acquisition, customer knowledge externalization, customer knowledge integration and customer knowledge internalization and ACI, EXN, ING and INN would be used to represent these four parts in some of the following sheets. The specific CK activities of this model will be explained below.

1. ACI

Christine, Devinney and Midgley believe that knowledge acquisition refers to the acquisition of knowledge when the outside organization and inside organization of an enterprise interact with each other (Soo, Devinney, & Midgley, 2004). Combining the special background of strategic alliances, Norman takes knowledge acquisition as the skills and knowledge that allied enterprises get during the period of the alliances (Norman, 2004). Based on the special research background, Wang Lisheng, doctor of Zhejiang University, believes that knowledge acquisition could be achieved when manufacturing enterprises deal with their customers.

Knowledge acquisition is the basis of KM. Current research including market orientation (A. K. Kohli & Jaworski, 1990; Narver & Slater, 1990), market information usage (Menon & Varadarajan, 1992) and organizational learning all stresses the significance of knowledge acquisition. Davenport and Prusak, as well as some other scholars, think that knowledge acquisition, whose aim is to obtain knowledge source consistent with and related to corporate goals, is the first step of KM implementation (Thomas H. Davenport & Klahr, 1998). In a word, knowledge acquisition, as one of the most important parts of corporate KM, is to acquire valuable and meaningful knowledge from various sources and channels for enterprises and ACI is the first step of CKM model, as well as the basis and start of CKM. Knowledge that is acquired will contribute to the long relations between enterprises and customers. This thesis identifies ACI as developing and collecting knowledge that is about customers, needed by customers and from
customers through information technology and direct contact with customers. Customer knowledge could be acquired through various approaches like phone calling, visiting and email. During the communication between enterprises and customers, enterprises not only provide information for customers but also receive knowledge from them. To obtain CK, enterprises will try different channels which require the participation of different departments, so besides salesmen, many other departments like marketing, customer service, R&D and finance department are also involved in the interaction with customers.

2. EXN

Knowledge externalization, initiated in the SECI model that talks about the interaction between explicit knowledge and tacit knowledge, is put forward by Nonaka who believes externalization means to convert tacit knowledge to explicit knowledge, exemplified by the action of summarizing lessons learned from practices to words on papers (Nonaka, 2015). This thesis will expand this definition to CKM activities conducted by corporate organizations. It mainly includes two parts:

(1) From tacit knowledge of employees to explicit knowledge of organizations

As carrier of tacit CK, employees who contact with customers directly absorb high-qualified tacit CK from considerable number of customers on the enterprise-customer interface, but the instability of personnel allotment increases the risk of losing great number of valuable customers. To solve the problem concerning the accumulation and sharing of organization tacit knowledge in a more efficient way, many high-tech enterprises take advantages of platform and KM software to allow members of an organization to share their achievements and experiences. During this process, personal tacit knowledge is transformed into explicit knowledge that could be learned and shared by other members, so is the transformation process of personal tacit knowledge-organizational explicit knowledge completed (Nonaka, 2015).

This transformation means to materialize tacit knowledge to machinery equipment, embody itself to enterprise values and put it into the mind of employees. Intangible and obscure tacit knowledge buried in employees’ skills and customer relations are thus transformed into tangible documents that could be filed by enterprises. In addition, transformation indicates the process of changing personal knowledge into notebooks accessible to everyone. Only in this way could a company manage to continue its knowledge accumulation when certain individuals end up leaving (Nonaka, 2015).

Due to the fact that each employee only holds tacit knowledge of certain interaction among certain customers, the tacit customer knowledge buried within employees’ mind should be accumulated on the basis of internal knowledge sharing. On the one hand, this enables all employees to have a complete understanding of CK. On the other hand, it prevents knowledge of this kind from draining (Nonaka, 2015).

This model is usually worked in this way: with the aid of necessary techniques, employees convert their tacit knowledge into systemized explicit knowledge and achieve explicit knowledge sharing through technology platform (Nonaka, 2015).

(2) From organizational tacit knowledge to organizational explicit knowledge

Organizational tacit knowledge is reflected by how employees understand and coordinate with each other and sublime it to organizational culture. Organizational tacit knowledge will be influenced by the flow of employees, so it would be necessary to record it in the form of documents, regulations, regimes, etc. and amend and update it when it goes through development so as to assure that the organization could last and improve itself endlessly (Nonaka, 2015).

3. ING

Knowledge generated during the process of ACI is unordered, scattered, vague and dispersed in the hands of different employees. Despite the fact that CK does its magic in improving personal skills of employees, it does little in improving overall knowledge level of enterprises. As a matter of fact, what really matters to enterprise operation is the structuralized, standardized and ordered CK. So CK should be integrated so as to take the maximum advantage of knowledge (Blosch, 2015).
In Architectural Innovation-Relocation of Current Product Technology and the Failure of Enterprises, Henderson and Clark initiate and exert full description of the term knowledge integration. From the perspective of product research and development, they propose component knowledge and architectural knowledge (Henderson & Clark, 1990). Component knowledge refers to the core design ideas of each product and the approach to applying these ideas to certain component. Architectural knowledge, on the other hand, is about integrating or connecting all those components into a united and integral methodology knowledge. They believe the architecture of component knowledge is stimulated by outer market demand and usually leads to problems. Architectural knowledge is sometimes used to solve this problem, which is called knowledge integration.

Kougut and Zander take knowledge integration as a new way for combinative capability to use existing knowledge, which underlines integration as the capability to combine existing and potential knowledge. Integration tools used here are not limited to hardware like database but also requiring the communication among employees and mutual cultural background (Kogut & Zander, 1992).

Inkpen and Dinur regard knowledge integration as knowledge connection, which is formed by formal and informal relations between individuals and organizations. These internal relations could accelerate sharing and communication of new knowledge and offer a basis for personal knowledge to transfer to organizational knowledge. When someone or some organization is connected to another organization in knowledge, the knowledge could be developed into organizational knowledge through discussion and disputation. The better knowledge is integrated; the stronger core competence will be (Inkpen & Dinur, 1998).

Michiel, Van Den Bosch and Voleberda consider knowledge as all coordination activities conducted by an enterprise to improve its work efficiency and operation efficiency of the system. Knowledge integration rather than single knowledge contributes to corporate competitive advantages because only by integrating knowledge could an enterprise be well guided to combine products and market in the highly changeable environment and finally develop products fast and efficiently to satisfy market demands (Boer, Bosch, & Volberda, 1999).

Tiwana thinks knowledge integration as a way to develop personal professional knowledge into organizational professional knowledge in certain conditions. Moreover, he points out that knowledge integration is key for the leverage effect of knowledge. Once more and more CK is provided by customers for trading objects or acquired by enterprises, enterprises will determine the way to digest and integrate all the knowledge. Enterprises able to transfer knowledge in the mind of customers and employees (human capital) into practical capacity (structural capital) and relations (relational capital) will finally lead the industry (A. Tiwana & Ramesh, 2001).

Wayland and Cole consider CK acquired by each enterprise comes from different channels which could be customer service system, contact with salesmen, sales center, direct emails, customer associations and maintenance center (Wayland & Cole, 1998). In fact, any interaction between customers and enterprises could be the source of ACI. These channels of ACI involve several functional departments, including sales department, marketing department and service department. Acquired CK is dispersed among corporate employees, processes, structures, departments and teams and information systems. However, if information sources turn out to be scattered, it would be hard to apply them altogether to certain communication activities, which makes it hard for enterprises to get a full understanding of customers, so some real customer demands gets partially understood and even misinterpreted.

In this case, enterprises are forced to coordinate, classify and analyze acquired CK so as to make a consistent customer profiles for future use. If this step fails to be completed, those valuable CK will be scattered in corners of enterprises and decrease their values. What merits notice here is that CK from different channels gives different observing perspectives of customers and has different features to satisfy
varied demands. In order to get intact CK, enterprises need to systematically organize and integrate storage media and knowledge resources and integrate scattered CK. For example, enterprises spare no efforts in keeping business personnel who have important customers, organize sales teams, build customer service knowledge associations, store and backup confidential papers of important customers, regularly visit customers and build customer knowledge repository, etc.

Customer knowledge integration is complicated. It composes, classifies and integrates CK of different sources, levels, structures and contents by means of scientific methods and technologies and then digs out various CK and mutual connections and dynamic relations among CK to reconstruct the single and scattered CK into new, unified and systemized knowledge system, realize its proper function and make it consistent with total performance. This definition means to state that the process of ING is not only about coordinating, classifying and analyzing the scattered customer information; it also requires finding out dynamic changes of CK. To be more specific, it means to build and expand CK repository, reconstruct personal CK by using document management, knowledge classification, knowledge coding and knowledge de-weighing and integrate scattered CK to make it more applicable and easier for employees to share and study. Meanwhile, ING ensures enterprises to respond in a consistent way to customer demands and preferences.

4. INN

Nonaka puts forward the concept of knowledge internalization in his SECI model which talks about inter-conversion of explicit and tacit knowledge. He believes internalization a process to transfer explicit knowledge to tacit knowledge and make it the practical capacity of both individuals and organizations (Nonaka, 2015). This thesis extends this idea to corporate organizations’ CKM activities which mainly include customer knowledge transfer, flow and knowledge sharing.

Knowledge transfer is also known as knowledge diffusion. Argote and Ingrain regard knowledge transfer a process of one being influenced by the management of another (Argote & Ingram, 2000). Ni Yannian identifies knowledge transfer as a process of social activities in which some social members deliver certain knowledge information and expect to get desired effects. It is the activity for knowledge to transfer from produce behavior to consuming behavior and from subject of innovation to subject of learning. It is also the intermediate link and process to transfer knowledge production to knowledge utilization and the action of delivering and distributing knowledge to information. To enterprises, knowledge transfer is a process to exchange information and technologies systematically among entities, among which management knowledge (like management skills, marketing skills, human resources skills, corporate culture and values and business strategic ideas and skills) and technical knowledge (like knowledge concerning manufacturing and products) should be key points for research on corporate knowledge transfer (Ni, 1999).

Knowledge flow is commonly paired with knowledge transfer. According to current papers, knowledge flow almost equals to knowledge transfer. For example, Chug, Gibbons and Herbert (2000) consider knowledge flow a specialized knowledge (skills or capacity) or transfer of external market data that have strategic values.

Due to discrepancy of research standards and perspectives, there hasn’t been an agreed definition for knowledge sharing.

Bostrom believes efficient knowledge sharing is the mutual understanding and respect among members of a team (Bostrom, 1989). Tan and Margaret applied the mutual understanding to the interaction between system analysts and users in information system design to highlight the necessity of mutual knowledge sharing. They believe knowledge sharing is in a way knowledge transfer (M. Tan & Igbaria, 1994). Davenport and Prusak take knowledge sharing as a process for internal corporate knowledge to be involved in knowledge market. Like other commodities and services, knowledge market has buyers and
sellers and all of its participants are convinced of their rewards. Despite of the similarities between knowledge sharing and market transaction, they are not all the same (Thomas H Davenport & Prusak, 1998). Nonaka and Takeuchi believe tacit and explicit knowledge leads to knowledge sharing among members and indirectly contributes to knowledge sharing between members and organization by means of socialization, externalization, combination and internalization (Nonaka & Takeuchi, 1995). Hendriks points out knowledge sharing is a process of communication. In his opinion, knowledge couldn’t be delivered as freely as commodities. When someone learns from others or shares knowledge, one is obliged to reconstruct one’s knowledge. So knowledge sharing involves two subjects including knowledge owners and knowledge demanders. Knowledge owners provide knowledge by means of speech, writing or other actions while knowledge demanders have to perceive the expression through imitation, listening or reading so as to recognize and understand the knowledge (Hendriks, Voeten, & Kroep, 1999). Botkin considers knowledge sharing the core of network management model. In brief, knowledge sharing is communication. To make communication work, there has to be a connection. Knowledge sharing is thus the connection and communication among human beings. He also mentions that this sort of connection and communication has different levels and scales. It could be conducted on the level of either individuals, work teams or even enterprises (Botkin, 1999).

Chinese scholars also elaborated their understandings of knowledge sharing from different perspectives. Li Changling identifies knowledge sharing as personal knowledge and organizational knowledge being shared to other members in the organization through various communication skills and managing to add its values through knowledge innovation (Li, 2005). Zhao Wenping et al equal knowledge sharing to the process of completing knowledge transfer from individuals to others (Zhao et al., 2004). Lei Ling believes that knowledge sharing is to share personal knowledge of employees with other members by means of communication modes and finally convert it into group knowledge or organizational knowledge (Lei, 2004).

Customer knowledge sharing is significant to CKM. It is the process to communicate customer knowledge via communication between employees, employees and organizations and employees and customers in order to learn from each other and allow corporate CK to be utilized by corporate employees, customer communication and sharing. The process of customer knowledge sharing is in fact the process of customer knowledge learning, which mostly happens among employees and between employees and customers. Customer knowledge sharing aims to break walls of knowledge owners and allow CK to flow and used freely in certain scope. By shaping employees into more knowledgeable beings, it promotes CK to be used and innovated within enterprises.

Explicit CK could be recorded and stored in the way of characters, graphs and numbers. Also, it can be analyzed and processed by computers. So sharing explicit CK is relatively much easier. The most efficient way to share this knowledge would be building knowledge repository. Internal employees of enterprises acquire necessary knowledge from CK repository through knowledge network and learning platform and then transfer it into their own knowledge to improve their capacities or skills and manage to transfer CK from enterprises to individuals. Based on this mechanism, knowledge sharing methods called inline organization and interconnection organization have emerged. Inline organization knowledge sharing utilizes information technology like Intranet to realize efficient communication mechanism in which information and knowledge is generally shared within organizations and between organizations. Interconnection organization knowledge sharing provides partners of organizations, suppliers and customers with a high-speed connection to achieve knowledge sharing between enterprises and customers.

Database and network techniques could hardly support tacit CK. Tacit CK, like working experiences, know-how or some other inspiration knowledge from work, is buried in the mind of employees and customers, so it is sort of monopolistic. Davenport and Prusak indicate the conditions when employees are
happy to share their knowledge, which are mutual benefits, reputation and selfless mentality. Actually, organizations have a knowledge trading market in which knowledge is exchanged by suppliers and buyers and its payment mechanism is supported by mutual benefits, reputation and selfless mentality. Newcomers are necessary for the success of this market management (Thomas H. Davenport & Klahr, 1998).

According to documents and case studies that are available now in terms of knowledge sharing, most enterprises use dialogues, shifts, mentoring, meetings or media to share tacit CK, by doing which they hope other members or groups share and own the same or similar knowledge and promote the spread of personal tacit CK. This is one of the most ancient and efficient ways to spread human knowledge. Meanwhile, with the support of some advanced technologies like BBS, enterprise portals and enterprise multimedia meetings, CK sharing platforms are flourishing.

Customer knowledge should not only be shared among employees but also between employees and customers. More than anything, customers need to know professional knowledge in fields like enterprise product features and service level to evaluate whether these products and services are worth exchanging. In this case, enterprises have to share and communicate their customer knowledge with customers to better educate them and guide their consumption to a more rationalized way in order to improve the effectiveness of enterprise marketing. Knowledge sharing between enterprises and customers is also a process for enterprises to learn from their customers, which creates a win-win atmosphere for both enterprises and customers.

3.2 Building Measurement Model of Innovation Capability

Based on the analysis above and combined with practical situations of architecture design innovation activities, this thesis builds an IC model based on innovation categories which include management innovation, procedure innovation, technological innovation and business innovation. MAI, PRI, TEI and BSI will represent these four parts below.

1. MAI

As the representative scholar of foreign MAI theories, Ray Stata firstly puts forward the problems of MAI in enterprises and distinguishes MAI from product innovation and PR, pointing out that MAI is the choke point of enterprise development (Stata, 2004). Based on the research on Japanese and Occident enterprises, he believes that MAI is key to the success of Japanese enterprises. Different from Occident whose enterprises grow on techniques, Japan enhances its industry strength through MAI. However, Ray Stata fails to give a further and concrete definition of MAI. After that, many scholars conducted researches on the conception and connotation of MAI from various perspectives. Abrahamson identifies MAI as changes of organization structure and culture made by organizations to coordinate input and output (Abrahamson, 1991).

Woodman, Sawyer & Griffin Sawyer et al. believe that creativity could be influenced by features, constitution and cultural atmosphere of organizations. They go further and put forward a multilevel model by building personal KM systems to generate organizational creativity (Woodmann, Sawyer, & Griffin, 2007). Form the view of personal creativity, Pettigrew et al. consider that organizations are formed during their interaction with each other. How a member of the organization chooses the direction of creativity could exert significant influence on organizational creativity (Ewan, Ferlie, Pettigrew, Ashburner, & Fitzgerald, 1997).

Organizational structures with rational design will change after being put into service. Similar to living bodies, in order to develop successfully under the ever-changing external environment, organization structures require constant adjustment and improvement. MAI is the process in which personal growth and organization goals are organically combined with the application of behavioristic knowledge and maximum operation income of organizations is achieved by the adjustment of organizational structure and
management methods.

MAI includes: the change of management function system (dividing organizational functions according to activity goals so as to redesign all management activities), the change of management structure (reforming and perfecting organization departments or position design in order to improve information exchange efficiency among departments) and the change of management system (including redesigning responsibilities and jurisdictions of managers and reallocating job duties). The transfer from original structure to a new one couldn’t be completed by enterprises right away. The transition period usually takes a long time. Organizational leaders should be observant to changes of the organization, seize the best time for reform and conduct MAI activities in time (DODGSON et al., 2011).

2. PRI

In the new manual about innovation of organization and enterprises, Organization for Economic Cooperation and Development (OCED) points out that PRI means the method of production and delivery by means of new or significantly improved service (Bi, 2005). PRI in this thesis is extended from process innovation which is a technical thing and one of the important parts of innovation management. Progress innovation is the innovation of operational program, ways and means and regulation system in technical or producing activities. As the generalized process innovation, PRI includes the innovation of various working processes which are not limited to production and crafts. Architecture design is the service industry of architecture industry. In terms of service industry, PRI improves not only equipment or software used by service enterprises but also procedures or skills applied in service delivery. GPS tracking equipment used in logistics service, new booking systems used by travel agencies and latest technologies used by consulting companies to manage and operate their projects all belong to PRI of service enterprises. Like knowledge-intensive service industry, architecture design also owns professional knowledge of special fields.

3. TEI

TEI is identified by academic community from perspectives of process and factor combinations. Based on different understandings of the innovation concept proposed by Schumpeter, early scholars offered and enriched different definitions of TEI. Solow initiated a two-step theory in his paper and believes new thoughts and their succeeding practices are significant to the realization of TEI (Solow, 1956). Barley pointed out in his paper that TEI is aggregated by several behaviors that include capital input, organization construction, projects planning and market development. He is the first one to give explicit definition of TEI from the perspective of behavior aggregation (Barley, 1998). Fu Jiaji demonstrates this idea from the most comprehensive economic significance and identifies TEI as a way entrepreneurs use to reorganize production elements and conditions for better economic interests. By building a business operation model with low economic costs and high productivity efficiency, they aim to develop new products or technology and open up new market (Fu, 1998).

From the view of economics, TEI of enterprises means that enterprises adopt better technologies and get higher efficiency in the next production cycle. TEI puts more stress on practical application effects technologies have in enterprises, so technologies, old as they may be when compared with internationally advanced technologies, are newer than currently used technologies. TEI could come from two main sources called introduced TEI and self-owned TEI.

4. BSI

Considering features of architecture industry and with a combination of product innovation, this thesis introduces BSI. BSI means to better satisfy customer demands, open up new market and develop new service business for enterprises (Wei et al., 2008). Product innovation and business innovation in service industry is usually mingled with each other, which could cause possible confusion. Product innovation refers to significant changes in functions and use values of new products (service) while business
innovation indicates changes in marketing concepts like product design. Product innovation is adopted when clothes are made with new materials for better air permeability and business innovation is used when new style clothes are made for certain customer groups. Taking features of architecture design industry into account, this thesis extends traditional product innovation to BSI that also includes the connotation of traditional product innovation.

This thesis involves an empirical study of the influences of the CKM model on IC, stating that CKM could bring positive impacts on IC. Their influence relations are shown in Figure III-1. (ACI is acquisition of customer knowledge, EXN is externalization of customer knowledge, ING is integration of customer knowledge and INN is internalization of customer knowledge; MAI is management innovation, PRI is workflow innovation, TEI is technology innovation and BSI is business innovation)

![Figure III-1: CKM-IC Relation Model](image)

Source: Personal Original Drawing

3.3 Research Methods

3.3.1 Pretest

This thesis adopts empirical analysis method and uses questionnaires to collect data. The questionnaire design strictly observes scale design principles and notes concluded by Churchill, Wang Chongming, Ma Guoqing, Li Huaizu, Yang Guoshu et al. (Li, 2000; Ma, 2002; Qu & Qu, 2013; Wang, 2001) and takes codes of languages under Chinese culture into account. Even though the scale has been modified, it may still remain terms that are not all satisfying. To decrease research errors and get a more reliable and valuable research result, questionnaires are usually pretested. Bailey and Burch (2002) believe the pretest of research should contain 10 steps: (1) informal observation/interview record; (2) determining rough frequency, time and behavior density; (3) choosing subjects to pretest and preparing for potential problems that could be met before a reliable observed results being got; (4) choosing locations and details for observation; (5) developing definitions and observational methods; (6) initiating first draft and data sheets; (7) training observers; (8) testing data sheets and draft; (9) necessary revision; (10) when necessary, making another reliability test to collected data and revising again (J. S. Bailey & Burch, 2002).

Following advice for questionnaire pretest offered by Bailey and Burch, this thesis mainly conducted tasks below.

Firstly, develop the first draft of the questionnaire and integrate measurement scales of all observational variables.

Secondly, by interviewing professors and relevant experts, with a qualitative method, analyze and refine concrete terms of the questionnaire from the perspective of theoretical discussion; find out errors of the research design and measuring tools and make modifications so as to decrease the amount of possible errors in sample survey, increase the reliability and validity of the research and obtain a more real and reliable research result.

Thirdly, interview middle and senior managers in enterprises. Analyze and refine items of the questionnaire
based on their practical working experience, make sure respondents understand items correctly and modify specialized and confusing words. Try to assure items of the questionnaire are more related to the practical work of enterprise employees, which will help respondents think and answer questions in accuracy and again make sure the questionnaire is not piled up by theoretical concepts but practical.

Fourthly, interview a senior manager of a consulting company, who has accumulated considerable experience in questionnaire delivery and collection, and absorb and adopt proper advice offered during the interview.

Fifthly, directed mostly at enterprises in Beijing, conduct small sample survey to test the validity and reliability of questionnaire draft. Take CITC and alpha reliability coefficient as standards to eliminate test items with relatively low relevance and make exploratory factor analysis of refined test items. Meanwhile, modify expressions of the questionnaire with accordance to small sample survey result.

Sixthly, adopt Likert Scale and with reference to practical situations (Robinson, 2014), invite employees of relevant departments in enterprises to rate each item.

### 3.3.2 Large Sample

When the pretest of this research has reached predetermined criteria, the modified large sample questionnaire will be available for the research. Before questionnaire inquiry, the research sample should be confirmed. Sample selection is significant to research work since the quality of samples determines the applicability and extrapolation of research result (Li, 2000). Mirroring sample programs concluded by Rong Taisheng (Rong, 2005) this research takes the following steps in sample selection.

1. **Sample population:** This research means to explore how the implementation of CKM influences IC. Limited by relevant problems like time, cost, vigor and the width and depth of the overlay network, this research combines stratified sampling and random sampling. It divides enterprises into different levels with accordance to their scales and use random sampling in each level.

2. **Identify sample units:** Enterprises are used as sample units in this research. To make sure answers from individuals could completely reflect the practical situations of enterprises and avoid possible influences of elements like personal working range and work satisfaction, questionnaires offered to each enterprises are limited to 1-3 and middle or above managers are preferred.

3. **Determine research plans:** To ensure the survey to be conducted successfully, concrete research plans, which include research scheduling and assuring enterprise contacts through permission of enterprise competent departments and recommendation through social network, are made beforehand. For the convenience of respondents and to minimize research costs, questionnaires are delivered by means of Internet and WeChat. Respondents remain anonymous in order to protect their personal privacy and assure the authenticity of research results.

4. **Decide sample size:** Structural equation model is adopted in this research for statistical analysis of the data. Structural equation model requires mass samples, but scholars haven’t agreed on the number of the samples. According to Anderson and Gerbing, the number should be above 100-150 (Anderson & Gerbing, 1988). Boomsma considers 400 as the proper number (Boomsma, 1982). Benfler and Bonett, Huang Fangming think five samples for one item should be enough if items are designed in common sense (Bentler & Bonett, 1980; Huang, 2005). Nunnally and Berstein suggest that sample size should be 5-10 times as item size (Nunnally & Bernstein, 1994). Therefore, taking advice above into account and based on practical situations, the research plans to deliver 300 questionnaires

5. **Questionnaires were delivered in two months from October 1, 2016 to December 1, 2016. All 300 questionnaires were delivered and 288 of them were retrieved, so the recovery rate is 96%.

Some questionnaires are eliminated when the following conditions happen: (1) Many questions remain
unanswered. (2) Answers of the questionnaire are given by certain pattern, e.g. too many items share one answer. (3) Respondents spend no more than 30 seconds on the questionnaire, which is obviously unusual. (4) Answers are the same to another respondent of the same enterprise. After proper selection, 277 questionnaires remained, which decreased the recovery rate to 92.3%.

In order to ensure the accuracy and reliability of the survey questionnaire, the research team randomly selected 20 from 277 questionnaires interviewees to verify the reliability of the questionnaire results by calling the interviewees. The results show that the 20 questionnaires are effective. The result showed the accuracy and reliability of the questionnaire we get.

3.3.3 Statistical Instruments: Structural Equation Modeling

Structural equation modeling (SEM) is a popular and universal technology to construct linear statistical model, which is widely used in psychology, economy, sociology, behavior science and many other fields. According to Mulaik and James, SEM is a representation of objective states of affairs expressed in object language. SEM is an integration of methods of statistical analysis in economytry, sociometry, psychometry and many other fields. As an emerging field in methods of statistical analysis, SEM is firstly used in papers published in 1960s and become widely used in 1990s. Multiple regression, factor analysis and path analysis are all forms of SEM. Also, SEM is called covariance structure models (CSM), linear structural relations model or LISREL. By specific statistical analysis technology, SEM deal with theoretical model of complex phenomena, and make evaluation on the theoretical model according to the extent to which theory is coincide with empirical data. In this way, SEM is able to carry out quantitative study on specific problems.

SEM mainly includes measurement model and structural model. Measurement model mainly tests the relationship between latent variables and corresponding observed variables, while structural model mainly tests on the relationship among latent variables. Theoretically, structural equation model is generally expressed with three matrix equations as follow:

\[ \eta = B\xi + \Gamma \zeta + \zeta \]
\[ y = \Lambda_y \eta + \varepsilon \]
\[ x = \Lambda_x \xi + \delta \]

\( \eta \) is endogeneity or mx1 order arbitrary vector of endogeneity. \( \xi \) is latent independent variable or nx1 order arbitrary vector of exogenous variables. \( B \) is matrix of mxm order correlation coefficients of \( \eta \); \( \Gamma \) is matrix of nxm order correlation coefficients of \( \zeta \); \( \zeta \) is mx1 order arbitrary vector of stochastic error.

In LISREL model, there are eight parameter matrix need to be estimated: \( \Lambda_x, \Lambda_y, \Gamma, B, \Phi, \Psi, \Theta, \Gamma \) and \( \Omega \). \( \Lambda_x \) and \( \Lambda_y \) are factor loading matrixes. \( \Gamma \) and \( B \) are matrixes of structural path coefficients. \( \Phi \) is the matrix of variance-covariance of exogenous latent variable \( \xi \). \( \Psi \) is the matrix of variance-covariance of residual \( \zeta \). The last two are matrixes of variance-covariance of observational residual (\( \delta \) and \( \varepsilon \)).

There are eight variables in this theoretical model including four exogenous latent variables—acquisition of CK (\( \xi_1 \)), externalization of CK (\( \xi_2 \)), integration of CK (\( \xi_3 \)) and internalization of CK (\( \xi_4 \))—and four endogenous latent variables—management innovation (\( \eta_1 \)), workflow innovation (\( \eta_2 \)), technology innovation (\( \eta_3 \)) and business innovation (\( \eta_4 \)).

3.3.4 In-depth Interview with Senior Managers

As supplement and cross validation of questionnaires, interview, one of the common approaches used in qualitative research, is adopted in the research. This interview is taken in a semi-structure way. Before the interview, a series of interview questions were prepared by the writer who kept a flexible and open mind. Further questions were put forward and more researches were conducted based on responses of interviewees. This approach provides a central point for the interview and allows the writer to respond...
flexibly and quickly to interviewees’ answers, which is why it is commonly exercised in qualitative research. To ensure interview quality and avoid misunderstanding, the writer did live recording as backup. To ensure the comprehensiveness and quality of interview notes, more details were cross-examined with the interviewee afterwards.

This research interviewed 8 core enterprise managers in depth with the following features:

1. Interviewees are senior managers with working experience of more than five years. They have participated in the core management strategy and management of an enterprise and have thorough understanding and perception about CKM and IC.

2. From 2012 to 2016, interviewees have been working in sample enterprises as core managers for over two years.

3. Interviewees are willing to take interview about CKM and IC and discuss practices with the interviewer.

4. Interviewees agree to confirm interview records and abstracts for academic communication.

5. Interviewees are interviewed in a face-to-face way.

All interviewees and interview details are listed in Table III-1 and interview outline and abstract of notes are available in appendix:
Table III-1: List of Interview with Senior Managers

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Position</th>
<th>Enterprise</th>
<th>Time</th>
<th>Location</th>
<th>Record Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sun Xiangshu</td>
<td>Chairman</td>
<td>Beijing Victory Star Architectural Design Co., Ltd.</td>
<td>2016.12.8</td>
<td>Chairman Sun’s Office</td>
<td>664</td>
</tr>
<tr>
<td>2</td>
<td>Wang Jing</td>
<td>General Manager</td>
<td>Beijing Tianhong Yuanfang Architectural Design Co., Ltd.</td>
<td>2016.12.9</td>
<td>Manager Wang’s Office</td>
<td>684</td>
</tr>
<tr>
<td>3</td>
<td>Huo Wenying</td>
<td>General Manager</td>
<td>China Architecture Design &amp; Research Group Consulting Company</td>
<td>2016.12.9</td>
<td>Manager Huo’s Office</td>
<td>604</td>
</tr>
<tr>
<td>4</td>
<td>Cong Xiaomi</td>
<td>President</td>
<td>Beijing Jiangong Architectural Design and Research Institute</td>
<td>2016.12.12</td>
<td>President Cong’s Office</td>
<td>1246</td>
</tr>
<tr>
<td>5</td>
<td>Huang Hu</td>
<td>Partner</td>
<td>BeijingSenleiyuan Planning &amp; Architectural Design Co., Ltd.</td>
<td>2016.12.12</td>
<td>Mr. Huang’s Office</td>
<td>924</td>
</tr>
<tr>
<td>6</td>
<td>Qin Yan</td>
<td>General Manager</td>
<td>Beijing Iixin Internaional Architecture Design Co., Ltd.</td>
<td>2016.12.13</td>
<td>Manager Qin’s Office</td>
<td>615</td>
</tr>
<tr>
<td>7</td>
<td>Zhang Jian</td>
<td>President</td>
<td>Institute of Architectural Exploratory and Design of Beijing University of Technology</td>
<td>2016.12.13</td>
<td>President Zhang’s Office</td>
<td>544</td>
</tr>
<tr>
<td>8</td>
<td>Yang Zheng</td>
<td>President</td>
<td>Beijing Urban Construction Group Co., Ltd. Architecture Design Institute</td>
<td>2016.12.15</td>
<td>President Yang’s Office</td>
<td>768</td>
</tr>
</tbody>
</table>

3.4 Questionnaire Design and Measurement Scale

On the one hand, questionnaire design should be closely connected to research questions and hypotheses. On the other hand, it should consider the limitation of respondents’ knowledge background and time. So questionnaires should be designed concise but to the point so as to avoid unnecessary problems on answering questionnaires. To make sure the validity and reliability of the research, complicated target variables are all measured multiple times. In this thesis, questionnaires mainly cover contents like the background of relevant enterprises and relevant variables of CKM and IC.

Directed at the research topic, relevant enterprise background mostly includes enterprise property, enterprise scale and enterprise output value.

Variables that should be measured in this research include ACI, EXN, ING, INN, MAI, PRI, TEI and BSI. Based on references (Jayachandran et al., 2004; Nonaka & Takeuchi, 1995; Taherparvar et al., 2014; A. Tiwana & Ramesh, 2001; Qi et al., 2012; Wang et al., 2015) and with a combination of the practical situations of
architecture design enterprise management, this thesis concludes four general measuring dimensions of CKM activities and IC to measure CKM. With reference to the focus group method adopted in the qualitative research, it further develops original test items. Afterwards, two professors and three doctors of management were invited to proofread the scale in a professional way. Eight middle enterprise managers were invited to make semantic analysis and amend the scale. After preliminary amendment, test items of all variables are mapped out from Table III-2 to Table III-9.

Table III-2: ACI Test Items

<table>
<thead>
<tr>
<th>Code</th>
<th>Item</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>I1</td>
<td>Highlight the importance of CK to enterprises</td>
<td>Jayachandran et al. (2004)</td>
</tr>
<tr>
<td>I2</td>
<td>Highlight customer background survey in the earlier stage of the project</td>
<td>Design of this thesis</td>
</tr>
<tr>
<td>I3</td>
<td>Highlight deep interaction with customers through meeting and project groups</td>
<td>Jayachandran et al. (2004)</td>
</tr>
<tr>
<td>I4</td>
<td>Highlight taking the initiative to collect customer feedback and complaints</td>
<td>Ii Liyun et al. (2012)</td>
</tr>
<tr>
<td>I5</td>
<td>Highlight acquiring CK by analyzing various market demands</td>
<td>Ii Liyun et al. (2012)</td>
</tr>
<tr>
<td>I6</td>
<td>Highlight customer evaluation to the service quality of other design enterprises</td>
<td>Design of this thesis</td>
</tr>
</tbody>
</table>

Table III-3: EXN Test Items

<table>
<thead>
<tr>
<th>Code</th>
<th>Item</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>I7</td>
<td>Highlight building interactive network platform with customers</td>
<td>Tiwana (2001)</td>
</tr>
<tr>
<td>I8</td>
<td>Highlight filing and keeping various customer profiles during the process of design</td>
<td>Nonaka (1995)</td>
</tr>
<tr>
<td>I9</td>
<td>Highlight regular updating of customer information in database</td>
<td>Tiwana (2001)</td>
</tr>
<tr>
<td>I10</td>
<td>Highlight building customer evaluation system and keeping evaluation results</td>
<td>Nastaran et al. (2013)</td>
</tr>
<tr>
<td>I11</td>
<td>Highlight building special departments or using special employees to systemize CK information</td>
<td>Nastaran et al. (2013)</td>
</tr>
</tbody>
</table>

Table III-4: ING Test Items

<table>
<thead>
<tr>
<th>Code</th>
<th>Item</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>I12</td>
<td>Highlight the integration of customer database in all departments</td>
<td>Tiwana (2001)</td>
</tr>
<tr>
<td>I13</td>
<td>Highlight building CK system and systemizing CK of different projects</td>
<td>Tiwana (2001)</td>
</tr>
<tr>
<td>I14</td>
<td>Highlight training employees to be familiar with customer database</td>
<td>Nastaran et al. (2013)</td>
</tr>
<tr>
<td>I15</td>
<td>Highlight adjusting enterprise strategies based on systemized CK</td>
<td>Nastaran et al. (2013)</td>
</tr>
<tr>
<td>I16</td>
<td>Highlight continuous research on customer demands and customer behavior</td>
<td>Ii Liyun et al. (2012)</td>
</tr>
<tr>
<td>I17</td>
<td>Highlight taking measures to break CK barriers inside enterprises</td>
<td>Ii Liyun et al. (2012)</td>
</tr>
</tbody>
</table>
### Table III-5: INN Test Items

<table>
<thead>
<tr>
<th>Code</th>
<th>Item</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>I18</td>
<td>Highlight the humanization and high efficiency of CK database</td>
<td>Nastaran et al. (2013)</td>
</tr>
<tr>
<td>I19</td>
<td>Highlight organizing experts to lecture employees CK</td>
<td>Design of this thesis</td>
</tr>
<tr>
<td>I20</td>
<td>Highlight taking measures to encourage employees to share CK</td>
<td>Tiwana (2001)</td>
</tr>
<tr>
<td>I21</td>
<td>Highlight examining and improving design results based on customer feedback information</td>
<td>Li Liyun et al. (2012)</td>
</tr>
<tr>
<td>I22</td>
<td>Highlight constant conclusion of failure of this enterprise and other enterprises</td>
<td>Design of this thesis</td>
</tr>
</tbody>
</table>

### Table III-6: MAI Capacity Test Items

<table>
<thead>
<tr>
<th>Code</th>
<th>Item</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>I23</td>
<td>Highlight constant exploration of new approaches to realizing enterprise objectives</td>
<td>Wang Yonggui (2015)</td>
</tr>
<tr>
<td>I24</td>
<td>Highlight constant change of working contents and working methods</td>
<td>Wang Yonggui (2015)</td>
</tr>
<tr>
<td>I25</td>
<td>Highlight regular collection of the gold points of employees and offering rewards</td>
<td>Design of this thesis</td>
</tr>
<tr>
<td>I26</td>
<td>Highlight encouraging employees to study best design cases</td>
<td>Design of this thesis</td>
</tr>
<tr>
<td>I27</td>
<td>Highlight smooth communication among all departments</td>
<td>Nastaran et al. (2013)</td>
</tr>
<tr>
<td>I28</td>
<td>Highlight the research on and response to relevant policies, new states of competitors and market condition</td>
<td>Design of this thesis</td>
</tr>
</tbody>
</table>

### Table III-7: PRI Capacity Test Items

<table>
<thead>
<tr>
<th>Code</th>
<th>Item</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>I29</td>
<td>Highlight how well work flow and service process go</td>
<td>Wang Yonggui (2015)</td>
</tr>
<tr>
<td>I30</td>
<td>Highlight the speed in solving customer problems</td>
<td>Wang Yonggui (2015)</td>
</tr>
<tr>
<td>I31</td>
<td>Highlight efficient control of project costs</td>
<td>Design of this thesis</td>
</tr>
<tr>
<td>I32</td>
<td>Highlight continuous attention on the change of market demands</td>
<td>Wang Yonggui (2015)</td>
</tr>
<tr>
<td>I33</td>
<td>Highlight the improvement of work flow and service process according to new technologies</td>
<td>Design of this thesis</td>
</tr>
</tbody>
</table>

### Table III-8: TEI Capacity Test Items

<table>
<thead>
<tr>
<th>Code</th>
<th>Item</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>I34</td>
<td>Highlight independent development of enterprise information and KM system</td>
<td>Wang Yonggui (2015)</td>
</tr>
<tr>
<td>I35</td>
<td>Highlight the rearrangement of funds so as to support TEI</td>
<td>Wang Yonggui (2015)</td>
</tr>
<tr>
<td>I36</td>
<td>Highlight the efficiency in deciding to adopt a new kind of technology</td>
<td>Design of this thesis</td>
</tr>
<tr>
<td>I37</td>
<td>Highlight high-level R&amp;D</td>
<td>Design of this thesis</td>
</tr>
<tr>
<td>I38</td>
<td>Highlight the use of new technology and ideas in management</td>
<td>Design of this thesis</td>
</tr>
</tbody>
</table>

### Table III-9: BSI Capacity Test Items

<table>
<thead>
<tr>
<th>Code</th>
<th>Item</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>I39</td>
<td>Highlight awards in design projects</td>
<td>Design of this thesis</td>
</tr>
<tr>
<td>I40</td>
<td>Highlight constant rise in percentage of new business</td>
<td>Wang Yonggui (2015)</td>
</tr>
<tr>
<td>I41</td>
<td>Highlight quick response to improving projects according to advice from other parts</td>
<td>Design of this thesis</td>
</tr>
<tr>
<td>I42</td>
<td>Highlight being imitated by competitors thanks to advanced ideas</td>
<td>Wang Yonggui (2015)</td>
</tr>
</tbody>
</table>
IV Analysis and Discussions of Results

This chapter analyzes and discusses the findings of this research. Firstly, descriptive statistical analysis as well as reliability & validity analysis is conducted on results derived from a widely-based questionnaire, to illustrate that the scale is usable and widely applicable. Secondly, structural equitation model is established to demonstrate the relationship between customer knowledge management (CKM) and IC. Thirdly, in-depth interviews will be carried out on representative enterprises, as a supplementation to the model. Finally, based on the results of this thesis, it will come to the social significance of this research and its enlightenment on management mode of architectural design enterprises.

4.1 Analysis of Questionnaire Results

Scale pre-testing is to refine the questionnaire to make it applicable to final test. Reliability analysis of pre-test questionnaire refines questions in questionnaire by CITC and evaluates the reliability of the scale with Cronbach α. Validity analysis examines rationality and correctness through exploratory factor analysis (EFA).

4.1.1 Testing Results of Pre-test Sample

4.1.1.1 Demographics of Respondents

Sample test is conducted by questionnairing 15 enterprises in Beijing, with 70 questionnaires sent out in total and 65 replied. Among 65 replied questionnaires, six are mal-informed and the others are valid, presenting 84.3% of total dispatched questionnaires, which is reliable and valid enough to apply to sample test. Statistics are shown as follows:

<table>
<thead>
<tr>
<th>Descriptive indicators</th>
<th>Proportion</th>
<th>Descriptive indicators</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>57.5%</td>
<td>bachelor’s degree</td>
<td>27.8%</td>
</tr>
<tr>
<td>Female</td>
<td>42.5%</td>
<td>master’s degree and higher</td>
<td>72.2%</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below 30</td>
<td>14.7%</td>
<td>less than 3 years</td>
<td>3.9%</td>
</tr>
<tr>
<td>31-40</td>
<td>34.1%</td>
<td>4 to 6 years</td>
<td>35.3%</td>
</tr>
<tr>
<td>41-50</td>
<td>30.4%</td>
<td>7 to 9 years</td>
<td>54.6%</td>
</tr>
<tr>
<td>Over 51</td>
<td>20.8%</td>
<td>Over 10 years</td>
<td>6.2%</td>
</tr>
<tr>
<td>State-owned enterprise</td>
<td>34%</td>
<td>below 100</td>
<td>32%</td>
</tr>
<tr>
<td>Private enterprise</td>
<td>54%</td>
<td>100-500</td>
<td>34%</td>
</tr>
<tr>
<td>Type of enterprise</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State holding enterprise</td>
<td>8%</td>
<td>500-1000</td>
<td>18%</td>
</tr>
<tr>
<td>Private holding enterprise</td>
<td>4%</td>
<td>Over 1000</td>
<td>12%</td>
</tr>
</tbody>
</table>

4.1.1.2 Descriptive Statistics of Variables

This table represents statistical analysis of different items including mean value, standard deviation, skewness and kurtosis which are used to examine if the data received form a normal distribution. According
to Kline, that the absolute value of skewness is lower than three and the absolute value of qutosis is lower than ten means that the data basically obeys normal distribution (R. B. Kline, 2010). As shown in the following table, the mean value of each item is between 2.82 and 3.86, and standard deviation between 0.8311 and 1.251, skewness between -0.838 and 0.259, qutosis between -1.072 and 1.262. Therefore, variables as CKM and IC form normal distribution and are applicable to reliability and validity analysis.

<table>
<thead>
<tr>
<th>No.</th>
<th>Mean value</th>
<th>Standard deviation</th>
<th>Skewness</th>
<th>Qutosis</th>
<th>No.</th>
<th>Mean value</th>
<th>Standard deviation</th>
<th>Skewness</th>
<th>Qutosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>I1</td>
<td>3.58</td>
<td>0.917</td>
<td>-0.07</td>
<td>-0.77</td>
<td>I7</td>
<td>3.22</td>
<td>1.139</td>
<td>-0.05</td>
<td>-0.75</td>
</tr>
<tr>
<td>I2</td>
<td>3.54</td>
<td>1.017</td>
<td>-0.06</td>
<td>-1.07</td>
<td>I8</td>
<td>3.37</td>
<td>1.180</td>
<td>-0.35</td>
<td>-0.45</td>
</tr>
<tr>
<td>I3</td>
<td>3.62</td>
<td>1.071</td>
<td>-0.43</td>
<td>-0.45</td>
<td>I9</td>
<td>3.46</td>
<td>1.251</td>
<td>-0.40</td>
<td>-0.86</td>
</tr>
<tr>
<td>I4</td>
<td>3.29</td>
<td>1.071</td>
<td>0.01</td>
<td>-0.44</td>
<td>I10</td>
<td>3.52</td>
<td>1.174</td>
<td>-0.42</td>
<td>-0.80</td>
</tr>
<tr>
<td>I5</td>
<td>2.85</td>
<td>1.176</td>
<td>0.19</td>
<td>-0.62</td>
<td>I11</td>
<td>2.88</td>
<td>1.153</td>
<td>0.18</td>
<td>-0.55</td>
</tr>
<tr>
<td>I6</td>
<td>3.38</td>
<td>1.011</td>
<td>-0.19</td>
<td>-0.41</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I12</td>
<td>2.97</td>
<td>1.131</td>
<td>0.20</td>
<td>-0.51</td>
<td>I18</td>
<td>2.89</td>
<td>0.986</td>
<td>0.12</td>
<td>-0.07</td>
</tr>
<tr>
<td>I13</td>
<td>3.11</td>
<td>1.002</td>
<td>0.26</td>
<td>-0.39</td>
<td>I19</td>
<td>3.08</td>
<td>0.989</td>
<td>-0.06</td>
<td>-0.10</td>
</tr>
<tr>
<td>I14</td>
<td>2.82</td>
<td>1.102</td>
<td>0.16</td>
<td>-0.20</td>
<td>I20</td>
<td>3.45</td>
<td>1.061</td>
<td>-0.10</td>
<td>-0.91</td>
</tr>
<tr>
<td>I15</td>
<td>3.06</td>
<td>1.088</td>
<td>-0.13</td>
<td>-0.44</td>
<td>I21</td>
<td>3.35</td>
<td>1.052</td>
<td>-0.43</td>
<td>-0.50</td>
</tr>
<tr>
<td>I16</td>
<td>3.35</td>
<td>1.067</td>
<td>-0.36</td>
<td>-0.24</td>
<td>I22</td>
<td>3.29</td>
<td>0.947</td>
<td>0.17</td>
<td>-0.37</td>
</tr>
<tr>
<td>I17</td>
<td>3.22</td>
<td>1.111</td>
<td>-0.44</td>
<td>-0.21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I23</td>
<td>3.68</td>
<td>0.886</td>
<td>-0.84</td>
<td>1.26</td>
<td>I29</td>
<td>3.62</td>
<td>0.896</td>
<td>-0.49</td>
<td>0.80</td>
</tr>
<tr>
<td>I24</td>
<td>3.66</td>
<td>0.871</td>
<td>-0.59</td>
<td>0.46</td>
<td>I30</td>
<td>3.86</td>
<td>0.846</td>
<td>-0.53</td>
<td>0.71</td>
</tr>
<tr>
<td>I25</td>
<td>3.72</td>
<td>0.910</td>
<td>-0.44</td>
<td>0.12</td>
<td>I31</td>
<td>3.43</td>
<td>0.901</td>
<td>0.08</td>
<td>-0.71</td>
</tr>
<tr>
<td>I26</td>
<td>2.89</td>
<td>1.062</td>
<td>0.14</td>
<td>-0.07</td>
<td>I32</td>
<td>3.51</td>
<td>0.886</td>
<td>-0.09</td>
<td>0.00</td>
</tr>
<tr>
<td>I27</td>
<td>3.49</td>
<td>0.986</td>
<td>-0.63</td>
<td>0.30</td>
<td>I33</td>
<td>3.71</td>
<td>0.879</td>
<td>-0.38</td>
<td>-0.43</td>
</tr>
<tr>
<td>I28</td>
<td>3.51</td>
<td>0.868</td>
<td>-0.17</td>
<td>0.12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I34</td>
<td>3.42</td>
<td>0.967</td>
<td>-0.29</td>
<td>-0.12</td>
<td>I39</td>
<td>3.32</td>
<td>1.161</td>
<td>-0.30</td>
<td>-0.62</td>
</tr>
<tr>
<td>I35</td>
<td>3.37</td>
<td>0.945</td>
<td>-0.24</td>
<td>-0.03</td>
<td>I40</td>
<td>3.48</td>
<td>0.937</td>
<td>-0.17</td>
<td>-0.32</td>
</tr>
<tr>
<td>I36</td>
<td>3.22</td>
<td>1.008</td>
<td>-0.26</td>
<td>-0.48</td>
<td>I41</td>
<td>3.60</td>
<td>0.932</td>
<td>-0.18</td>
<td>-0.23</td>
</tr>
<tr>
<td>I37</td>
<td>3.37</td>
<td>0.977</td>
<td>-0.09</td>
<td>-0.17</td>
<td>I42</td>
<td>3.77</td>
<td>0.932</td>
<td>-0.47</td>
<td>-0.52</td>
</tr>
<tr>
<td>I38</td>
<td>3.14</td>
<td>1.088</td>
<td>-0.36</td>
<td>-0.20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 4.1.1.3 Reality analysis

This research adapted CITC and Cronbach α to examine whether the scale is consistent and stable enough to measure related variables. Cronbach α reflects the extent to which items relating to one variable correlate to each other. The value of Cronbach α should fall between zero and one. The higher the value, the more correlated the items are and the higher the validity is. When the value of Cronbach α is higher than 0.8, reliability is good (R. B. Kline, 2010).
### Table IV-3: Results of Validity Analysis

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>No.</th>
<th>CITC</th>
<th>Alpha if Item Deleted</th>
<th>Cronbach α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition of CK</td>
<td>I1</td>
<td>0.77</td>
<td>0.900</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I2</td>
<td>0.64</td>
<td>0.909</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I3</td>
<td>0.69</td>
<td>0.905</td>
<td>0.914</td>
</tr>
<tr>
<td></td>
<td>I4</td>
<td>0.74</td>
<td>0.901</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I5</td>
<td>0.78</td>
<td>0.898</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I6</td>
<td>0.73</td>
<td>0.902</td>
<td></td>
</tr>
<tr>
<td>externalization of CK</td>
<td>I7</td>
<td>0.61</td>
<td>0.947</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I8</td>
<td>0.86</td>
<td>0.930</td>
<td>0.942</td>
</tr>
<tr>
<td></td>
<td>I9</td>
<td>0.8</td>
<td>0.934</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I10</td>
<td>0.78</td>
<td>0.935</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I11</td>
<td>0.85</td>
<td>0.931</td>
<td></td>
</tr>
<tr>
<td>Integration of CK</td>
<td>I12</td>
<td>0.77</td>
<td>0.927</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I13</td>
<td>0.85</td>
<td>0.921</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I14</td>
<td>0.82</td>
<td>0.923</td>
<td>0.935</td>
</tr>
<tr>
<td></td>
<td>I15</td>
<td>0.82</td>
<td>0.923</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I16</td>
<td>0.8</td>
<td>0.924</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I17</td>
<td>0.75</td>
<td>0.928</td>
<td></td>
</tr>
<tr>
<td>Internalization of CK</td>
<td>I18</td>
<td>0.67</td>
<td>0.906</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I19</td>
<td>0.69</td>
<td>0.904</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I20</td>
<td>0.77</td>
<td>0.898</td>
<td>0.913</td>
</tr>
<tr>
<td></td>
<td>I21</td>
<td>0.75</td>
<td>0.899</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I22</td>
<td>0.81</td>
<td>0.895</td>
<td></td>
</tr>
<tr>
<td>Capacity of management innovation</td>
<td>I23</td>
<td>0.75</td>
<td>0.902</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I24</td>
<td>0.74</td>
<td>0.903</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I25</td>
<td>0.74</td>
<td>0.902</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I26</td>
<td>0.72</td>
<td>0.905</td>
<td>0.915</td>
</tr>
<tr>
<td></td>
<td>I27</td>
<td>0.83</td>
<td>0.895</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I28</td>
<td>0.73</td>
<td>0.904</td>
<td></td>
</tr>
<tr>
<td>Capacity of work flow innovation</td>
<td>I29</td>
<td>0.72</td>
<td>0.887</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I30</td>
<td>0.69</td>
<td>0.889</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I31</td>
<td>0.73</td>
<td>0.886</td>
<td>0.902</td>
</tr>
<tr>
<td></td>
<td>I32</td>
<td>0.8</td>
<td>0.880</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I33</td>
<td>0.77</td>
<td>0.883</td>
<td></td>
</tr>
<tr>
<td>Capacity of technology innovation</td>
<td>I34</td>
<td>0.72</td>
<td>0.917</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I35</td>
<td>0.68</td>
<td>0.920</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I36</td>
<td>0.78</td>
<td>0.911</td>
<td>0.925</td>
</tr>
<tr>
<td></td>
<td>I37</td>
<td>0.84</td>
<td>0.907</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I38</td>
<td>0.82</td>
<td>0.909</td>
<td></td>
</tr>
<tr>
<td>Capacity of product innovation</td>
<td>I39</td>
<td>0.64</td>
<td>0.917</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I40</td>
<td>0.71</td>
<td>0.908</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I41</td>
<td>0.77</td>
<td>0.904</td>
<td>0.918</td>
</tr>
<tr>
<td></td>
<td>I42</td>
<td>0.81</td>
<td>0.901</td>
<td></td>
</tr>
</tbody>
</table>

According to this table, Cronbach α values on four dimensions of CKM and four dimensions of IC are all above 0.80, which means that the scale including these eight dimensions are of good reliability. As for CITC values on these dimensions, they are all above 0.5, indicating that the scale has a good consistency.
4.1.1.4 Validity analysis

Validity analysis is able to test if the conceptual dimensions and empirical dimensions are applicable. To value the validity of these dimensions, KMO (Kaiser-Meyer-Olkin) and Bartlett Test of Sphericity will be taken. When the value of KMO is higher than 0.9, EFA is applicable (Bagozzi, 1981). When the value of KMO is lower than 0.5, EFA is inapplicable. Then we will conduct validity analysis of variables of CKM and IC.

Table IV-4: KMO and Bartlett Test of Sphericity on CKM

<table>
<thead>
<tr>
<th>KMO</th>
<th>Measures of sampling adequacy</th>
<th>0.922</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bartlett Test of Sphericity</td>
<td>Approximate chi-square</td>
<td>1250.78</td>
</tr>
<tr>
<td></td>
<td>Degree of freedom (DF)</td>
<td>151</td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Table IV-5: Exploratory factor analysis (EFA) on variables of CKM

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>No.</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge acquisition</td>
<td>I2</td>
<td>0.780</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I4</td>
<td>0.765</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I6</td>
<td>0.674</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I5</td>
<td>0.545</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I3</td>
<td>0.545</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I1</td>
<td>0.511</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge externalization</td>
<td>I10</td>
<td>0.745</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I7</td>
<td>0.714</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I9</td>
<td>0.676</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I8</td>
<td>0.604</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I11</td>
<td>0.536</td>
<td>0.587</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge integration</td>
<td>I16</td>
<td>0.753</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I12</td>
<td>0.714</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I14</td>
<td>0.642</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I15</td>
<td>0.608</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I17</td>
<td>0.574</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I13</td>
<td>0.515</td>
<td>0.528</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge internalization</td>
<td>I20</td>
<td>0.767</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I19</td>
<td>0.742</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I22</td>
<td>0.727</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I18</td>
<td>0.641</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I21</td>
<td>0.542</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Shown as results of EFA on CKM: The value of KMO is 0.922, indicating that factor analysis is applicable. Besides, the value resulting from Bartlett Test of Sphericity turns out to be 1250.78 (DF is 231) and the value of sig is 0.000, reaching significance level, which indicates that there are common factors among relating matrices of population and factor analysis is applicable. Also, according to varimax, this research intercept data by taking eigenvalue as one, with four factors whose eigenvalue is above one selected out, explaining 74.4% of total variance over primitive variables. At the same time, factor loading of every item in every single dimension is higher than 0.5, which indicates good convergent validity and dimensional unicity. What’s more, most of the items failed to gain high factor loadings simultaneously in
different dimensions, e.g. there is no trans-factor loading (Cross . Loading), exhibiting some discriminate validity. Trans-factor loading can be observed only between I11 and I13. However, considering the number of samples in pre-test is limited causing instability to analytical results, we retain these two pre-test and will five more attention in large sample research.

Shown as results of EFA on IC: the value of KMO is 0.868, indicating that IC is fit to factor analysis. Besides, value resulting from Bartlett Test of Sphericity turns out to be 1092.77 (Df is 190) and the value of sig is 0.000, reaching significance level, which indicates that there are common factors among relating matrices of population and factor analysis is applicable. Also, according to varimax, this research intercept data by taking eigenvalue as one, with four factors whose eigenvalue is above one selected out, explaining 74.4% of total variance over primitive variables. At the same time, factor loading of every item in every single dimension is higher than 0.5, which indicates good convergent validity and dimensional unicity.

What’s more, most of the items failed to gain high factor loadings simultaneously in different dimensions, e.g. there is no trans-factor loading (Cross . Loading), exhibiting some discriminate validity.

Table IV-6: KMO and Bartlett Test of Sphericity on IC

<table>
<thead>
<tr>
<th>KMO</th>
<th>Measures of sampling adequacy</th>
<th>0.868</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bartlett Test of Sphericity</td>
<td>Approximate chi-square</td>
<td>1092.77</td>
</tr>
<tr>
<td></td>
<td>Degree of freedom (DF)</td>
<td>187</td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Table IV-7: Example factory analysis (EFA) on variables of IC

<table>
<thead>
<tr>
<th>Dimension</th>
<th>No.</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management</td>
<td>I28</td>
<td>0.786</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I24</td>
<td>0.745</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>innovation</td>
<td>I26</td>
<td>0.647</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I23</td>
<td>0.624</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I25</td>
<td>0.565</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I27</td>
<td>0.547</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work flow</td>
<td>I30</td>
<td>0.786</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>innovation</td>
<td>I32</td>
<td>0.696</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I29</td>
<td>0.693</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I33</td>
<td>0.671</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I31</td>
<td>0.585</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td>I37</td>
<td>0.803</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>innovation</td>
<td>I34</td>
<td>0.728</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I36</td>
<td>0.703</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I35</td>
<td>0.594</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I38</td>
<td>0.53</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td>I39</td>
<td>0.798</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovation</td>
<td>I40</td>
<td>0.772</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I41</td>
<td>0.676</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I42</td>
<td>0.671</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

After pretest, the wording of the questionnaire was improved. Also, the reliability and validity of the original version was manifested, with some irrelevant items deleted and some items needing extra attention
put forward, coming to a final version of the questionnaire.

4.1.2 Testing Results of Large Sample

4.1.2.1 Demographics of Respondents and Descriptive Statistics of Variables

After we worked out large sample based on pretest, three hundred questionnaires were sent out as elaborated in researching method. Totally 288 questionnaires were answered, presenting 96% of those sent out and 277 were selected out as effective, presenting 92.3%, as shown in the following table.

According to the results, the mean value of each item falls between 2.68 to 3.77, and standard deviation between 0.54 to 0.89, skewness between 0.77 to 0.43 and quotion between -0.63 to 0.95, indicating that variables of CKM and IC follow formal distribution and are applicable to reliability and validity analysis.

Table IV-8: Demographics of Respondents on large sample

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Proportion</th>
<th>Indicators</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td>Education level</td>
<td></td>
</tr>
<tr>
<td>male</td>
<td>65.7%</td>
<td>bachelor’s degree</td>
<td>31.4%</td>
</tr>
<tr>
<td>female</td>
<td>34.3%</td>
<td>master’s degree or higher</td>
<td>68.6%</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>Length of service</td>
<td></td>
</tr>
<tr>
<td>Below 30</td>
<td>16.7%</td>
<td>Less than 3 years</td>
<td>7.8%</td>
</tr>
<tr>
<td>31-40</td>
<td>27.1%</td>
<td>Four to six years</td>
<td>31.4%</td>
</tr>
<tr>
<td>41-50</td>
<td>32.6%</td>
<td>Seven to nine years</td>
<td>53.0%</td>
</tr>
<tr>
<td>Over 51</td>
<td>23.6%</td>
<td>Over 10 years</td>
<td>7.8%</td>
</tr>
<tr>
<td>State-owned enterprise</td>
<td></td>
<td>below 100</td>
<td>38%</td>
</tr>
<tr>
<td>Private enterprise</td>
<td>56%</td>
<td>100-500</td>
<td>34%</td>
</tr>
<tr>
<td>Type of enterprise</td>
<td></td>
<td>Enterprise size</td>
<td></td>
</tr>
<tr>
<td>Stata holding enterprise</td>
<td>10%</td>
<td>500-1000</td>
<td>20%</td>
</tr>
<tr>
<td>Private holding enterprise</td>
<td>1%</td>
<td>over 1000</td>
<td>8%</td>
</tr>
</tbody>
</table>
Table IV-9: Descriptive Statistics of Variables

<table>
<thead>
<tr>
<th>No.</th>
<th>Mean value</th>
<th>Standard deviation</th>
<th>Skewness</th>
<th>Qutosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>I1</td>
<td>3.58</td>
<td>0.69</td>
<td>0.43</td>
<td>-0.43</td>
</tr>
<tr>
<td>I2</td>
<td>3.59</td>
<td>0.76</td>
<td>0.37</td>
<td>-0.54</td>
</tr>
<tr>
<td>I3</td>
<td>3.52</td>
<td>0.79</td>
<td>0.09</td>
<td>-0.17</td>
</tr>
<tr>
<td>I4</td>
<td>3.29</td>
<td>0.75</td>
<td>-0.08</td>
<td>-0.04</td>
</tr>
<tr>
<td>I5</td>
<td>3.07</td>
<td>0.78</td>
<td>0.26</td>
<td>-0.08</td>
</tr>
<tr>
<td>I6</td>
<td>3.43</td>
<td>0.77</td>
<td>-0.23</td>
<td>-0.17</td>
</tr>
</tbody>
</table>

**Acquisition of CK**

<table>
<thead>
<tr>
<th>No.</th>
<th>Mean value</th>
<th>Standard deviation</th>
<th>Skewness</th>
<th>Qutosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>I7</td>
<td>3.03</td>
<td>0.77</td>
<td>-0.04</td>
<td>-0.28</td>
</tr>
<tr>
<td>I8</td>
<td>3.32</td>
<td>0.80</td>
<td>-0.25</td>
<td>0.10</td>
</tr>
<tr>
<td>I9</td>
<td>2.94</td>
<td>0.72</td>
<td>-0.18</td>
<td>-0.24</td>
</tr>
<tr>
<td>I10</td>
<td>2.91</td>
<td>0.77</td>
<td>0.01</td>
<td>-0.11</td>
</tr>
<tr>
<td>I11</td>
<td>2.98</td>
<td>0.67</td>
<td>-0.19</td>
<td>0.93</td>
</tr>
</tbody>
</table>

**Externalization of CK**

<table>
<thead>
<tr>
<th>No.</th>
<th>Mean value</th>
<th>Standard deviation</th>
<th>Skewness</th>
<th>Qutosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>I12</td>
<td>2.81</td>
<td>0.79</td>
<td>0.06</td>
<td>-0.31</td>
</tr>
<tr>
<td>I13</td>
<td>3.02</td>
<td>0.62</td>
<td>0.04</td>
<td>0.49</td>
</tr>
<tr>
<td>I14</td>
<td>2.68</td>
<td>0.80</td>
<td>-0.13</td>
<td>-0.21</td>
</tr>
<tr>
<td>I15</td>
<td>3.29</td>
<td>0.73</td>
<td>-0.16</td>
<td>0.17</td>
</tr>
<tr>
<td>I16</td>
<td>3.41</td>
<td>0.66</td>
<td>-0.29</td>
<td>0.15</td>
</tr>
<tr>
<td>I17</td>
<td>3.09</td>
<td>0.74</td>
<td>-0.62</td>
<td>0.93</td>
</tr>
</tbody>
</table>

**Integration of CK**

<table>
<thead>
<tr>
<th>No.</th>
<th>Mean value</th>
<th>Standard deviation</th>
<th>Skewness</th>
<th>Qutosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>I18</td>
<td>2.78</td>
<td>0.54</td>
<td>-0.60</td>
<td>0.81</td>
</tr>
<tr>
<td>I19</td>
<td>3.42</td>
<td>0.89</td>
<td>0.08</td>
<td>-0.63</td>
</tr>
<tr>
<td>I20</td>
<td>3.29</td>
<td>0.72</td>
<td>-0.47</td>
<td>-0.31</td>
</tr>
<tr>
<td>I21</td>
<td>3.46</td>
<td>0.69</td>
<td>-0.77</td>
<td>0.28</td>
</tr>
<tr>
<td>I22</td>
<td>3.40</td>
<td>0.73</td>
<td>-0.36</td>
<td>0.03</td>
</tr>
</tbody>
</table>

**Capacity of management innovation**

<table>
<thead>
<tr>
<th>No.</th>
<th>Mean value</th>
<th>Standard deviation</th>
<th>Skewness</th>
<th>Qutosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>I23</td>
<td>3.62</td>
<td>0.64</td>
<td>-0.58</td>
<td>0.83</td>
</tr>
<tr>
<td>I24</td>
<td>3.54</td>
<td>0.65</td>
<td>0.18</td>
<td>0.02</td>
</tr>
<tr>
<td>I25</td>
<td>2.72</td>
<td>0.63</td>
<td>0.05</td>
<td>0.33</td>
</tr>
<tr>
<td>I26</td>
<td>3.31</td>
<td>0.67</td>
<td>-0.35</td>
<td>0.13</td>
</tr>
<tr>
<td>I27</td>
<td>3.31</td>
<td>0.62</td>
<td>-0.06</td>
<td>0.02</td>
</tr>
<tr>
<td>I28</td>
<td>3.35</td>
<td>0.59</td>
<td>0.34</td>
<td>0.38</td>
</tr>
</tbody>
</table>

**Capacity of work flow innovation**

<table>
<thead>
<tr>
<th>No.</th>
<th>Mean value</th>
<th>Standard deviation</th>
<th>Skewness</th>
<th>Qutosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>I29</td>
<td>3.38</td>
<td>0.62</td>
<td>-0.18</td>
<td>0.28</td>
</tr>
<tr>
<td>I30</td>
<td>3.77</td>
<td>0.67</td>
<td>0.07</td>
<td>-0.16</td>
</tr>
<tr>
<td>I31</td>
<td>3.30</td>
<td>0.66</td>
<td>-0.24</td>
<td>-0.53</td>
</tr>
<tr>
<td>I32</td>
<td>3.59</td>
<td>0.58</td>
<td>-0.14</td>
<td>-0.45</td>
</tr>
<tr>
<td>I33</td>
<td>3.34</td>
<td>0.55</td>
<td>0.29</td>
<td>-0.43</td>
</tr>
</tbody>
</table>

**Capacity of technology innovation**

<table>
<thead>
<tr>
<th>No.</th>
<th>Mean value</th>
<th>Standard deviation</th>
<th>Skewness</th>
<th>Qutosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>I34</td>
<td>3.45</td>
<td>0.63</td>
<td>-0.60</td>
<td>0.21</td>
</tr>
<tr>
<td>I35</td>
<td>3.03</td>
<td>0.58</td>
<td>-0.13</td>
<td>0.96</td>
</tr>
<tr>
<td>I36</td>
<td>3.15</td>
<td>0.60</td>
<td>-0.08</td>
<td>0.40</td>
</tr>
<tr>
<td>I37</td>
<td>3.19</td>
<td>0.76</td>
<td>-0.35</td>
<td>-0.16</td>
</tr>
<tr>
<td>I38</td>
<td>3.34</td>
<td>0.73</td>
<td>-0.20</td>
<td>-0.33</td>
</tr>
</tbody>
</table>
4.1.2.2 Consistency test

Reliability analysis of consistency will also be studied through CITC and Cronbach $\alpha$. As shown in Table IV-11, Cronbach $\alpha$ values on four dimensions of CKM and IC are all above 0.7, indicating the scale including these eight dimensions is of good reliability. As for the value of CITC, the last item I28 relating to capacity of management innovation turns out to be 0.246<0.3 (minimum standard). If delete I28, the value of $\alpha$ elevates to 0.77. Therefore, I28n should be deleted out, leaving other 41 items, whose CITC values are all over 0.4, indicating that the scale is of good consistency.

Table IV-10: Descriptive Statistics of Variables

<table>
<thead>
<tr>
<th>No.</th>
<th>Median</th>
<th>Mode</th>
<th>Minimum value</th>
<th>Maximum value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I1</td>
<td>4.00</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>I2</td>
<td>3.00</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>I3</td>
<td>3.00</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I4</td>
<td>3.00</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I5</td>
<td>3.00</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I6</td>
<td>3.00</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I12</td>
<td>3.00</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I13</td>
<td>3.00</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I14</td>
<td>3.00</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I15</td>
<td>3.00</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I16</td>
<td>3.00</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I17</td>
<td>3.00</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I23</td>
<td>4.00</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I24</td>
<td>4.00</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I25</td>
<td>3.00</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I26</td>
<td>3.00</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I27</td>
<td>3.00</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I28</td>
<td>3.00</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I34</td>
<td>4.00</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I35</td>
<td>3.00</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I36</td>
<td>3.00</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I37</td>
<td>3.00</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>I38</td>
<td>3.00</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

Table IV-11: Reliability analysis of consistency
<table>
<thead>
<tr>
<th>Dimensions</th>
<th>No.</th>
<th>CITC</th>
<th>Alpha if Item Deleted</th>
<th>Cronbach α</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acquisition of CK</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I1</td>
<td>0.601</td>
<td>0.655</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I2</td>
<td>0.414</td>
<td>0.706</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I3</td>
<td>0.409</td>
<td>0.708</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I4</td>
<td>0.486</td>
<td>0.684</td>
<td></td>
<td>0.729</td>
</tr>
<tr>
<td>I5</td>
<td>0.464</td>
<td>0.691</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I6</td>
<td>0.423</td>
<td>0.703</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Externalization of CK</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I7</td>
<td>0.540</td>
<td>0.767</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I8</td>
<td>0.558</td>
<td>0.762</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I9</td>
<td>0.580</td>
<td>0.754</td>
<td></td>
<td>0.794</td>
</tr>
<tr>
<td>I10</td>
<td>0.613</td>
<td>0.743</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I11</td>
<td>0.587</td>
<td>0.752</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Integration of CK</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I12</td>
<td>0.565</td>
<td>0.766</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I13</td>
<td>0.625</td>
<td>0.755</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I14</td>
<td>0.559</td>
<td>0.768</td>
<td></td>
<td>0.800</td>
</tr>
<tr>
<td>I15</td>
<td>0.523</td>
<td>0.776</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I16</td>
<td>0.480</td>
<td>0.785</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I17</td>
<td>0.586</td>
<td>0.761</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Internalization of CK</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I18</td>
<td>0.416</td>
<td>0.775</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I19</td>
<td>0.571</td>
<td>0.698</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I20</td>
<td>0.671</td>
<td>0.659</td>
<td></td>
<td>0.757</td>
</tr>
<tr>
<td>I21</td>
<td>0.501</td>
<td>0.722</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I22</td>
<td>0.573</td>
<td>0.695</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Capacity of management innovation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I23</td>
<td>0.527</td>
<td>0.618</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I24</td>
<td>0.443</td>
<td>0.646</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I25</td>
<td>0.459</td>
<td>0.673</td>
<td></td>
<td>0.744</td>
</tr>
<tr>
<td>I26</td>
<td>0.570</td>
<td>0.600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I27</td>
<td>0.411</td>
<td>0.661</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I28</td>
<td>0.246</td>
<td>0.705</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Capacity of work flow innovation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I29</td>
<td>0.448</td>
<td>0.699</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I30</td>
<td>0.422</td>
<td>0.704</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I31</td>
<td>0.582</td>
<td>0.670</td>
<td></td>
<td>0.731</td>
</tr>
<tr>
<td>I32</td>
<td>0.481</td>
<td>0.693</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I33</td>
<td>0.401</td>
<td>0.714</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Capacity of technology innovation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I34</td>
<td>0.408</td>
<td>0.747</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I35</td>
<td>0.533</td>
<td>0.706</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I36</td>
<td>0.602</td>
<td>0.682</td>
<td></td>
<td>0.753</td>
</tr>
<tr>
<td>I37</td>
<td>0.514</td>
<td>0.714</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I38</td>
<td>0.556</td>
<td>0.696</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Capacity of product innovation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I39</td>
<td>0.481</td>
<td>0.811</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I40</td>
<td>0.587</td>
<td>0.796</td>
<td></td>
<td>0.822</td>
</tr>
<tr>
<td>I41</td>
<td>0.561</td>
<td>0.799</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I42</td>
<td>0.683</td>
<td>0.782</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**4.1.2.3 Exploratory Factor Analysis (EFA)**

According to the results of EFA on CKM: the value of KMO is 0.878, indicating that EFA is applicable. Besides, value resulting from Bartlett Test of Sphericity turns out to be 2880.78 (Df is 231) and the value of sig is 0.000, reaching significance level, which indicates that there are common factors among relating matrixes of population and factor analysis is applicable. Also, according to varimax, this research
intercept data by taking eigenvalue as one, with four factors whose eigenvalue is above one selected out, explaining 64.4% of total variance over primitive variables. At the same time, factor loading of every item in every single dimension is higher than 0.5, which indicates good convergent validity and dimensional unicity. Attention should be paid that there are trans-factor loadings among I5, I11 and I13, which is to some extend similar to the results of pretest, making some trouble to factor discrimination. Thus, to ensure the consistency of scale, these three questions will be deleted out.

Therefore, this research has manifested by EFA that the four dimensions concluded from theoretical induction are basically coincide with the four dimensions gained from empirical data. It means that CKM can be divided into four dimensions including the acquisition, externalization, integration, and the internalization of CKM. In this process, I5, I11 and I13 were deleted out leaving nineteen questions in total.

Table IV-12: KMO and Bartlett Test of Sphericity on CKM

<table>
<thead>
<tr>
<th>KMO</th>
<th>Measures of sampling adequacy</th>
<th>0.878</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bartlett Test of Sphericity</td>
<td>Approximate chi-square</td>
<td>2880.78</td>
</tr>
<tr>
<td></td>
<td>Degree of freedom</td>
<td>231</td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Table IV-13: EFA on variables of CKM

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>No.</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge acquisition</td>
<td>I4</td>
<td>0.847</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I3</td>
<td>0.699</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I6</td>
<td>0.612</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I2</td>
<td>0.604</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I1</td>
<td>0.584</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I5</td>
<td>0.555</td>
<td>0.847</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge externalization</td>
<td>I7</td>
<td>0.701</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I10</td>
<td>0.639</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I8</td>
<td>0.608</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I9</td>
<td>0.607</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I11</td>
<td>0.591</td>
<td>0.587</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge integration</td>
<td>I12</td>
<td></td>
<td></td>
<td>0.706</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I14</td>
<td></td>
<td></td>
<td>0.691</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I16</td>
<td></td>
<td></td>
<td>0.650</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I15</td>
<td></td>
<td></td>
<td>0.649</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I17</td>
<td></td>
<td></td>
<td>0.506</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I13</td>
<td></td>
<td>0.527</td>
<td>0.576</td>
<td></td>
</tr>
<tr>
<td>Knowledge internalization</td>
<td>I18</td>
<td>0.772</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I20</td>
<td>0.728</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I21</td>
<td>0.702</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I22</td>
<td>0.682</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I19</td>
<td>0.608</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

According to the results of EFA on IC: the value of KMO is 0.813, indicating that EFA is applicable. Besides, value resulting from Bartlett Test of Sphericity turns out to be 2072.86 (Df is 190) and the value of sig is 0.000, reaching significance level, which indicates that there are common factors among relating matrixes of population and factor analysis is applicable. Also, according to varimax, this research intercept
data by taking eigenvalue as one, with four factors whose eigenvalue is above one selected out, explaining 57.7\% of total variance over primitive variables. At the same time, factor loading of every item in every single dimension is higher than 0.5, which indicates good convergent validity and dimensional unicity. Attention should be paid that there are trans-factor loadings between I32 and I35, which has caused some trouble to factor discrimination. Thus, to ensure the consistency of scale, these two questions will be deleted out.

Therefore, this research has manifested by EFA that the four dimensions concluded from theoretical induction are basically coincide with the four dimensions gained from empirical data. It means that IC can be divided into four dimensions including management innovation, work flow innovation, technology innovation and business innovation. In this process, I32 and I35 were deleted out leaving seventeen questions in total.

<table>
<thead>
<tr>
<th>Table IV-14: KMO and Bartlett Test of Sphericity on IC</th>
</tr>
</thead>
<tbody>
<tr>
<td>KMO Measures of sampling adequacy 0.813</td>
</tr>
<tr>
<td>Bartlett Test of Sphericity Approximate chi-square 2072.86</td>
</tr>
<tr>
<td>Degree of free 190</td>
</tr>
<tr>
<td>Significance 0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table IV-15: EFA on variables of IC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension No. Factor 1 Factor 2 Factor 3 Factor 4</td>
</tr>
<tr>
<td>Management innovation I24 0.685 I27 0.676 I26 0.609 I25 0.562 I23 0.539</td>
</tr>
<tr>
<td>Process innovation I29 0.694 I33 0.666 I31 0.611 I32 0.587 0.607 I30 0.585</td>
</tr>
<tr>
<td>Technology innovation I35 0.765 0.786 I37 0.775 I38 0.653 I34 0.627 I36 0.605</td>
</tr>
<tr>
<td>Work flow innovation I39 0.681 I40 0.636 I42 0.578 I41 0.555</td>
</tr>
</tbody>
</table>

4.1.2.4 Analysis of the Convergent Validity of the Scale

Reliability reflects the consistency or stability of the measures, while convergent validity measures the relevance among items. This thesis examines the consistency and validity of latent variables by composite reliability (CR) and average variance extracted from the subscales (AVE). In the measurement model of the structural equation model, the higher the composite reliability, the higher the relevance
among indicators. If the composite reliability is very low, the indicator is not relevant enough, which is unfavorable to the measurement of the latent variables. The measurement equitation of CR is as follow. Generally, it is preferred that CR is higher than 0.6:

\[ CR = \frac{(\sum \lambda)^2}{(\sum \lambda^2 + \sum \varepsilon_i)} \]

\( \lambda \) represents the standard load of observed variable to latent variable. And \( \varepsilon_i \) represents the measurement residual of the observed variable whose number is i.

The average variance extracted from the subscales (AVE) is the extent to which variables vary, which is relevant to measurement residual. This variable represents the proportion of true variance in observes variance. CR is more like the sum of scale’s reliability, while AVE refers to the indicators’ variances caused by one single factor, representing the overall variance ratio brought about by latent variable. AVE fluctuates between zero and one. According to Dillon and Goldstein, when AVE is higher than 0.5, the scale and variables are of good reliability (Dillon, 1986).

The measurement equation is as follow:

\[ AVE = \frac{\sum \lambda^2}{\sum \lambda^2 + \sum \varepsilon_i} \]

\( \lambda \) represents the standard load of observed variable to latent variable. And \( \varepsilon_i \) represents the measurement residual of the observed variable whose number is i.

The measurement results of CR and AVE in CKM scale can be observed in Table IV-16. For each one of the nineteen items, the CR value of every dimension is over 0.80; and the AVE value over 0.60. Besides, the standard load of every item to relevant latent variable falls between 0.71 and 0.86, higher than the minimum value of 0.7 suggested by Hair and Barcly (Hair, Black, Babin, & Anderson, 2010) and demonstrating strong statistical significance when \( P<0.001 \). Therefore, the scale of CKM in this research is of good reliability and convergent validity.

The measurement results of CR and AVE in IC scale can be observed in Table IV-17. For each one of the seventeen items, the CR value of every dimension is over 0.80; and the AVE value over 0.60. Besides, the standard load of every item to relevant latent variable falls between 0.73 and 0.83, higher than the minimum value of 0.7 and demonstrating strong statistical significance when \( P<0.001 \). Therefore, the scale of IC in this research is of good reliability and convergent validity.

<table>
<thead>
<tr>
<th>Latent variable</th>
<th>Observed item</th>
<th>Standardized factor loading</th>
<th>Standardized residual</th>
<th>SMC</th>
<th>CR</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>11</td>
<td>0.727</td>
<td>0.31</td>
<td>0.393</td>
<td>0.905</td>
<td>0.657</td>
</tr>
<tr>
<td>acquisition</td>
<td>12</td>
<td>0.861</td>
<td>0.301</td>
<td>0.213</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table IV-17: Reliability and Convergent Validity analysis of IC scale

<table>
<thead>
<tr>
<th>Latent variable</th>
<th>Observed item</th>
<th>Standardized factor loading</th>
<th>Standardized residual</th>
<th>SMC</th>
<th>CR</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management innovation</td>
<td>I23</td>
<td>0.782</td>
<td>0.359</td>
<td>0.393</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I24</td>
<td>0.832</td>
<td>0.206</td>
<td>0.213</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I25</td>
<td>0.767</td>
<td>0.371</td>
<td>0.268</td>
<td>0.910</td>
<td>0.669</td>
</tr>
<tr>
<td></td>
<td>I26</td>
<td>0.788</td>
<td>0.232</td>
<td>0.373</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I27</td>
<td>0.732</td>
<td>0.342</td>
<td>0.353</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process innovation</td>
<td>I29</td>
<td>0.818</td>
<td>0.366</td>
<td>0.403</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I30</td>
<td>0.793</td>
<td>0.282</td>
<td>0.385</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I31</td>
<td>0.791</td>
<td>0.286</td>
<td>0.441</td>
<td>0.891</td>
<td>0.672</td>
</tr>
<tr>
<td></td>
<td>I33</td>
<td>0.828</td>
<td>0.341</td>
<td>0.527</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology innovation</td>
<td>I34</td>
<td>0.859</td>
<td>0.202</td>
<td>0.369</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I36</td>
<td>0.767</td>
<td>0.418</td>
<td>0.403</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I37</td>
<td>0.822</td>
<td>0.23</td>
<td>0.369</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work flow innovation</td>
<td>I38</td>
<td>0.752</td>
<td>0.234</td>
<td>0.382</td>
<td>0.904</td>
<td>0.703</td>
</tr>
<tr>
<td></td>
<td>I39</td>
<td>0.754</td>
<td>0.336</td>
<td>0.234</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I40</td>
<td>0.848</td>
<td>0.298</td>
<td>0.440</td>
<td>0.888</td>
<td>0.665</td>
</tr>
<tr>
<td></td>
<td>I41</td>
<td>0.817</td>
<td>0.273</td>
<td>0.520</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I42</td>
<td>0.741</td>
<td>0.355</td>
<td>0.463</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To evaluate the fitness of presumptive model to theoretical model, both absolute fit index and comparative fit index are examined. In absolute fit index, $\chi^2$ represents the extent to which estimated covariance matrix (E) similar to unlimited sample covariance matrix (S). Generally, the lower the value of $\chi^2$, the more similarity are there between presumptive model and theoretical model. Df reflects the model’s degree of complexity. The simpler the model, the higher the degree of complexity and vice versa. Absolute fit index also includes GFI, AGFI, NFI, CFI, RMSEA and RMR, among which GFI and AGFI represents absolute goodness of fitness index, NFI and CFI represents comparative goodness of fitness index. If their values are approximate or equal to 0.9, the model is of good fitness; RMSEA represents approximate root mean square error. When the value of RMSEA is lower than 0.08. The fitness degree of the model is acceptable. RMR represents square root of the mean value of fit residuals. When the value of RMR is lower than the 0.05, the model is considered of good fitness. Comparative fit index includes $\frac{\chi^2}{df}$, NFI and CFI. $\frac{\chi^2}{df}$
is to measure the relative efficiency of fitness degree between different models. It is suggested by researchers that $\chi^2/df$ falls between 2.0 and 5.0 indicates proper fitness. This study is on the measurement model of CKM scale and IC scale. The fitness of models is as played in Figure IV-1, Table IV-18, and Figure IV-2, Table IV-19.

Table IV-18: Fit index of EFA on CKM scale

<table>
<thead>
<tr>
<th>$\chi^2$</th>
<th>$df$</th>
<th>$\chi^2/df$</th>
<th>GFI</th>
<th>AGFI</th>
<th>NFI</th>
<th>CFI</th>
<th>RMSEA</th>
<th>RMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>692.75</td>
<td>146</td>
<td>4.74</td>
<td>0.94</td>
<td>0.91</td>
<td>0.96</td>
<td>0.90</td>
<td>0.074</td>
<td>0.041</td>
</tr>
</tbody>
</table>
Figure IV-2: EFA on IC

Source: Personal Original Drawing

Table IV-19: Fit index of EFA on IC scale

<table>
<thead>
<tr>
<th>$\chi^2$</th>
<th>$df$</th>
<th>$\chi^2/df$</th>
<th>GFI</th>
<th>AGFI</th>
<th>NFI</th>
<th>CFI</th>
<th>RMSEA</th>
<th>RMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>563.20</td>
<td>133</td>
<td>4.23</td>
<td>0.92</td>
<td>0.90</td>
<td>0.93</td>
<td>0.91</td>
<td>0.074</td>
<td>0.042</td>
</tr>
</tbody>
</table>
According to the results of EFA, in the model to measure CKM, the value of $\chi^2$ is 692.75, $df$ is 146, $\frac{\chi^2}{df}$ is 4.74 falling between 2.0 and 5.0. Besides, NFI and CFI fall on 0.96 and 0.90 respectively, surpassing the minimum value of 0.90. The value of RMSEA is 0.074 lower than 0.08, which meets the standard put forward by Gundersen. What’s more, the value of RMR is 0.041, meeting the standard brought up by Reisinger that RMR is supposed to be lower than 0.05. All these parameters have demonstrated that the presumptive variables of CKM fits well to the empirical data.

In the model to measure IC, the value of $\chi^2$ is 563.20, $df$ is 133, $\frac{\chi^2}{df}$ is 4.23 falling between 2.0 and 5.0. Besides, NFI and CFI fall on 0.92 and 0.90 respectively, satisfying the minimum standard of 0.90. The value of RMSEA is 0.074 lower than 0.08, which meets the standard put forward by Gundersen. What’s more, the value of RMR is 0.042, meeting the standard brought up by Reisinger that RMR is supposed to be lower than 0.05. All these parameters have demonstrated that the presumptive variables of CKM fits well to the empirical data.

4.1.2.5 Discriminate validity analysis of scale

Discriminate validity represents the extent to which one specific dimension varies to the other dimensions. Bagozzi and Richard measure this degree of variance by the average variance extracted (AVE) of each dimension (Bagozzi, 1981). To be specific, if the AVE value between two dimensions is higher than the square of their correlation coefficient, or the square root of AVE between two dimensions is higher than their correlation coefficient, there are valid discrimination between these two dimensions.

In this thesis, for dimensions in CKM and IC measurement scale, the AVE value of each dimension and their correlation coefficient between other dimensions are listed out in Table IV-20. As shown in the table, figures on the diagonal are the dimension’s square root of AVE.

<table>
<thead>
<tr>
<th>Acquisition of CK</th>
<th>Externalization of CK</th>
<th>Integration of CK</th>
<th>Internalization of CK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition of CK</td>
<td>0.82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Externalization of CK</td>
<td>0.77</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>Integration of CK</td>
<td>0.71</td>
<td>0.69</td>
<td>0.80</td>
</tr>
<tr>
<td>Internalization of CK</td>
<td>0.79</td>
<td>0.77</td>
<td>0.70</td>
</tr>
</tbody>
</table>

For each dimension of CKM variables, the square root of their AVE falls between 0.80 to 0.82, while the correlation coefficient between each two of them falls between 0.69 and 0.79. Therefore, for every dimension, the square root of AVE is higher than the corresponding correlation coefficient, which means there are good discriminate validity among dimensions of CKM scale.

<table>
<thead>
<tr>
<th>Management innovation</th>
<th>Workflow innovation</th>
<th>Technology innovation</th>
<th>Business innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.82</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table IV-20: Results of discriminate validity analysis of CKM (AVE)

Table IV-21: Results of discriminate validity analysis of IC (AVE)
For each dimension of IC variables, the square root of their AVE falls between 0.82 to 0.84, while the correlation coefficient between each two of them falls between 0.54 and 0.79. Therefore, for every dimension, the square root of AVE is higher than the corresponding correlation coefficient, which means there are good discriminate validity among dimensions of CKM scale.

4.1.2.6 Cross-validation analysis

Cross-validation of scale is to examine the predictive validity of linear regression equation. To conduct cross-validation on the scale’s validity and multidimensional stability, this research takes conventional method to measure cross-validation: Put the samples into two group and conduct duplicate test. If the results of these two tests present high degree of similarity, the measurement scale is proved to be highly valid.

Samples in this research are randomly divided into calibration samples and validation models, through which the model measuring property-related antecedents will be test. The test will adopt ECVI, AIC and CAIC index to examine the cross-validation of measurement scale and at the same time figure out the value of NFI，CFI and $\chi^2/df$ to indicate the fitness degree of models. The lower the value of ECVI, the better the cross-validation. AIC represents the extent to which one parameter that figured out by one sample is still valid when put into the other sample. It is the index to evaluate how the models fit to one sample, thus it is also an indicator of cross-validation. The lower the value of AIC, the better the cross-validation (Hair et al., 2010). CAIC is a revision for AIC, in case the value of AIC stagnated at a low level when there is not enough samples. According to Bozdogan, CAIC index is more conventional when selecting models with only a small number of parameters. That is to say CAIC is more applicable to simple models with a small number of parameters (Bozdogan, 1987).

Table IV-22: Cross-validation test on CKM scale

<table>
<thead>
<tr>
<th>Validation sample(277)</th>
<th>Sample mode</th>
<th>ECVI</th>
<th>AIC</th>
<th>CAIC</th>
<th>NFI</th>
<th>CFI</th>
<th>$\chi^2/df$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Saturation</td>
<td>3.16</td>
<td>780.8</td>
<td>984.2</td>
<td>0.96</td>
<td>0.90</td>
<td>4.74</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.11~3.77)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Saturation</td>
<td>3.21</td>
<td>810.2</td>
<td>1137.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calibration sample(277)</td>
<td>Sample mode</td>
<td>3.39</td>
<td>792.2</td>
<td>976.3</td>
<td>0.96</td>
<td>0.90</td>
<td>4.72</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.33~4.04)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Saturation</td>
<td>3.49</td>
<td>823.1</td>
<td>1023.1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

According to the results of CKM scale, as listed in Table IV-22, $\chi^2/df$ values on validation sample and calibration sample are 4.74 and 4.72 respectively. Both fall on the standard interval from two to five, indicating that the measurement of these two samples is generally of good fitness. At the same time, the value of ECVI is 3.16 when based on validation sample, within 90% of confidence interval. The value of ECVI is 3.39 when based on calibration sample, within 90% of confidence interval. Besides, the scale’s cross-validation is also examined through AIC index and CAIC index. As the results, the values of both
AIC and CAIC indexes are lower than corresponding values in saturation model, in coincidence with the theoretical model put forward by Cudeck and Browne—the values of AIC and CAIC must be lower than that of theoretical model (Cudeck & Browne, 1983).

Table IV-23: Cross-validation test on IC scale

<table>
<thead>
<tr>
<th></th>
<th>ECVI</th>
<th>AIC</th>
<th>CAIC</th>
<th>NFI</th>
<th>CFI</th>
<th>$\chi^2/df$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Validation sample</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample mode (277)</td>
<td>3.43</td>
<td>643.2</td>
<td>828.2</td>
<td>0.93</td>
<td>0.91</td>
<td>4.23</td>
</tr>
<tr>
<td>Saturation mode</td>
<td>3.54</td>
<td>723.1</td>
<td>1092.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Calibration sample</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample mode (277)</td>
<td>3.57</td>
<td>632.1</td>
<td>898.1</td>
<td>0.93</td>
<td>0.91</td>
<td>4.18</td>
</tr>
<tr>
<td>Saturation mode</td>
<td>3.67</td>
<td>823.1</td>
<td>1121.4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

According to the results of IC scale, as listed in Table IV-23, $\chi^2/df$ values on validation sample and calibration sample are 4.23 and 4.188 respectively. Both fall on the standard interval from two to five, indicating that the measurement of these two samples is generally of good fitness. At the same time, the value of ECVI is 3.43 when based on validation sample, within 90% of confidence interval. The value of ECVI is 3.57 when based on calibration sample, within 90% of confidence interval. Besides, the scale’s cross-validation is also examined through AIC index and CAIC index. As the results, the values of both AIC and CAIC indexes are lower than corresponding values in saturation model.

Therefore, these two samples are of good cross-validation, indicating that the CKM scale and the IC scale have trans-sample validation and stability.

4.2 Correlation Analysis

Correlation analysis of each variable should go before test on structural equation model. Correlation analysis is a preliminary test on presumption. Generally speaking, two variables in presumption should be correlated to some extend and the correlation coefficient is of statistical significance. Table IV-24 displays the Pearson correlated correlation coefficient among variables. This research adopts 0.7 as a standard to judge where there is a high degree of correlation between variables (Wang et al., 2010). However, even though the presumption proved to be significant statistically, it does not mean that path coefficient is still significant under structural equation model. Therefore, structural equation model is still necessary in further research.

Table IV-24: Correlation analysis of variables

<table>
<thead>
<tr>
<th></th>
<th>ACQ</th>
<th>EXN</th>
<th>ING</th>
<th>INN</th>
<th>MAI</th>
<th>PRI</th>
<th>TEI</th>
<th>BSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACQ</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXN</td>
<td>0.635</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ING</td>
<td>0.438</td>
<td>0.334</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
According to Table IV-24, for the correlation of every two variables of the presumption, as long as the correlation coefficient is lower than 0.01, the coefficient is statistically significant. Also, the correlation coefficient between every two latent variables of CKM and IC are lower than the significant level of 0.7, indicating that these indicators are hardly correlated and easily distinguish after delete some items. So we can that indicators after amendment is good in structural validation, and applicable to structural equation model analysis.

4.3 Construction of Structural Equation Model

Combing the forehead analysis and the presumption put forward in Chapter III, the primitive structural equation mode (M1) can be concluded as Figure IV-3:
4.4 Model Analysis

4.4.1 Analysis of Fitting Results of Primitive Structural Model

Through foregoing analysis, the model to measure variables prove to be of good reliability and validity. To further explore the correlation of variables, analysis will be carried out on primitive structural model through AMOS.

Table IV-25: Fit index of primitive structural model (M1)

<table>
<thead>
<tr>
<th>$\chi^2$</th>
<th>$df$</th>
<th>$\chi^2/df$</th>
<th>GFI</th>
<th>AGFI</th>
<th>NFI</th>
<th>IFI</th>
<th>CFI</th>
<th>RMSEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1710.28</td>
<td>621</td>
<td>2.75</td>
<td>0.823</td>
<td>0.863</td>
<td>0.947</td>
<td>0.949</td>
<td>0.943</td>
<td>0.043</td>
</tr>
</tbody>
</table>
Table IV-25 exhibits the fitting results of primitive structural model. The value of $\chi^2/df$ is 2.75 falling between two to five. The value of RMSEA is below the maximum limit of 0.08. The value of NFI and CFI are above the minimum limit of 0.9, indicating that the primitive model is fitting well. Considering that the value of GFI and AGFI is higher than 0.8 but lower than 0.9, further revision is necessary to refine the primitive model, so that we can get a best fitting model.

Figure IV-4: Primitive structural model M1

Source: Personal Original Drawing
Table IV-26: Path analysis of primitive structural model M1

<table>
<thead>
<tr>
<th>Original presumption</th>
<th>Path of correlation</th>
<th>Standardized path coefficient</th>
<th>Significant or not</th>
<th>Result of test</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1a</td>
<td>Management innovation←Knowledge acquisition Management</td>
<td>0.386</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H1b</td>
<td>Management innovation←Knowledge externalization Management</td>
<td>0.313</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H1c</td>
<td>Management innovation←Knowledge integration Management</td>
<td>0.359</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H1d</td>
<td>Management innovation←Knowledge internalization Management</td>
<td>0.27</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H2a</td>
<td>Workflow innovation←Knowledge acquisition Workflow</td>
<td>0.487</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H2b</td>
<td>Workflow innovation←Knowledge externalization Workflow</td>
<td>0.404</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H2c</td>
<td>Workflow innovation←Knowledge integration Workflow</td>
<td>0.397</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H2d</td>
<td>Workflow innovation←Knowledge internalization Technology</td>
<td>0.225</td>
<td>No</td>
<td>0.004</td>
</tr>
<tr>
<td>H3a</td>
<td>Technology innovation←Knowledge acquisition Technology</td>
<td>0.308</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H3b</td>
<td>Technology innovation←Knowledge externalization Technology</td>
<td>0.368</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H3c</td>
<td>Technology innovation←Knowledge integration Technology</td>
<td>0.204</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H3d</td>
<td>Technology innovation←Knowledge internalization Business</td>
<td>0.456</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H4a</td>
<td>Business innovation←Knowledge acquisition Business</td>
<td>0.439</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H4b</td>
<td>Business innovation←Knowledge externalization Business</td>
<td>0.229</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H4c</td>
<td>Business innovation←Knowledge integration Business</td>
<td>0.397</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H4d</td>
<td>Business innovation←Knowledge internalization</td>
<td>0.31</td>
<td>Yes</td>
<td>***</td>
</tr>
</tbody>
</table>

Note: ***P<0.001
As observed in the table, four standardized path coefficients indicating the correlations of the four dimensions of CKM (acquisition of CK, externalization of CK, integration of CK and internalization of CK)
to enterprise’s innovation turns out to be 0.386, 0.313, 0.359 and 0.270 respectively, reaching the level of significance. Four standardized path coefficients indicating the correlations of the four dimensions of CKM to enterprise’s workflow innovation turns out to be 0.487, 0.404, 0.397 and 0.225, among which the correlation of CKM internalization to workflow innovation is not significant. Four standardized path coefficients indicating the correlations of four dimensions of CKM to enterprise’s technology innovation turn out to be 0.308, 0.368, 0.204 and 0.456, all of which are significant. Four standardized path coefficients indicating the correlations of four dimensions of CKM to enterprise’s business innovation turn out to be 0.439, 0.229, 0.397, and 0.310, all of which are significant.

4.4.2 Model Revising Analysis

Insignificant path, e.g. “workflow innovation—knowledge internalization”, should be picked out from the primitive structural model. After applying the data again to revised model M2, the fitting results of M2 can be observed in Table IV-27, Table IV-28 and Figure IV-5.

Table IV-27: The fit index of revised structural model M2

<table>
<thead>
<tr>
<th>$\chi^2$</th>
<th>df</th>
<th>$\chi^2/df$</th>
<th>GFI</th>
<th>AGFI</th>
<th>NFI</th>
<th>IFI</th>
<th>CFI</th>
<th>RMSEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1510.28</td>
<td>606</td>
<td>2.49</td>
<td>0.912</td>
<td>0.923</td>
<td>0.951</td>
<td>0.952</td>
<td>0.947</td>
<td>0.036</td>
</tr>
</tbody>
</table>

Figure IV-5: Revised structural model M2

Source : Personal Original Drawing
<table>
<thead>
<tr>
<th>Original presumption</th>
<th>Path of correlation</th>
<th>Standardized path coefficient</th>
<th>Significant or not</th>
<th>Result of test</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1a</td>
<td>Management innovation←Knowledge acquisition Management</td>
<td>0.386</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H1b</td>
<td>Management innovation←Knowledge externalization Management</td>
<td>0.313</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H1c</td>
<td>Management innovation←Knowledge integration Management</td>
<td>0.359</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H1d</td>
<td>Management innovation←Knowledge internalization Workflow</td>
<td>0.27</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H2a</td>
<td>Workflow innovation←Knowledge acquisition Workflow</td>
<td>0.487</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H2b</td>
<td>Workflow innovation←Knowledge externalization Workflow</td>
<td>0.404</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H2c</td>
<td>Workflow innovation←Knowledge integration Technology</td>
<td>0.397</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H3a</td>
<td>Technology innovation←Knowledge acquisition Technology</td>
<td>0.308</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H3b</td>
<td>Technology innovation←Knowledge externalization Technology</td>
<td>0.368</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H3c</td>
<td>Technology innovation←Knowledge integration Technology</td>
<td>0.204</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H3d</td>
<td>Technology innovation←Knowledge internalization Business</td>
<td>0.456</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H4a</td>
<td>Business innovation←Knowledge acquisition Business</td>
<td>0.439</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H4b</td>
<td>Business innovation←Knowledge externalization Business</td>
<td>0.229</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H4c</td>
<td>Business innovation←Knowledge integration Business</td>
<td>0.397</td>
<td>Yes</td>
<td>***</td>
</tr>
<tr>
<td>H4d</td>
<td>Business innovation←Knowledge internalization</td>
<td>0.31</td>
<td>Yes</td>
<td>***</td>
</tr>
</tbody>
</table>

Note: ***P<0.001

After revision, the value of chi-square falls. The value of \( \chi^2/df \) is 2.49, higher than two and lower than five. The value of RMSEA is lower than the maximum limit of 0.08. The value of NFI and CFI is higher than minimum limit of 0.9, indicating that the revised model is fitting well. Therefore, the revision is
Table IV-29 summarizes the results of presumption test

<table>
<thead>
<tr>
<th>No.</th>
<th>Description of presumption</th>
<th>Result of test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Conducting CKM is able to brought positive influence to enterprise’s manage innovation capability</td>
<td>Agree</td>
</tr>
<tr>
<td></td>
<td>Conducting CKM is able to brought positive influence to enterprise’s workflow innovation capability</td>
<td>Agree</td>
</tr>
<tr>
<td></td>
<td>Conducting CKM is able to brought positive influence to enterprise’s technology innovation capability</td>
<td>Agree</td>
</tr>
<tr>
<td></td>
<td>Conducting CKM is able to brought positive influence to enterprise’s business innovation capability</td>
<td>Agree</td>
</tr>
<tr>
<td>H1a</td>
<td>Acquisition of CK will positively influence enterprise’s management innovation</td>
<td>Agree</td>
</tr>
<tr>
<td>H1b</td>
<td>Externalization of CK will positively influence enterprise’s management innovation</td>
<td>Agree</td>
</tr>
<tr>
<td>H1c</td>
<td>Integration of CK will positively influence enterprise’s management innovation</td>
<td>Agree</td>
</tr>
<tr>
<td>H1d</td>
<td>Internalization of CK will positively influence enterprise’s management innovation</td>
<td>Agree</td>
</tr>
<tr>
<td>H2a</td>
<td>Acquisition of CK will positively influence enterprise's workflow innovation</td>
<td>Agree</td>
</tr>
<tr>
<td>H2b</td>
<td>Externalization of CK will positively influence enterprise’s workflow innovation</td>
<td>Agree</td>
</tr>
<tr>
<td>H2c</td>
<td>Integration of CK will positively influence enterprise’s workflow innovation</td>
<td>Agree</td>
</tr>
<tr>
<td>H2d</td>
<td>Internalization of CK will positively influence enterprise’s workflow innovation</td>
<td>Disagree</td>
</tr>
<tr>
<td>H3a</td>
<td>Acquisition of CK will positively influence enterprise’s technology innovation</td>
<td>Agree</td>
</tr>
<tr>
<td>H3b</td>
<td>Externalization of CK will positively influence enterprise’s technology innovation</td>
<td>Agree</td>
</tr>
<tr>
<td>H3c</td>
<td>Integration of CK will positively influence enterprise’s technology innovation</td>
<td>Agree</td>
</tr>
<tr>
<td>H3d</td>
<td>Internalization of CK will positively influence enterprise’s technology innovation</td>
<td>Agree</td>
</tr>
<tr>
<td>H4a</td>
<td>Acquisition of CK will positively influence enterprise’s business innovation</td>
<td>Agree</td>
</tr>
<tr>
<td>H4b</td>
<td>Externalization of CK will positively influence enterprise’s business innovation</td>
<td>Agree</td>
</tr>
<tr>
<td>H4c</td>
<td>Integration of CK will positively influence enterprise’s business innovation</td>
<td>Agree</td>
</tr>
<tr>
<td>H4d</td>
<td>Internalization of CK will positively influence enterprise’s business innovation</td>
<td>Agree</td>
</tr>
</tbody>
</table>

4.5 Analysis of In-depth Interviewing Results

Interviews in this research are conducted face to face and recorded acoustically. All of the eight interviewers are chief executives of architectural design enterprises including two state-owned designing institutes, two designing institutes of universities, two private designing institutes and two architectural design offices. Of these eight organizations, five are listed in Top 500 Chinese architectural design
enterprises and rank 2nd, 71st, 386th, 390th and 481st respectively among 500 architectural design enterprises. The other three enterprises are out of Top 500. Enterprises interviewed diverse widely in terms of scale and type and the ideas of interviewees is highly represented and practical. Based on the presumption and model of this research, in combination with interviewees’ opinions, this thesis tried to put forward some suggestions on practice of CKM and enterprise innovation for architectural design IC in China. Considering the personal privacy, any interviewer’s name appears in this section is a pseudonym.

The interviewees came to a consensus that CKM and IC are two important factors for the operation and management of architectural design enterprises. These two aspects are mutually reinforcing, CKM brings significant promotion to IC.

All the interviewees are senior managers in architectural design enterprises. Their opinions are more practical and more feasible and very helpful to analyze and summarize the feasibility and practice of this thesis. Also, their opinions provide new ideas to further research, for example, Cong Xiaomi believes that “Craftsman is an innovation. Serious heritage is the basis of innovation. Development based on heritage is an important way to innovate”. Huang Hu thinks that “external study is more important.” Huo Wenying put forward that “the definition on customers should be expanded. Departments within one enterprise may become each other’s customer. One can even become the customer of himself.” Qin Yan brings up the concepts of “fine database” and “clan designing”. Sun Xiangshu emphasizes that “enterprises tend to start from learning customers’ advanced concepts and positively find out customers’ demand and weakness”. Yang Zheng believes that the most important innovation at present is to “reconstruct workflow” and “learn from others”. Wang Jing put forward the concept called “database of tacit knowledge”. Zhang Jian thinks that “innovation should be accumulated step by step rather than achieved at once”.

According to these opinions, the understanding about CK in CKM can be considered in the following six aspects. Firstly, it refers to the demand and way of thinking of customers. Cong Xiaomi believers that it is very important to have a profound understanding about customers’ ideas. Enterprises should think in customers’ shoes.” Yang Zheng believes that it is more important to find out the tacit demand of customers. Zhang Jian believes that enterprises need to understand themselves before understanding their customers. The second is the destination and direction of customer’s development. Huang Hu believes that customer’s development vision underlies enterprise’s prediction on customer’s behavior, though which enterprise can predict potential projects and make preparation for them. Cong Xiaobi said enterprise should reflects in the shoes of customers the reason for which customer starts a specific project and what would this project brought to customer’s development. The third is the management concepts and cooperate culture of customer. Sun Shuxiang believes that advanced management concepts and cooperate culture will activate designing enterprise to work better. The fourth is the background information of customer. Huo Wenying thinks that background information includes the credit and performance ability of customers. Huang Hu believes that it consists of customers’ business, capital composition, and information of related person in charge. Wang Jing believes that it is very important to know customer’s strength. The strength of enterprises does not lie in its scale, but its good management. The fifth is compatibility between enterprise and customer’s demand. Huo Wenying believes that compatibility should be a focus at the beginning of projects. Qin Yan believes that customer and enterprise choose each other. Zhang Jian believes that enterprise should have a clear awareness about its own ability. Wang Jian believes that enterprise should make sure that enterprise can satisfy the demand of customers. The sixth is customer’s brand and its status in market. Sun Shuxiang believes that when working with China’s Top 100 enterprises, enterprise can reinforce its influence through the cooperation and learn advanced knowledge from customers.

In summary, divided by definitions of CK, the fourth and the sixth aspects are knowledge about customer. The first and fifth are knowledge for customer. The second and the third are knowledge from customer. The fourth and the fifth are explicit knowledge. The first and the sixth fall between explicit
knowledge and tacit knowledge. The second and the third are tacit knowledge (Blosch, 2015).

As for externalization and integration of CK, all the interviewees believe that it is very important to build and effectively apply customer’s database. Their opinions can be generalized as follows. Firstly, enterprise should sort out CK. Huo Wenying believes that CK should be categorized in accordance with different systems and culture for efficient application. Huang Hu believes information should not be shared to everyone indiscriminately within enterprise, but should be shared by type and by grade to different people. Yang Zheng thinks that CK can be divided by customer’s industry. Secondly, the content of CKM differs among enterprises of different scales. Huang Hu thinks that customer database is of great importance to sized enterprise, but can be simplified for small-sized enterprises. Qin Yan puts forward the concept of fine database. Thirdly, effective system and enterprise culture should be set up to manage CK. Zhang Jian believes establishing a complete system holds the key to the application of database. Enterprise can use system to back CKM. Cong Xiaomi emphasized that enterprise should have the conscious to accumulate CK, which requires excellent cooperate culture.

Every interviewer agrees that communication with customers and communication within enterprise are very important. There are five opinions concerning method and content of communication. Firstly, acknowledgement of customer and trust relationship with customer are the basis of communication. Cong Xiaomi thinks that open communication must be based on mutual trust. Sun Shuxiang thinks that it is beneficial to communicate openly under the circumstance of mutual trust. Secondly, only in-depth communication can help to acquire customer’s earnest demand. Zhang Jian believes that casual connection cannot help to acquire customer’s earnest demand. Cong Xiaomi believes that in-depth communication is communication about values and culture. Yang Zheng thinks that profound communication is to acquire customer’s tacit demand. Qin Yan believes that in-depth communication focus on exchanging and negotiating of ideas, whose result will direct project. Thirdly, communication with customers should be classified. Huo Wenying thinks that different class of communication gives different class of information. Wang Jing thinks chief executives should be sent to call up customers, which will catch customer’s attention and gain more information. Fourthly, the aim of CKM can be reached only by sharing CK with enterprises. Huo Wenying believes that sharing CK within enterprise will lower the cost of communication between enterprise and customer, but not everyone is able to communicate with customer profoundly. Zhang Jian said the system is necessary. Critical information should be applied into specific projects. Fifthly, CK acquired should be managed discriminately. Hung Hu thinks not all information should be open to everyone, but should be discriminated. Wang Jing believes that common employees are seldom exposed to confident knowledge.

Communication and sharing of CK is the core of CKM. By exchanging knowledge with customers, among design enterprises and inside enterprise, circulating and increasing the depth and width of communication, great enthusiasm for knowledge and learning will be activated and new knowledge will be generated, which will make the enterprise a learning organization and help enterprise to form core competence that no one can copy.

The interviewees firmly agreed on the importance of IC of architectural design enterprises. Their understandings about IC can be generalized as follows: firstly, way of thinking is the substantial IC. Huo Wenying believes that it is very important for enterprise to brave innovation. Cong Xiaomi believes that the basis of enterprise’s innovation lies in ideological system, the most substantial problem is emancipation of mind. Sun Shuxiang thinks that architectural design industry is conventional service industry, whose importance should fall on innovation of way of thinking. Secondly, materials of innovation come from daily work. Innovation is not great subversion but innovation in the process of transmission. Wang Jiang said that coming up with solutions to problems occurred in daily work is innovation. Yang Zheng believes that designing enterprise’s innovation should focus on reconstructing existing designing floe. Huang Hu
thinks that new methods to satisfy customers are innovations. Zhang Jian believes innovation comes from everyday work. Thirdly, there is no innovation mode universally applicable. Due to differences in enterprise’s scale and feature, different enterprises have different way to practice. Qin Yan believes that small-sized enterprises should focus on product innovation. Good innovation is to make sure the product cannot be copied. Wang Jing thinks that the most important thing is to find where to innovate. Fourthly, communication is very important for IC. Sun Xiangshu believes that exchange and cooperation with counterparts reflects the ability of leaders, which is a vital part of their work. Qin Yan believes that enterprises need to choose their own way of cooperation. Yang Zheng thinks that it is very important to learn from others. Fifthly, technology innovation, organization innovation and market innovation is correlated and indispensable to each other. Enterprises should have its focus according to their own features. Cong Xiaomi said that almost every industry in China attached more importance to marketing than technology, while architectural design enterprises should focus on technology innovation. Qin Yan believes that technology innovation is foundation, while organization innovation and market innovation are guarantees. Wang Jing thinks that enterprises need to figure out where to innovate according to different projects. Yang Zheng believes that it is most important and most difficult for sized enterprises to innovate organization. Sixthly, innovation needs a proper environment, atmosphere and enterprise culture. Cong Xiaomi thinks that enterprise should try to build an atmosphere promoting communication, sharing and innovation.

Acquisition of CK is the first step and the basis of CKM. In this process, it is most important for the head of enterprise to have clear awareness about the importance of CKM. Chef executives need to repeatedly emphasize the importance of CKM, which requires investment of personnel, money and other materials. Also, it requires to establish management mechanism of CK to expect good effects. The acquisition of CK can be processed through three steps. First, enterprises can try to acquire explicit knowledge of customers, such as basic information, honesty, contractual ability, business history, capital, operation standardization, project manager, compatibility with enterprise and basic demand, etc. According to features of different customers, enterprise can choose two or three of them to focus. The second step is to explore customer’s demand, where enterprise should stand in the customer’s shoes and pay attention to customers’ earnest demand, customer’s way of thinking, customer’s development expectations and direction. The third step is to learn from customers and vice versa, paying attention to advanced management philosophy and enterprise culture, customers strategies about brand and market and customer’s overall situation, so as to have mutual knowledge with customers (Taherparvar et al., 2014).

Externalization and internalization of CK mainly occurred within enterprise, which actually is construction and effective application of customer database. Enterprises differ a lot in these two processes, so enterprises need to take different methods according their own features. Small-sized enterprise can build “fine database”, while large-scale enterprise should have some system to ensure the building of “large-scale database”. However, it is not appropriate for large-scale enterprises to adopt database and information system completely from external database companies, but should adopt personal-oriented database, in case the database brought in cannot fit well. Externalization and integration of CK need to do a lot for preparation. Enterprises need to recruit a professional knowledge management team to work together with technology staff to help to sort out, classify and itemize customer knowledge. “Tacit knowledge database” is an important concept, since the most valuable knowledge about customers are always not able to be made explicit. Mutual trust is the foundation to give full play to tacit knowledge. It is a difficulty and worth a lot energy to achieve (C. Bailey & Clarke, 2000).

Internalization of CK is a critical and difficult link in CKM. The process of internalization is a circulation that never ends. Effective communication and personal teaching are critical to this process. The head of enterprise is the glass ceiling over enterprise’s development. So chief executives especially head of
enterprises must keep learning and improving themselves. To intelligent employees, material motivation is not that useful, so enterprises need to improve the quality of managers and other employees, concentrating on their values. The core values of enterprise is extremely important, but most enterprises do not care about this, setting up some great dreams easily and never making it work. Many employees even know nothing about enterprise’s values or just never consider themselves as part of them. More than two hundred years ago, a great team in America spent years surveying, communicating and exploring and finally breed the shaking Declaration of Independence which has been leading America to today’s prosperity. This is what our leaders should learn from—to find out the core values that will represent not only expectations of enterprise but also employees’ value. This core values should help employees to be pregnant with appropriate outlook on life, value and history and help to foster a mutual-trust atmosphere within enterprise, so that enterprise can establish a learning organization. Only in this way, can customer knowledge from customers, enterprises themselves and rivals be integrated into mind (Blosch, 2015).

There are many ways to classify IC. This research classified IC into management innovation, technology innovation, business innovation and process innovation, which are independent to each other but at the same time are mutually functioned and mutually promoted. They form a dynamic integration. In innovation activities of enterprises, managers should pay attention to the following problems. Innovation at first is the innovation of way of thinking and innovation of ideas, which is the best way or maybe the only way to change way of thinking. Enterprises should create an environment that encourages learning, which will help to establish a “learning organization”.

Innovation is not great, but from everyday work. Innovation is not utopia but protopia. Protopia is a state that is better than today than yesterday, although it might be only a little better. There is not any regular mode for innovation. Innovation differs among enterprises. Innovation itself is an example of differentiation. Enterprises need to discover innovation point when communicate with customers, rivals and employees, finding out the hot point and critical point in work and making subtle adjustment to them, which should be considered as innovation. Innovation requires a relaxing atmosphere. If managers are too serious, it is hard for employees to innovation. We should learn from Silicon Valley about their “fault-tolerant culture” that mistake is tolerable, but empty head is intolerable.

4.6 Discussions

4.6.1 Discussions on Components of CKM

Opinions differ on components of CKM. Researchers study knowledge management capacity not only from the perspective of knowledge management flow, but also from enterprise’s culture, strategy, facility construction, incentive system, and many other perspectives. Therefore, there isn’t any comprehensive system to study the components of CKM capacity.

Based on former researches, in combination with features of architectural design industry, this thesis established a four-dimension model for enterprise’s knowledge management capacity, including acquisition of CK, externalization of CK, integration of CK and internalization of CK. In this research, Amos software will be used to carry out reliability and validity analysis of the revised scale of knowledge management capacity. According to the results, both indicators and fit indexes meet the standard, indicating that the model is fitting well and the four-dimension structural model we established is rational and applicable.

Based on the results of his paper, in combing with managing practice in architectural design industry, discussions will be made respectively on four dimensions of CKM:

1. Acquisition of CK

Acquisition of CK is the first step as well as the basic of CKM. To do a good job in CKM, leaders of enterprises, especially senior leaders must give full recognition to the importance of CKM, as well as its
complexity and chronicity. Senior leaders must hold the belief that enterprise should be constructed as a “learning organization”, and make it a belief of other inferior leaders and employs. Every enterprise has its own features, thus there isn’t any mode of CKM universally applicable. The four dimensions of CKM we brought up only provides a direction and major concept. Besides, oversights of our research are unavoidable. Therefore, to make the theory work, it’s necessary to explore in practice and develop specific methods in accordance with specific problems. Enterprises should progress in mistakes. As the beginning of CKM, acquisition of CK may be the most difficult step.

To establish a good relationship with customers, it is necessary for enterprises to get detailed knowledge about customers. For different kinds of CK, different methods should be taken to acquire them. Therefore, distinguish should be made on CK at first. CK can be distinguished as tacit and explicit knowledge. Explicit knowledge can be transformed into formalized and systematic language, taking up a major part of CK and including customers’ demographics and transaction records. Explicit knowledge mainly comes from the structural data in transaction, which can be observed by POS system and transaction records. Related data in daily transaction will be stored and become a source of CK. They are raw materials of explicit customer knowledge. Enterprises need to process these materials and turn them into CK that can give direction to enterprise strategy, in which process advanced technology such as knowledge abstraction and the assistance of IT system is quite important. Compared with the acquisition of tacit knowledge, it is much easier for enterprises to acquire explicit customer knowledge.

From the perspective of interpersonal communication, Wayland and Cole put up on psychological basis three methods to acquire tacit customer knowledge: the first one is dialogue (Wayland & Cole, 1998). This method is the simplest one as well as the one to be misinterpreted most easily. Therefore, it would be very helpful to present products and company through stories, pictures, and books. The second method is observation. The more substantial products enterprises provide, the more chances will come to enterprises to observe customers’ demand. From the perspective of analysis technology, this method can be divided into customer’s psychology (intellectual and emotional) and product’s observationability (material and nonmaterial). The third method is prediction. This method is to build predictable knowledge based on known knowledge and research. This knowledge is helpful to build analysis mode, which can be used to predict the demand and reaction of customers and expect CKM to bring more goodness to enterprise.

To acquire tacit CK better, suggestions are made as follows:

Firstly, enterprises can regularly hold customer communication meeting and call up customers, which enables enterprises to communicate with customers face to face and have a better understanding on customers’ attitude and suggestions on products and service. In this way, enterprises can solve problem in sale and after-sale period timely. At the same time, customer communication meeting is able to promote the interaction between customers, which enables customers to exchange opinions and experience of using produces and service. In this way, enterprises will have a better understanding on customers and gain more valuable and direct tacit CK.

Secondly, in 1970s, E.V. Hippel found that most product innovation is motivated by terminal users rather than enterprise themselves (Tyre & Hippel, 1997). Therefore, in the process of product developing, enterprises are suggested to invite some volunteers to have a trail on newly-developed products for free. Employees can record customers’ feeling, suggestions and even complaints in this process. In this way, the developing crew is able to acquire more important CK (Gibbert et al., 2002).

The third method is to build communication platform such as customer service center and service hotline. At present, service hotline is the most popular platform to acquire CK. Service hotline can not only collect explicit knowledge through self-service system, but also enables employees to collect tacit CK when solving customer’s problems. Some researchers found that customers who always complain are potentially loyal to enterprise. Therefore, customers should pay enough attention to customers’ complaints and the
efficiency to solve these problems.

Fourthly, as the development of market, customers’ purchase behavior is becoming increasingly mature. Their attitude and preference to products and service are changing, too. The trend of customer behavior is a very important CK, which will help enterprises to be in command of market trend.

Fifthly, enterprises must have a clear knowledge on what kind of customers worth investing and make sure that attention and budget put onto worthwhile customers. At the same, when provide service to customers, employees can observe and record customers’ behavior and their attitude to service. Besides, enterprise is suggested to observe customers’ new behavior after service and summarize its own performance regularly.

For architectural design industry, CKM should be taken step by step, starting from the simplest things and motivating employees after things coming into effect. For example, enterprises can start from “survey on customers’ background”. As shown by our interviews, most design enterprises didn’t finish this job substantially, and even less of them have summarized and recorded this information into CKM base. Many enterprises know nothing about their customers before projects designing and get to know customers’ background when designing has already started, which is not always timely enough. For example, many enterprises will find their customer is not reliable enough in credit, strength and compatibility in the process of designing, which has brought loss to both sides. As we all know, it is very important to know our customers to become success. To have a good understanding of our customers, enterprises needs to work hard to make CKM a system and a link of business flow.

Meetings and communications with customers is common in every enterprise. However, such activities are always passive communication. Enterprises seldom initiatively follow up to collect feedbacks and complaints, therefore, it is a big problem that enterprises are not able to collect true information and do not give enough attention to customers. So what should enterprises do to catch customers’ interest? What enterprises can gain from this job? How to establish customer-oriented projects targeting customers of different size and different type? How to make this job an indispensable link of work flow. How to make designers realize the importance of this job? All these problems need to be solved in various strategies according to different features of enterprise itself.

Due to the homogenization of most design enterprises, there are always little connection and cooperation among enterprises. Communication among design enterprises can avoid duplicate efforts, improve efficiency and reduce designing cost. Besides, communication enable enterprises to learn from other enterprises and improve themselves. Customers’ feedback on other design enterprises are always rational, so advantages in the feedback should be taken and the disadvantages should be watched out. As long as enterprises stay modest, advantages worth effort will be found out.

Acquisition of CK distinguishes in terms of focus, category, and method for different design enterprises as well as for customers of different industries. Enterprises need to design where to set down to acquire CK according to their own conditions and follow the principles of simplicity and efficiency, gradually making acquisition of CK a part of every projects and making it work well.

2. Externalization of CK

According to related management theory of Nonaka, externalization of CK refers to turning tacit knowledge into explicit knowledge (Nonaka et al., 2000).

In the era of Internet, many enterprises have their own websites, APP platform, mail box and many other online platforms and tool. However, as observed, most enterprises didn’t give a full play to these online platforms. For instance, enterprises often do not have professional designing team but hire Internet companies to maintain their websites whose major function is exhibition and promotion rather than recording and managing connection records with customers. Under this circumstances, different projects always connect with customers on their own and seldom communicate with each other. Besides,
communication with customers are always project-oriented, whose results are only kept by employees or never kept by anyone of other projects, so there are a lot of customer experience never spread out.

Practice community of CKM is a good method to externalize and internalize CK under O2O mode. Enterprises are suggested to organize offline seminars (offline practice community) of different themes, different customers and different specialists. These offline seminars will afterwards be developed into long-term online seminars, after which offline seminars still need to be held regularly and recorded by professional team. Such online interactive platform can maintain a large amount of knowledge about customers and professions from different projects for the reference of technology and management staff on different projects.

Besides, it is also very important to record and maintain information and knowledge occurred in the process of designing, such as design specifications, collection reports of projects, scheme discussion records and quote records. Building “big data” for projects is the basis of CK integration, whose responsibility must be taken by specialized and professional team. There must be a chief knowledge official (CKO) to take the leading role. This is an important feature to demonstrate the “differentiation of designing management”, which worth money and talents to have a try.

Summarizing feedbacks to build “customer evaluation system” is a key link of CK externalization. In working practice, design enterprises may always collect feedbacks from customers by telephone and sometimes call-up or random communication, but this is far from enough. Enterprise are suggested to delegate a professional team led by CKO to establish a rational customer assessment system and organize communication activities with customers, so as to catch the interest of customers, progress greatly and create a virtuous circle for enterprise’s CKM activities.

3. Integration of CK

Wayland and Cole believes that CK of different enterprises have different sources including customers service system, connection between salesmen and customers, sales center, direct mail exchange, customer community and maintenance center, etc (Wayland & Cole, 1998). In fact, every interaction between customers and enterprises can be used as a source of CK. The acquisition of CK involves several departments including sales department, marketing department and service department, etc. The knowledge acquired will be in the command of employees and contained in workflow, organization, departments, teams and information systems. However, if the information scattered around, it is hard to apply it to specific communications. Under this circumstance, enterprise cannot have an overall understanding of customers, or even misunderstand the demand of customers. Therefore, CK integration is necessary for enterprises.

CK integration contains the following aspects. The first aspect is the integration of CK of different specialization and departments, such as the integration of architectural design specialization, structural design specialization and machinery design specialization as well as the integration of operating department, economic department, and financial department. The second aspect refers to the integration of CK of different projects within enterprise. If the integration concerns only one project, it can be conducted under the leadership of project manager. If the integration concerns multiple projects, the integration must be carried out by professional team under the leadership of chief executives. The third aspect is the integration of CK of different enterprises, which is the most difficult aspect as well as the most beneficial one. This integration should be taken up by the heads of enterprises, mutual belief is necessary.

It is necessary for CK integration to build database of CK, which can start from building department database and integrate them together or build a comprehensive database at first. The key to establish CK database is that the lead of enterprise must attach great importance to this construction and invest to organize professional team. For SMEs, management work can be delegated to technology staff and recruit professional management talents when develop a proper management mode. Even this way, investment is
still indispensable.

The database product in market may be not suitable enough to specific enterprise. Therefore, it is suggested that enterprises employ a professional database building team to build a database step by step. The only principle should be fitness rather than grandness. Or else, enterprise can organize employees to build the database at the very beginning and introduce professional team to improve later. The convenience of database is very important, so the database can be built in a way widely accepted by employees and at the same time enterprises can train their employees to use the database.

Inkpen and Dinur consider knowledge integration as knowledge connection formed formally or informally between individual and organization (Inkpen & Dinur, 1998). These internal relationships promote the sharing and exchange of new knowledge and provide a basis to change individual knowledge to the knowledge of organization. When the knowledge of individual or group get connected with the knowledge of other group, the knowledge is possible to be elevated to the knowledge of organization through discussion, the better the knowledge integrated, the more the core competence will be elevated. Therefore, chief executives especially head of enterprise need to accept the idea of “open-source economics” and make it accepted by employees, breaking the information barriers between different specializations within industry, between enterprises outside industry. This project can progress step by step and carry out in large scale after people’s confidence elevated by some achievements.

It is very important to analyze and explore database. The demand of customers and the motivation behind customers’ behaviors need consistent in-depth analysis. Also, the summary should be made regularly on phrasal analysis results of database.

4. Internalization of CK

CK internalization is senior phrase of CKM as well as the condition to start an advanced new circle. The internalization of CK cannot be finished at one step, but requires long-term study, communication, and practice. Internalization of CK is the destination of CKM. Only internalized as part of employees, knowledge acquired, externalized and integrated can exert positive influence on enterprises, promote the core competence of enterprise and make enterprise successful in fierce competence.

It is the basis of CK internalization to make CK database more customer oriented and improve the availability of database. Professional ideas on database designing are indispensable. Besides, it is still necessary to build a small but highly efficient database at the beginning of project, so as to activate the interest of employees and make the database an indispensable part of project designing gradually. Though CK internalization cannot be realized only through application of database, application of database holds the key to CK internalization.

It is an effective method to internalize knowledge by transferring knowledge directly from teacher to pupils. It is especially effective to the heritage of valuable tacit knowledge whose delivery requires long-term face to face teaching. To internalize knowledge, it is effective to invite specialists inside or outside enterprise to give lessons, implement teacher-to-pupil teaching method and provide initiatives for experienced employees that pass knowledge to inexperienced ones.

As pointed out by Davenport and Prusak, reciprocity, reputation and altruism would have a positive effect on attitudes toward knowledge sharing (Thomas H Davenport & Prusak, 1998). As a matter of fact, inside organization forms a market to exchange knowledge where knowledge exchanges between supply and demanding parities and where reciprocity, reputation and altruism work as payment mechanism. Therefore, enterprises should encourage communications between different tiers of employees by creating communication places as “discussion room” and “café”, providing buffet for employees, organizing relaxing gatherings and dining together, etc. Necessary motivating and initiative systems can be established to encourage communications and exchanges of knowledge.

Summarizing experience and lessons is the best way to learn. It is of special importance to get together
and discuss failed or defected cases, which will greatly elevate employees’ knowledge level. However, in practice, most enterprises attach more importance to summarizing successful cases or best practice, rather than failed cases that worth more time to study. Also, it is observed that it is more difficult to reflect on failed cases than on successful practice. Maybe it is OK to reflect on the failure of other enterprises or departments, but many enterprises or departments do not brave to reflect on their own failure. Thus enterprises needs to build motivating and initiative system to encourage or push employees to absorb experience from failures.

4.6.2 Discussions on Components of IC

Due to diverse classification of IC and fragmented research on IC, methods to measure IC differ in a thousand ways. Based on existing research, in combination with features of architectural design industry, a four-dimension model is constructed to study IC from the perspectives of management innovation, workflow innovation, technology innovation and business innovation. This thesis carried out detailed reliability and validity analysis through AMOS software on revised scale of IC. The indicators and fit indexes tested out satisfy testing requirement, indicating the model fits well and the four-dimension model is rational and applicable.

1. Management Innovation Capability

Benghozi compared management innovation with technology innovation and market innovation, and believes that problems enterprises faced with not only involves technology and economy, but also involves cooperation flow inside enterprise, development budget and personal control, extracting management innovation out of market innovation and technology innovation (Benghozi, 1990). In Harvard Business Review published in 2006, Hamel pointed out that management innovation is the reform of management mode brought out by the management principles, process, practices or organizational form implemented by the organization that that distinguish from the traditional ones (Hamel et al., 2002).

Design enterprises of different scale and type have different manage modes. However, it is still very necessary to innovate and improve management methods. That is why many managers keep improving management ability. Management innovation cannot copy the experience of other enterprises, but relies on managers’ diligent exploration to find out their own method.

As a traditional industry, many state-owned designing enterprises in China maintain the content and method of work derived from era of Soviet Union, which cannot satisfy customers. As economy growing rapidly, these defects are still tolerable when there are a lot of projects and few advanced design enterprises in industry. But when the industry starts to transit, those enterprises do not change with time will be in danger.

Pettigrew has studied from the perspective of individual innovation, pointing out that the formation of organization relies on complex correlation with other organizations (Pettigrew & A., 1970). In architectural industry, technology staff working on front line and junior managers deal with customers almost every day. They are in command of first hand materials about customers. Therefore, it is important to give full play to their capacity of management innovation and avoid confining management innovation within leading team. Considering that even junior managers only have executive rights, much less technology staff, it is suggested to take initiative measures to award employees provide suggestions on management. Architectural design enterprises work with customers from various industries, among which there must be some excellent and leading enterprises. So it is very important for design enterprises to learn management innovation experience from excellent customers.

2. Workflow IC

Workflow IC is comprehensive, which is the senior level of IC. Workflow innovation is an integration of business innovation, technology innovation and management innovation, focusing on turning
enterprise’s producing and operating flow into knowledge. Workflow innovation internalize the achievements of CKM into enterprise operation and management and make it circulate and upgrade in the practice of enterprise operation and management, so as to elevate the overall IC of enterprise.

Whether the production flow and service flow of a designing enterprise is rational and effective is a critical factor to ensure designing pace and project quality. Designing enterprise should formulate simple and efficient production flow and service flow in accordance with its own technology, features of project and requirement on designing pace. Designing flow should be customer oriented, so it is better to learn from CK to improve the workflow and make customers more satisfied.

In design cooperation or construction cooperation, provisional requirements from customers cannot be satisfied timely, causing customers’ complaints. This has long been a problem of design enterprises. CKM will help enterprises to predict customers’ requirements more accurately and will also help employees refer to solutions to similar problems quickly, making problem solving a program.

Cost control is critical to enterprise management. Widely applying and managing CK will help enterprise solve customers’ problems more accurately, reduce duplicate work, improve the structure of workflow, and cut the cost of projects, so as to make enterprises more competent and more sustainable.

3. Technological IC

As a technological enterprise, architectural design enterprise takes technological IC as basic IC. Technology innovation has two aspects as operation technology and design technology. The former includes database construction and management technology, such as human resources technology, financial technology, and management technology, etc. The latter includes project designing capacity and development capacity, etc. Design enterprises are knowledge intensive, whose ability is directly related with the ability of talents.

At present, technology is upgrading in Chinese architectural design industry. BIM technology is coming into application gradually, which is the second technology reformation since CAD replaced manual drawing. BIM technology integrates scheming, designing, constructing, and operating together, and will brought reformation to construction designing technology. Besides, as the success of 3D printing technology, designing and construction are possible to separate from each other for the first time. With this technology, all aspects of projects including scheming, designing, construction and operating can be integrated into one designing process, leaving construction and operation in later stage only to print and apply. In a knowledge explosive era, all the architectural design enterprise will be exposed to technology reformation.

The conduction of CKM will improve enterprise’s technological IC constantly. New demands of customers will promote inner studies and external integration of technology resources. The development of information database and knowledge database will help enterprise improve information technology level and introduce professional new technology. Customer-oriented strategy will promote the overall development of design enterprises, while HR management technology, financial management technology and operational management technology will progress greatly as the absorption of CK.

4. Business IC

The business innovation of architectural design enterprise includes product innovation, service innovation and mode innovation. New demand of customers, expansion of market and new direction of government strategy will stimulate the occurrence of new products, such as sponge city and city lounge. New knowledge in CKM will also motivate designing enterprise to bring up new service, such as planning for front end of architectural industry chain, cost consulting, construction management and operation management, etc. Mode innovation is the most valuable and the most difficult one, which concerns the innovation of overall designing industry, such as BIM-directed designing business.

After CKM getting on track, enterprise will acquire unprecedented information, demand and
knowledge about customers, stimulating enterprise expanding its shares in market and developing new business. As government strategies change, some emergent business such as culture design, environment design and sponge city springs up, while traditional business as property design will recess. New market and new business hold the key to the sustainable development of designing industry. Enterprises do not change will become outdated.

For architectural design industry, the key to business innovation is to give full play to methods of CKM and have a good knowledge about customers. It is of special importance to learn about goals and directions of enterprises that seem unrelated with design. By tapping into customers and preparing necessary knowledge in designing, enterprises can predict customers’ potential needs and prepare some solutions, so that they can make quick action to customer’s new requirements.

Homogeneity is increasingly widespread in architectural design industry, so it is very hard to keep technology a secret. Besides, most projects do not have high requirements for technology, so plagiarizing is very common within industry. To maintain a leading role, enterprise must consistently innovate its business based on CK acquisition, externalization, integration, and internalization.

Customer management system in traditional designing customers is severely lagged behind in terms of information. Summaries and call-up are usually conducted after projects are finished and some information is even acquired after completion of projects. If CK cannot be updated and applies timely, communications among different projects will be blocked out and summarized experience will be put aside and become useless. Improving methods of CKM will make things better.

In summary, the revised scale and questionnaire about CKM and IC prove to be rational. Besides, the conceptual model and questionnaire developed by Nonaka, Jayacjandran and Nastaran prove to be applicable to Chinese architectural design enterprises.

4.6.3 Results and Discussions on Relationship between CKM and IC

This thesis brought up sixteen presumptions about the relationship between CKM and IC. Through structural equation model analysis, the fitting results indicating that except the path between CK internalization and enterprises workflow innovation, all the other path coefficients corresponding to fifteen presumptions are greater than zero. At the same time, all the significance of these path coefficients satisfies the identification requirement of 0.001. Therefore, all the fifteen presumptions about CKM and IC prove to be rational.

4.6.3.1 Relationship between CKM and IC

The path coefficients between acquisition, externalization, integration, internalization of CK and enterprise’s management innovation are 0.435, 0.378, 0.482 and 0.294 respectively. Four factors of CKM have significant positive influence on enterprise’s management IC (P<0.001). Therefore, CKM especially CK acquisition and integration has significant influence on enterprise’s management IC, which is coincide with practice. Enterprise’s knowledge mainly comes from learning and acquisition of external knowledge. To enrich the storage of knowledge, enterprises need to elevate its ability to adapt to the external knowledge environment. Since absorb knowledge from external environment, enterprises not only need to enrich storage of knowledge, but also need to improve its ability to deal with knowledge. Management innovation will not only stimulate enterprise’s technology innovation, but will also improve the efficiency of management, so as to make enterprise stands out in competence.

H1a: The more CK enterprise acquires, the higher the IC will be.

Customers are whom we learn from about management, for there are commonplace among management of different enterprises. Customers of architectural design enterprises are usually enterprises or institutions with pretty strength and scale, because only enterprises with pretty capital and resource such as property companies, government and enterprises are likely to construct their own building. Since these
enterprises have already developed to a certain scale, most of them have mature experience which will help to improve management ability and thinking mode of architectural enterprises, just like “cross-industry way of thinking” and “cross-industry of cooperation” which are very popular these days. For architectural design enterprises, customers are their best teachers outside industry, they can learn administration and HR management from customers and should pay special attention to failures, so as to change and expand their way of thinking, bringing positive influence to management innovation of their own.

H1b: The higher the extent to which CK is externalized, the higher the enterprise’s management IC will be.

Both architectural design enterprises themselves and their customers are sized enterprises with many functions and employees. Every designing enterprise has a lot of customers and every project of every customer has many participators. Therefore, through connection with different customers in different projects, design enterprises can acquire a lot of advanced and innovative management experience from different customers. This knowledge about customers are huge and collected by many people, which cannot be stored completely in people’s mind but only by externalization can experience be stored in database. The process of externalization requires enterprises change their way of management. Besides, this precious management experience is stored in brains of employees (designers and customers) and hard to put down or unwilling to speak out. Externalization of CK is systematic, complicated. The management method of CK should keep innovating. CK externalization will stimulate the management innovation of enterprise.

H1c: The higher the extent to which CK is integrated, the higher the enterprise’s innovation will be.

CK from various projects, various customers and individuals is usually fragmented and complicated, concerning various aspects of various industries. If merely externalized this knowledge into database and do not make summary and integration, the effects of CKM will be fragmented, too, for example, business management experience may be separated from administration experience. When it comes to one specific project, management experience acquired by designers, operators and administrators respectively may differ or even conflict due to different perspective of observation and communication, and therefore cannot do well to the substantial development of enterprises. Through integration of CK, on the one hand, enterprises can summarize customer management experience sharing and communicating with others, so as to stimulate new ideas about management innovation. On the other hand, the process of summarizing customer’s management experience will stimulate enterprise to create new management methods. What’s more, after the integration of CK, enterprises can pick out and sort out novel experience that will do well to enterprise innovation.

H1d: The higher the extent to which CK is internalized, the higher the enterprise’s management IC will be.

It is a long process from acquisition of knowledge to absorption of knowledge and finally to application of knowledge. This process is especially long when it comes to precious tacit knowledge, which will go through a circulation as “learn—summarize—apply—relearn—resummarize—reapply”. Internalization of customer’s management experience means successful application of the knowledge absorbed from customers, so enterprises need to communicate thoroughly and repeatedly with customers from many perspectives, absorbing useful management experience, applying it into daily management and refining it in practice. This is “in-depth” study, which is a main source of management innovation.

4.6.3.2 Relationship between CKM and Enterprise’s Workflow IC

The path coefficients between acquisition, externalization, and integration of CK and enterprise’s workflow innovation are 0.430, 0.374, and 0.409 respectively. Three factors of CKM has significant positive influence on enterprise’s workflow IC (P<0.001). Strong ability of acquisition and integration of CK will help enterprise to utilize stored knowledge more effectively. After knowledge externalization,
enterprise will be exposed to tacit knowledge acquired by employees, then summarize and transform the knowledge to better serve enterprise itself and elevate workflow IC.

H2a: The more CK enterprises acquire, the higher the enterprise’s workflow IC will be.

Acquisition of CK is an important link in architectural design enterprise’s workflow. To be simple, the start of a project is acquisition of CK. Acquisition of CK is a link of designing process, in which process managers of designing enterprise get connected with customers, have a basic knowledge about customers’ demand, help customers compose design specification and have a basic knowledge about the environment of project, etc. More incisively, on the one hand, a thorough knowledge about customers will help to grasp customers’ demand as much as possible, which will help to avoid detouring in designing process, improve efficiency and simplify workflow. To improve efficiency is to innovate. On the other hand, enterprise will learn a lot about customers’ workflow management after communicating with customers, which will help to add new ideas to workflow management and activate workflow innovation of design enterprises.

H2b: The higher the extent to which CK is externalized, the higher the enterprise’s workflow innovation ability will be.

CK externalization is to turn fragmented, oral and tacit CK into tacit knowledge recorded in customer database. CK externalization is also an important component of enterprise’s workflow management. For instance, the importance of customer meeting notes has been emphasized for years, but there are few projects keep records from the very begging to the end. Even if some projects keep records sometimes, few of them made summary and classification for these records. Besides, design enterprises that keep customers’ collection materials in record are no more than one tenth in industry. Therefore, it is more difficult for enterprises to turn customers’ tacit knowledge into explicit knowledge. For architectural design enterprises, externalization of CK is part of workflow innovation. Enterprise should extensively learn from customers and rivals about workflow management and summarize the features of workflow management, so as to improve manage methods and make them explicit, which will elevate the overall ability of workflow management.

H2c: The higher the extent to which CK is integrated, the higher enterprise’s workflow IC will be.

CK integration is to sort out, summarize, induce, and refine the externalized CK. Even externalized, CK is still very fragmented and unsystematic. For instance, enterprises still need to sort out and summarize common problems and solutions in many projects, analyze the differences and connections between customer knowledge of different projects and summarize the “best practice”, etc. Only after integration, can employees of enterprise apply what they have learnt and CKM can really help to elevate the core competence of enterprise. CK integration is the basis of enterprise workflow innovation, providing direction and significance to enterprise’s workflow innovation.

H2d: The higher the extent to which CK is internalized, the higher the enterprise’s workflow IC will be. The extent to which CK is internalized do not have significant (P>0.001) influence on enterprise’s workflow IC. Thus this presumption is not supported.

CK internalization is the most valuable link of CKM. Due to its high value, it is the most difficult link. Firstly, CK internalization is the final link of CKM. All the former links are to make employees get fully command of CK. Only when employees keep this knowledge in mind, can CK gives its full play. Secondly, CK internalization starts the next circulation of CKM. Only through internalization, the direction of next CKM circulation can be settled down and the new circulation can conduct on a more advanced level. Enterprise’s workflow innovation is a difficulty in four dimensions of architectural design enterprise’s innovation, while most enterprises didn’t realize this, or didn’t set down to this work even realized. Since CK internalization and enterprise’s workflow innovation are difficult areas in relationship between CKM and IC, most enterprises haven’t set down to these two areas yet. Therefore, it is natural that the results of our questionnaire turned out to be unsupportive. It is believed that as the transformation of architectural
design industry from “industry enterprises” to “knowledge-oriented enterprises” and the application of our research, the chief executives may change their ideas and pay attention to this presumption.

4.6.3.3 Relationship between CKM and Enterprise’s Technological IC

The path coefficients between acquisition, externalization, integration, and internalization of CK and enterprise’s technology innovation are 0.347, 0.237, 0.172 and 0.395 respectively. Four factors of CKM has significant positive influence on enterprise’s workflow IC (P<0.001). CKM can integrate, sort out and store knowledge by setting up a comprehensive database of customer knowledge inside enterprise, so as to satisfy the demand of different technology innovators for CK.

H3a: The more CK enterprise acquires, the higher enterprise’s technology innovation ability will be.

Customers’ demand is the motivation and engine of enterprise technology innovation. Enterprise must have a good command on customer’s exact demand, especially their earnest demand so that they can direct technology innovation according to customer’s demand. It is one of the most critical targets to have a good command of customer’s real demand. Firstly, customers of design enterprises are from various industries. In this case, customers’ understanding to their own industry is usually more thorough than designers. For architectural design enterprises, the process to acquire customer’s demand is to learn. Many customers invite designers to visit similar projects so that designers have gotten the chance to get command of first-hand materials about similar projects, which is very important to designing enterprise’s technology innovation. Secondly, when designing enterprise is not able to satisfy customer’s requirements in technology or some other aspects of projects, enterprise will be motivated to seek technology support outside, which will also activate technology innovation. Thirdly, IC of outstanding customers will also bring designing enterprise to the technology innovation of specific project. In a word, as the results of this research, CK acquisition has significant positive influence on IC.

H3b: The higher the extent to which CK is externalized, the higher the enterprise’s technological IC will be.

Technology innovation is the basis of CK externalization, which will reduce the cost and difficulty of externalization and help to complete CK externalization with enterprise’s budget. CK externalization is the engine of enterprise’s technology innovation. No matter in junior and small-sized externalization or in senior full-scale externalization of CK, enterprise need to innovate its technology according to specific conditions. There are three aspects of CK externalization for architectural design enterprise. Junior aspect concerns keying basic customer material and related designing material into database. The second aspect is to externalize customer-related meeting notes, communicating and interviewing material during project. Senior aspect is to externalize customer knowledge and tacit knowledge. This aspect is extremely difficult, for which enterprise needs to design and innovate technology in terms of strategy, structure, and system, etc. For architectural design enterprise, CK externalization is the engine of technology innovation.

H3c: The higher the extent to which CK is integrated, the higher the enterprise’s technological IC will be.

CK integration is an important link after CK externalization. Through integration, a large amount of fragmented CK will be integrated together into a complete knowledge system. Customer knowledge database without integration is inefficient and will become nothing at last. CK can be integrated by various framework from which architectural design enterprise can select the most suitable one or even can they create a new framework that never exist before. For example, integration can be made according to customer type, designing type, location of projects and project type, etc. There is not any standard framework for CK integration. It is necessary for enterprise to explore constantly in integration and find out an optimal framework, which is an engine and challenge to enterprise’s technology innovation.

H3d: The higher the extent to which CK is internalized, the higher enterprise’s technological IC will
be.

CK internalization is the senior phrase of CKM circulation as well as the destination of CKM. Only by CK internalization can CK system formed through acquisition, externalization, and integration gives its full play to improve IC and elevate its core competence. The concept of customer should be understood in a broad sense. In projects, the proprietors are customers. In cooperation with design enterprises, the other design enterprises or teams are customers, too. With one enterprise, different designing departments can become the customer of each other. Distinguished by different customers and different knowledge, CK internalization can be divided into three aspects. The first is the internalization of proprietor’s knowledge. The second is the internalization of other designing enterprise’s (or rival’s) knowledge. The third is the internalization of other employees’ knowledge. Architectural design enterprise is naturally technology enterprise, so the instruction of CK will certainly strengthen enterprise’s technological IC.

4.6.3.4 Relationship between CKM and Enterprise’s Business IC

The path coefficients between acquisition, externalization, integration, internalization of CK and enterprise’s business innovation are 0.366, 0.229, 0.384 and 0.471 respectively. Four factors of CKM has significant positive influence on enterprise’s business IC (P<0.001). As indicated by the path coefficients, the influence of CK internalization on business innovation is most significant. By turning explicit knowledge to tacit knowledge, CK internalization represents the real capacity of individual and enterprise. Good ability to apply CK will help to innovate management methods, speed up products development and improve business innovation ability.

H4a: The more CK enterprise acquires, the higher enterprise’s business innovation ability will be.

The collection of customers, e.g. market, is the source of designing enterprise’s business. An important point for business innovation is to develop new products to develop new market and at the same improve existing products to expand existing market. By acquisition of CK from various aspects, designing enterprise is able to gain first-hand materials about customer, learn about customer’s business flow and then figure out the development destination and direction of customer, so as to develop new ideas and new way of thinking for business innovation.

H4c: The higher the extent to which CK is externalized, the higher enterprise’s business IC will be.

CK externalization and construction of CK database can exhibit CK of different time and different projects to employees, expanding the application of CK from team crew to all staff. This will open employees’ eyes and avoid many duplicated work among departments. Also, it will promote the communication among different specializations and departments so that information can be shared among leaders, operating department, designing department, technology & quality department, and HR & financial department. Enterprises will become more sensitive to new business and their decisions on operability and technology feasibility will speed up, which will directly promote enterprise’s business IC.

H4c: The higher the extent to which CK is integrated, the higher enterprise’s business IC will be.

Most business of architectural design enterprise is complex, which cannot be finished only by individual knowledge. Some business even requires the experience accumulated by generations. So it is necessary to make systematic summarization on various experience, materials and information. CK is one of the most important factors for design enterprises to finish complex designing. Integration, induction and deduction of CK will greatly improve the efficiency and quality of design enterprises and promote business IC.

H4d: The higher the extent to which CK is internalized, the higher enterprise’s business IC will be.

There are commonplace between CK internalization and enterprise’s business IC. CK internalization is to absorb various tacit and explicit CK profoundly, while business innovation is to apply this absorbed knowledge to practice and bring up new knowledge. CK internalization has positive influence on
enterprise’s business IC. As Cong Xiaomi, the dean of Designing school of Beijing University of Civil Engineering and Architecture, said in our interview, it is impossible for an enterprise to stagnant if its core values, strategic layout, structure, system, and other critical factors are well designed. Also, if enterprise does a good job in CK internalization, it is impossible for this enterprise to stagnant.

4.6.4 Discussions on Chinese Culture's Impacts on CKM

In the process of in-depth interviews, many business managers mentioned the Chinese "relationship" culture’s impacts on the implementation of customer knowledge management. For Chinese enterprises, "relationship" generally refers to use the relationship with someone in custom enterprise to obtain competitive advantages. From the view of customer knowledge management, using "relationship" can make enterprise have access to gain more customer knowledge, so that enterprise has more competitive advantages.

The concept of relationship marketing was presented in the early 1980s (Jackson, 1985), from many different origins, such as industrial marketing, service and international marketing, and so on (Berry, 1995). At present, there is a general accepted definition from Morgan and Hunt: relationship marketing refers to all marketing activities aimed at establishing, developing and maintaining relational exchange (Morgan & Hunt, 1994). Different from transactional marketing, the relationship marketing base on the invisible things (such as feelings, commitments, trust, etc.) for the exchange, reflecting a continuous mutual benefit process. When it comes to the sale of goods, the relationship marketers not only concerned about their own interests in the transaction, but also concerned about the interests of buyers. They rather reduce their own temporary profit to ensure the interests of each other. Therefore, the relationship marketing has a time dimension more than transactional marketing. Buyers and sellers have mutually benefit, and they do not need the other side give the equivalent return immediately. The non-immediate return of relational marketing determines the importance of trust and commitment in relationship marketing, which is the two key intermediate variables of relational marketing(Morgan & Hunt, 1994).

Based on interviewee's management experience, the correct use of Chinese "relationship" cultural factor has a positive impact on customer knowledge management.

1. The establishment of "relationship" is a quick way to understand the real customer background and the project background.

Customer background information and specific project background information is very important to enterprise. During in-depth interviewing, most of the interviewees have mentioned the importance of the customer background. Public information about customer is limited. It is hard to know the background information about customer and project. For the project design work, public information is not enough. The establishment of "relationship" is a quick way to understand the real customer background and the project background.

2. The establishment of "relationship" can help to get the customer demands

For the architectural design enterprises, customer demand is often reflected in the design task book offered by customer. Because the customer is not professional in design wok, the design task book is usually unscientific. In addition, the design task book is generally made by common employee in customer enterprises and leaders in customer enterprises often do not look at the details of design task book. It does not represent the true intention of customer enterprise. The establishment of "relationship" is a quick way to get the customer demands because you can get more detail information of customer enterprise and project.

3. The establishment of "relationship" can quickly establish a mutual trust with the customer

The basis of communicating deeply with customer is to build mutual trust. There are varieties of ways to establish mutual trust with customer.

First of all, to show a large number of successful projects before and invite customers to visit the
projects are both good ways to establish trust. This way is a very important method in China and even some enterprises use the “impostor” project to win customer trust. Second, outstanding design team is another factor attract customers to establish trust. In addition, the "relationship" is the same as one of the most important ways.
V Conclusions and Expectations

5.1 Conclusions and Innovations of the Research

As the concluding part, this chapter generalized the innovation and contribution of this research. Analysis will be made on what direction this research may have to management practice. Also, reflections will be made on the limitations of this research and suggestions will be made on further study.

5.1.1 Conclusions

Based on CKM theory, enterprise innovation theory and related statistics theory, this thesis carried out empirical research on CKM activities of architectural design enterprises. To analyze the correlation between CKM and IC, CKM-IC correlation model was set up. In this model, CKM was divided according to knowledge process into four dimensions including acquisition of CK, externalization of CK, integration of CK and internalization of CK, while IC is divided into management innovation, workflow innovation, technology innovation and business innovation. Based on this model, close researches on the relationship between CKM and IC were carried out. Combining theoretical investigation and management practice, this thesis has designed scale and questionnaire on CKM and IC, and has conducted surveys with questionnaire and interviews with chief executives. Through empirical research, conclusions can be reached as follows:

1. EFA on results of questionnaire is conducted with SPSS, with some problematic items deleted out. Then confirmatory factor analysis was carried out with Amos on four dimensions of CKM model (acquisition of CK, externalization of CK, integration of CK and integration of CK) and four dimensions of IC model (management innovation, workflow innovation, technology innovation and business innovation). It turns out these two models are of good structural validity, which has ensured the validity of scale and the feasibility of data.

2. This thesis puts forward sixteen presumptions about CKM and IC. Based on structural equation model, this thesis analyzes the survey results with Amos, which turns out that fifteen of them proved to be right. Apart from the correlation path between CK integration and enterprise’s workflow innovation, other corresponding relations between CKM and enterprise’s innovation are in significant positive correlation.

3. This thesis has studied the correlating mechanism between CKM and IC with both theoretical and empirical methods and has comprehensively analyzed the correlation between them, in expectation to provide some new ideas for architectural design enterprises to improve management ability and innovation ability.

5.1.2 Summary of Innovations

1. This thesis has studied CKM activities of architectural design enterprises, provided materials for CKM researches and brought new contents to management of architectural design enterprises.

According to literature review in Chapter 2, research on CKM of Chinese architectural design enterprises mainly focuses on personnel management and project management, while research on customer relationship management mainly focuses on customer satisfaction. Research on management activities of architectural design enterprises rarely takes the perspective of CKM flow. Based on related management theory, and in combination with management practice, this thesis has studied the relationship between knowledge-flow-based CKM and IC, expanding CKM research to architectural design history and providing a new idea to researches on CKM of architectural design enterprises.

2. Combining CKM theory and management practice of architectural design industry, this thesis sets
up a CKM model based on knowledge flow.

This thesis firstly reviews related literature to systematically summarize and compare existing CKM models so that we can have a clear awareness of the strength and weakness of these models and then study through management practice of architectural design enterprises. More than sixty definitions and classifications of CKM put forward by nearly one hundred scholars and research teams have been reviewed, including more than fifty kinds of activities about CK. To every knowledge activity, this thesis has critically examined its connotation and definition. By concept classification, this thesis has classified CK activities into acquisition, externalization, integration, and internalization, on the basis of which a knowledge-flow-based CKM model is constructed. This model contains four major CK activities as acquisition of CK, externalization of CK, integration of CK and internalization of CK. What’s more, discussions have also been made on the importance of environment variables, such as enterprise culture, technology support, leaders’ support and initiative systems, to the effective conduction of CKM.

3. Amendments have been made to existing CKM scales and a new scale has been formed and proved to be applicable to CKM of architectural design enterprises.

Based on summary and systematic analysis of literature about KM and CKM concerning knowledge flow and activities both home and abroad, in combination with management practice of Chinese architectural design enterprises, this thesis supposes four dimensions of CKM—acquisition of CK, externalization of CK, integration of CK and internalization of CK. With reference to existing scales to measure variables of CKM, this thesis has developed a scale to measure CKM and examined the reliability and validity of the scale in combination with the reality of Chinese architectural design industry. It has been proved that it is somewhat rational and scientific to classify CKM into four activities about CK.

5.2 Implications of the Findings for Research and Literature

1. This research has summarized and sorted out the concepts of CKM

The history of researches on CKM is not long, which can be inferred from various definitions of CKM. One of the most representative definition was put forward by Wayland and Cole in 1997. This thesis mainly focuses on the definition of Wayland and Cole, and reviews many representative definitions. Finally, definitions of CKM are classified into three types according to different purpose of their study: target/process theory emphasizes that the target of CKM is to develop enterprise’s competitive edge. Synthesis/integration theory (considering CKM as the integration of CKM and KM); Technology/flow theory (emphasizing the importance of information technology and the operating flow of CKM). In summary, the generalization on concepts of CKM has laid a solid foundation from further study on CKM.

2. This research has filled the vacancy of quantitative CKM research in architectural design industry

According to the literature review in Chapter II, enterprise’s KM is relatively weak in China, especially in terms of quantitative study. This research defined the classification of knowledge, setting up a study model containing four activities of CK. Data is collected from Chinese architectural design enterprises and the results proved models established in this research was rational. Multiple indicators were adopted to examine the reliability and validity of scales, with every indicator reaching standards and a four-dimension scale containing 22 indicators formed. Empirical study on CKM is a new field in China, even many foreign researches study CKM merely from one dimension, which will obviously decrease the value and meaning of CKM. Therefore, study with CKM scale is a big progress to quantitative study in this area, which will lay a profound foundation for further study in this area and help to study relationship between CKM and other concepts.
3. This research has made amendment to CKM scale and IC scale and proved their applicability in the cultural background of Chinese architectural design enterprises.

Regarding CKMC as core competence of enterprises, this thesis believes that CKMC has direct influence on IC. Firstly, researches made amendments and examinations on CKM scale and IC scale. In combination with related theories, a four-dimension scale is formed for CKM and IC respectively. Data of this research is collected from Chinese architectural design enterprises. The results of analysis have demonstrated that our amendments are rational. Many indicators are adopted to examine the reality and validity of the scales, with every indicator reaching corresponding standards. Finally, a four-dimension CKM scale including 22 indicators and a four-dimension IC scale including twenty indicators came into being. In conclusion, set in Chinese culture and rooted in the management practice of Chinese architectural design enterprises, the scales used in this research are revised versions of foreign scales and proved to be applicable. Therefore, this research laid a foundation for quantitative study applying CKM scale and IC scale to Chinese architectural design enterprises, which has enriched the research of this area.

4. This thesis has further generalized the relationship between CKM and IC

Many scholars have studied the influence of CKM on IC, whose results enriched the theoretical system of CKM research. However, most existing researches are qualitative. For instance, some researches focus on the methods of CKM—the application of intent chain, and some are concentrated on enterprise’s core competence. Still, in-depth and quantitative analysis of relationship between CKM and IC is rare. Therefore, against the background of Chinese architectural design industry where CKM is emerging, this thesis tried to figure out how CKM influence IC. Based on theories of KM, CKM, enterprise’s core competence, IC and enterprise’s resources, this thesis established a structural relation chain between CKM and IC, and uncovered the influence of CKM on IC. In summary, this thesis established the chain representing influence of CKM on IC and made quantitative analysis of the correlation between them, enriching researches on CKM and laying a profound theoretical and empirical foundation for further studies in this area.

5.3 Implications of the Findings for Management, Business and Industry

1. This research has provided directions for CKM of architectural design enterprises and helped them to elevate IC.

As a traditional service industry, architectural design enterprises are customer-oriented. As architectural design is called “solidified art”, IC is necessary for architectural design enterprises. Therefore, CKM and IC are two important factors in the development of design enterprises of various scales. No matter consciously or unconsciously, CKM and IC are never absent from the operation of enterprises and the chief executives always have their own experience and understandings. However, as shown by the interviews, most enterprises haven’t put the implementation of CKM and IC improvement into development strategies. The stagnation of practice development is mainly because the lack of supportive theory. Therefore, the development of theory and practice are mutually promoted. So implement CKM, what should be included in the basic business flow for enterprises to undertake? This research constructed CKM model from the perspective of enterprise’s knowledge activity. Four activities about customer knowledge are very applicable to the business flow and management practice of enterprises, therefore the models will function well as a direction of practice. In this way, CKM will no longer be an abstract concept for enterprises, but a practical management activity, operation activity and production activity. This research enriches theories about how to help architectural improve CKM and IC and is of both theoretical and practical meaning to upgrade China’s design enterprises from extensive management to intensive
management, transform from production oriented to knowledge oriented and finally improve international competence.

2. This research has provided a valid tool to diagnose whether CKM practice is successful or failed.

At present, some architectural design enterprises in China have already started to manage CK. However, due to different background, scale, and operational features, enterprises differ a lot in CKM ability. Therefore, scale developed to measure CKM can be used to diagnose problems occurred in CKM practice. With this scale, enterprises are able to have a clearer awareness about their own CKM ability which refers to not only comprehensive ability but also specific strengths and weaknesses. When there are problems, enterprises can make surveys accordingly among related employees and important customers and make analysis of four dimensions of scale respectively, so that enterprise can find out the problems and make adjustment accordingly based on existing CKM strategies. What’s more, further specifications under each item will help enterprises decrease the range of problems, so that enterprises can solve problems more quickly and more targeted. In this way, the development and success of CKM practice will be largely promoted.

5.4 Limitations and Future Research

At present, researches on CKM are basically theoretical discussions, where theories about inherent composition and operation mode haven’t been set up yet. There are still many important theories and practical problems to be discussed in this area. This research is merely a primitive exploration. Though some achievements have been made, limitations are unavoidable.

5.4.1 Limitations of this Research

1. The problem of sampling distribution. Due to limitation of time, energy and survey’s feasibility, samples of this research are mainly distributed in Beijing, Tianjin and Shanghai. The number of samples fulfills the requirement for statistical analysis and the models and presumptions are proved to be valid. But considering the purpose of this study—from the perspective of management practice of Chinese architectural design enterprises, coverage of this area is not wide enough to present the practical features of this industry, so it stills requires further test on the results to see if is universally applicable.

2. Data in this research was collected through questionnaire. Since every questionnaire can be finished by only one employee, common variance may occur. Further researches can try to use multiple methods to collect information.

3. The development of enterprise is dynamic. Only persistent follow-up survey can discover the development law between CKM and IC. Due to limitation of personnel, material and time, this research adopted cross-sectional study whose results are naturally reflect the relationship between variables. But to get more rigorous results, longitudinal study is necessary. In further researches, follow-up researches will be taken on representative enterprises to provide more valuable suggestions for enterprises.

5.4.2 Future Research

Based on this research, further studies may focus on these aspects:

1. Relationship of the four knowledge activities in CKM model

As emphasized in Chapter 3, four knowledge activities of CKM model are correlated, forming a mutually-influenced integration. The empirical research also proves that these activities are significantly correlated to each other (covariance is significant). However, further verification has never been taken to prove the correlation between knowledge activities. A circulation as “CK acquisition—CK
externalization—CK integration—CK internalization” is supposed to be verified and examined in further studies with a no recursive model in SEM.

2. Comparison of architectural design enterprises home and abroad

This research focuses on Chinese architectural design enterprises, while excellent architectural design enterprises have world leading management method and operation mode. If it is possible to tap into foreign enterprises, quantitative contractions can be conducted to compare practice of CKM against different culture background and their influence on enterprise performance respectively, which will greatly help to improve management efficiency of Chinese architectural design enterprises.

3. Follow-up survey should be taken on representative architectural design enterprises for persistent longitudinal studies.

As elaborated in research limitations, this is a cross-sectional research whose results cannot be observed dynamically. A more rigorous result shall come from longitudinal study. So, persistent tracking studies should be taken on representative enterprises by giving quantitative studies regularly, so as to figure out the dynamic relationship between CKM and IC of Chinese architectural design enterprises.

4. Specific problems in CKM practice of architectural design enterprises

This research is more theoretical than practical. CKM practice of architectural design enterprises is still under exploration in China. There are many problems to be solved. For example, it is the key to improve efficiency of projects and elevate IC to solve problems as knowledge loss, knowledge sharing and tacit knowledge management in projects. In the process to turn tacit knowledge into explicit knowledge, how to explore project manager’s tacit knowledge is a focus in CKM practice. Besides, it is also an important task to evaluate the efficiency of CKM measures and improve these measures accordingly. Indicator system put forward is just a preliminary attempt and needs further exploration.
APPENDIX

Appendix I: Questionnaire

Investigation on Customer Knowledge Management and Innovation Capability of Architectural Design Enterprises

Dear Colleagues:

Good day! I am Wei Wang from the Design Institute of Beijing University Of Civil Engineering And Architecture, and I am conducting research on the relationship between customer knowledge management capability and innovation ability of Chinese architectural design enterprises. Thank you for agreeing to take part in this important research. The result will be sent to you for reference. Be assured that all answers you provide will be kept in the strictest confidentiality.

Each question in the questionnaire is divided into five levels. You can choose one of the five choices based on the performance of your organization on the issue: Very Poor, Poor, Fair, Good, and Very Good.

Glossary: Customer knowledge contains three categories: 1. Knowledge about customers (customer background, customer credit, design conditions of projects, etc.); 2. Knowledge from customers (evaluation and suggestions, evaluation to our competitors, ideas and opinions on the demand of service, etc.); 3. Knowledge for customers (our technical and service capabilities, technical research and market research for our customers, our unique services, etc.).

Investigation on Customer Knowledge Management Capability of Architectural Design Enterprises

Customer Knowledge Acquisition

Your organization is
1. Emphasizing the importance of customer knowledge constantly. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
2. Conducting customer background investigation before the project. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
3. Interacting with customers deeply through the convening of customer meetings and establishment of a common project team. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
4. Collecting customer feedback and complaint information actively. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
5. Acquiring customer knowledge from analysis of various types of market demand. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
6. Learning about evaluation of your competitors’ service quality from customers actively. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good

Application of customer knowledge

Your organization is
7. Establishing network platform for customer interaction (customer complaints center on enterprise website, WeChat group, II group, etc.) [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
8. Archiving customer data generated in the design process. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
9. Updating customer information in the database regularly. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
10. Establishing customer evaluation system and archiving the results. [Multiple Choice]
    ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
11. Setting specialized departments or personnel responsible for collating customer knowledge and materials. [Multiple Choice]
    ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
Customer knowledge portfolio
Your organization is
12. Integrating customer databases of various departments. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
13. Building customer knowledge system and sort out customer knowledge of different projects. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
14. Training employees to use the customer database. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
15. Adjusting enterprise strategy according to the summary of customer knowledge. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
16. Researching the demands and behaviors of customers. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
17. Taking measures to unblock the barriers of customer information among various departments. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good

Adoption of customer knowledge
Your organization is
18. Optimizing customer database for more convenient and efficient use. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
19. Organizing experts to train employees about customer knowledge. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
20. Encouraging employees to share customer knowledge. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
21. Improving design results according to customer responses. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
22. Summing up the lessons from your own or other enterprises’ failure. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good

Investigation on Innovation Capability of Architectural Design Enterprises
Management innovation ability
Your organization is
23. Exploring new ways to achieve business goals. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
24. Improving work content and working methods. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
25. Collecting and rewarding employees’ good ideas regularly. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
26. Encouraging employees to learn and study typical design cases. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
27. Promoting smooth communication among various departments. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
28. Researching and responding to relevant policies, competitor dynamics and market conditions [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good

Process innovation capability
Your organization is
29. Implementing production and service processes. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
30. Resolving customer issues quickly. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
31. Controlling project costs effectively. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
32. Paying continuous attention to changes in market demand. [Multiple Choice]
   ○ Very Poor ○ Poor ○ Fair ○ Good ○ Very Good
33. Improving production and service processes continuously according to new technologies. [Multiple Choice]
   ○ Very Poor  ○ Poor  ○ Fair  ○ Good  ○ Very Good

   Technological innovation ability
   Your organization is
34. Developing the enterprise information and knowledge management system independently. [Multiple Choice]
   ○ Very Poor  ○ Poor  ○ Fair  ○ Good  ○ Very Good
35. Arranging funds to support technological innovation. [Multiple Choice]
   ○ Very Poor  ○ Poor  ○ Fair  ○ Good  ○ Very Good
36. Being able to decide to adopt a new technology soon. [Multiple Choice]
   ○ Very Poor  ○ Poor  ○ Fair  ○ Good  ○ Very Good
37. Conducting high-level research and development. [Multiple Choice]
   ○ Very Poor  ○ Poor  ○ Fair  ○ Good  ○ Very Good
38. Adopting new technologies and ideas. [Multiple Choice]
   ○ Very Poor  ○ Poor  ○ Fair  ○ Good  ○ Very Good

   Product innovation ability
   Your organization is
39. Winning design projects awards. [Multiple Choice]
   ○ Very Poor  ○ Poor  ○ Fair  ○ Good  ○ Very Good
40. Improving the proportion of new business continuously. [Multiple Choice]
   ○ Very Poor  ○ Poor  ○ Fair  ○ Good  ○ Very Good
41. Adjusting and improving the design project according to views of various stakeholders. [Multiple Choice]
   ○ Very Poor  ○ Poor  ○ Fair  ○ Good  ○ Very Good
42. Being imitated often by competitors in terms of advanced concept. [Multiple Choice]
   ○ Very Poor  ○ Poor  ○ Fair  ○ Good  ○ Very Good

   Respondent's personal information
43. The nature of your enterprise: [Multiple Choice]
   ○ state-owned enterprise
   ○ private enterprise
   ○ State-owned holding enterprise
   ○ Private holding enterprise
44. Enterprise scale (people): [Gap Filling]
45. Annual output value (ten thousand Yuan): [Gap Filling]
Appendix II: Interview Outline

Interview with top managers about architectural design enterprise customer knowledge management capability and enterprise's innovation capability

This is a study about the relationship between customer knowledge management and enterprise's innovation capability of Chinese architectural design enterprises. The interview is intended to collect and help understand enterprises' top managers' views of this research topic and the management practices of their own enterprises in these two aspects.

This interview will take you 45 minutes, contents involving customer knowledge management, enterprise's innovation capability and the relationship between these two aspects. The interview structure includes retrospect on interview background and specific interview questions. Wish to listen to your business experience.

I. Retrospect on Interview Background
   (1) Retrospect on Enterprise’s Customer Knowledge Management
      1. China is transforming from production-based economy to intelligence-based economy, where intelligent resource will take the place of land, material capital and other conventional factors and become the most critical resource in nation’s competence.
      2. To be simple, knowledge management is to collect intelligence of the mass and apply it into every aspect of operational management, so as to improve the core competence of enterprises.
      3. Customer knowledge management is the integration of knowledge management and customer relationship management, which is a form of “knowledge management getting down to customers”.
   (2) Retrospect on Enterprise’s Innovation Capability
      1. Enterprise’s Innovation Capability includes four aspects as management innovation, workflow innovation, technology innovation and business innovation.
      2. Enterprise’s Innovation Capability makes an important part of enterprise’s core competence.

II. Questions of the Interview
   (1) Questions on Customer Knowledge Management
      1. What do you think are important things enterprise should do to get customer knowledge? Which one is the most important?
      2. Do you think it is important to collect information and other materials about customers to build a customer knowledge database? Is it important for enterprises to have system and culture to get customer knowledge?
      3. Do you believe that it is important to have in-depth communication with customers and share the communicating results within enterprise? Why? What problem may occur in this process?
   (2) Questions on Enterprise’s Innovation Capability
      1. What do you think are most important things enterprise should do to develop enterprise’s innovation capability?
      2. Among management innovation, workflow innovation, technology innovation and business innovation, which one do you think is the most important? Or whether do you think all of them are very important?
      3. Do you think it is good way for developing enterprise’s innovation capability by constantly communicating and cooperating with other enterprises? Why?
   (3) Comprehensive questions
      1. The results indicate that implement of customer knowledge management will significantly improve enterprise’s innovation capability, do you agree with it? If you agree with it, how customer knowledge management improve innovation capability do you think?
      2. Do you have any supplementary to our questions?

This research promises to keep interviewees’ information confidential, which means this research is not going to publicize their identities and interview contents. Information concerned is only used for academic study of Tsinghua University and Université de Paris. Academic study based on these interviews will reflect interviewees’ narration objectively and these materials will be applied only to overall analysis. The disclosure of any single case is forbidden. We are pleased to share with you our results after the research is finished. Thank you for your support.
### Appendix III: Interview Records

1. **Xiaomi Cong, Beijing Jiangong Architectural Design and Research Institute**

<table>
<thead>
<tr>
<th>Interviewee: Xiaomi Cong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewer: Wei Wang</td>
</tr>
<tr>
<td>Interview time: December 12, 2016</td>
</tr>
<tr>
<td>Interview Location: Cong’s office of the Institute, Beijing</td>
</tr>
<tr>
<td>Interview form: face to face</td>
</tr>
</tbody>
</table>

#### Interviewee profile:

Cong is the director of Beijing Jiangong Architectural Design and Research Institute (school-run design institute with 460 staffs, ranks among the national top 500, annual output value: CNY 200 million) and the general manager of the school-run enterprise of Beijing University of Civil Engineering and Architecture.

#### Interview records:

**Q1:** Thank you for your question. Customer knowledge management is very important for business. Each enterprise has its own idea of customers, and I think customers are most concerned about the quality of the project. In-depth understanding of customer demands is crucial, which calls for more study and research. Only by understanding the character of customers can we customize the service. Moreover, we should take some other questions into consideration such as why the customer wants to do the project and what the meaning is for its development.

**Q2:** The importance of gathering customer information and building databases is beyond question. The thousand proprietors we have worked with are helpful for our future work. Corporate culture should encourage accumulating and sharing database matters, and we should endeavor to develop the habit to use and share database.

**Q3:** Communication with customers is of three different levels. The first is getting to know each other, basic for frank exchanges. The second is customers’ recognition of our technics, which requires our continuous learning to improve. The third is the deepest communication - values and culture. We should be clear that different result of exchange should be shared with different levels of staffs.

**Q4:** I think the most fundamental is innovation of the way of thinking, which is involved with the ideological system. For example, in China, the artisan spirit itself is an innovation. Inheriting and developing of the 5,000 years of civilization is an important part of innovation. Besides, hard work, the foundation of innovation, cross-border thinking and Internet thinking are essential.

**Q5:** Technological innovation is the key. Without our own core technology, it is impossible or difficult to do other innovation. For example, the British industrial revolution was driven by technological innovation. Market innovation and organization innovation serve technological innovation, and they three are interdependent.

**Q6:** Communication and cooperation is a crucial issue, especially the purposeful, organized and directional ones. External exchange and cooperation, ubiquitous like air, exerts a subtle influence to enterprises. It's a mutual learning process around central business, which enhances our core competitiveness.

**Q7:** I basically agree with the conclusion you have made in your research. We provide service to customers, so customer knowledge management is very important. With customer knowledge
management, enterprises would get improved rapidly. What’s more, through the summary of each progress in the work, we can better service the next customer. Thus, customer knowledge management is inevitable to enhance the IC of enterprises.

Q8: The influence of customer knowledge management on the capacity of enterprise innovation is a good research. More efforts are needed to put the theoretical result into practice so as to guide the development of enterprises and the industry. I suggest the theory can be applied in some project of one year to test and improve its value. This topic contains wide extension and connotation. I think it would be better if it can raise some practical actions to upgrade our work and innovation. What is the key to innovation? It is the improvement of our core competitiveness. I think the research should be conducted around customers and the ways to innovation should be detailed. In addition, we should adopt the successful practice of enterprises in other industry like Huawei. A research beneficial for enterprises and the industry will be useful. I expect your research to be successful.
Hu Huang, Beijing Senleiyuan Planning & Architectural Design Co. Ltd.

<table>
<thead>
<tr>
<th>Interviewee: Hu Huang</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewer: Wei Wang</td>
<td></td>
</tr>
<tr>
<td>Interview time: December 12, 2016</td>
<td></td>
</tr>
<tr>
<td>Interview location: Huang’s office, Beijing</td>
<td></td>
</tr>
<tr>
<td>Interview form: face to face</td>
<td></td>
</tr>
</tbody>
</table>

Interviewee profile:

Huang is the partner of Beijing Senleiyuan Planning & Architectural Design Co. Ltd (30 employees, ranks among the national 501-5000, annual output value: 12 million Yuan).

Interview summary:

**Q1:** Every design company may have its own idea. As our team is small, three aspects may be much more important. The first thing we may focus on may be the customer’s background like the customer’s previous businesses, the formation of its finance, the background of the project director, etc. The second is that we must be clear of the customer’s immediate needs. The third is to learn about the customer’s medium-and-long-term development goal, its direction, problems, policy environment, etc., so as to decide if it will be our long-term customer.

**Q2:** The collection of customer information is very important for judgment at work through mutual comparison. I have presided over the establishment of a customer database, and I believe that it is very necessary for large companies to focus on key customers through analysis, and to small businesses, the database can be simplified.

**Q3:** It is important, indeed. But not all information should be shared with all people, and it needs to be categorized. In-depth communication should not be about technics entirely.

**Q4:** I think innovation is not necessarily specific things, but that we take a new way to meet the customer’s needs. Innovation is important, and it requires us to form a learning-style organization. The knowledge we learn is not limited within our own professional. Besides, many projects require full participation and brainstorming, so we should not limit the ideas by blocking different departments. The environment for innovation should encourage ideas and be tolerant of mistakes. Innovation should be guaranteed by the system. Employees’ ideas will not be free unless the organization is free.

**Q5:** I think these three aspects are equally important and linked. The goal of enterprises determines the classification of innovation. For example, our goal is to do some projects we are interested in rather than in pursuit of scale expansion, so we will adjust the three aspects based on our customers’ demands. If such adjustment is a kind of innovation, we have already done it.

**Q6:** External communication is definitely important. If we are not experienced in some projects that we are interested in, communication with counterparts will guide and correct our work.

**Q7:** The implementation of customer knowledge management has a great effect on the improvement of enterprise innovation ability. For example, based on the development vision of customers, we can provide service of high quality soon by predicting the upcoming work and making advanced knowledge reserve. We sum up the experience from our previous projects.

**Q8:** A design enterprise can focus more on its nature of enterprise or design art, which is not right or wrong but individual’s interest. It is more possible to allow you to pursue what you really want by taking design art as the main task.
2 Wenying Huo, China Building Design Consultants Co., Ltd

<table>
<thead>
<tr>
<th>Interviewee: Wenying Huo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewer: Wei Wang</td>
</tr>
<tr>
<td>Interview time: December 9, 2016</td>
</tr>
<tr>
<td>Interview location: Huo’s office, Beijing</td>
</tr>
<tr>
<td>Interview form: face to face</td>
</tr>
</tbody>
</table>

Interviewee profile:

Huo is the general manager of China Building Design Consultants Co., Ltd (large state-owned design institute with 4,500 staffs, ranks the 2nd place, annual output value: 4 billion).

Interview summary:

Q1: I think the most important one is the understanding of customer background, including customer integrity, performance, etc. Besides, our ability to match customers’ needs should also be put into consideration.

Q2: There is no doubt that the establishment of customer database is very important. In regard to how to more efficiently use the database, different enterprises may differ in practice. But I suppose the database should be classified according to qualitative and quantitative natures, so is the enterprise system and corporate culture.

Q3: The question is not difficult to understand. Communication with customers and sharing the result in the enterprise are important, because only by communicating with customers can we understand and meet the demands of customers. On the one hand, in-depth communication with customers and sharing the result will save much communication cost. On the other hand, it is impossible that customers communicate with every staff, and communication at different levels generates different information.

Q4: The idea of advancing with the times and being courageous to innovate is more important.

Q5: I think the most important is organizational innovation and the fundamental is the change of thinking way.

Q6: Surely important. The lessons and experience from continuous communication and cooperation with counterparts make us understand the demand of the market and thus adjust the operation of our company.

Q7: This question is a summary of the preceding questions, and I agree with your conclusion. Personally, I think the most important is the change of our way of thinking. Through one-year learning in the UK, I learned that various departments in the company should treat each other like customers. For example, structure department treats architectural department as customer, and vice versa. Deepening and widening the concept of customers is conducive to our work. Besides, we should also treat ourselves as a customer, because it will push us to feel what the customer really feels.

Q8: The examination of the customer and our own ability, the mutual understanding, and the joint effort to the work are important.
Interviewee: Jing Wang
Interviewer: Wei Wang
Interview time: December 9, 2016
Interview location: Wang’s office, Beijing
Interview form: face to face

Interviewee profile:

Wang is Beijing Tianhong Yuanfang Architectural Design Co., Ltd. (medium-sized private design institute with 200 staffs, ranks the 481st place in China, annual output value: 100 million).

Interview summary:

Q1: When we deal with customers, several aspects must be attached importance to. First of all, the company, no matter big or small, must be legitimate and of strength. Second, we must make sure that the customer’s project is among the service we can provide. Third, additional requests must be noticed, especially those beyond the normal range, such as asking us to take responsible for some risk of breaking the rule.

Q2: It is important and necessary to collect customers’ information and build the database. Our company is trying to do so, but has not yet formed a complete one. We need to better know our customers. Some information is important, but it is implicit. Through analysis of the database, we can understand and then choose our customers, which is beneficial for our work.

Q3: In-depth communication contains different information. We would scarcely share information involving corporate secrets with ordinary staffs, but general information is sharable. Besides, customers’ attitude also makes a difference. If we assign ordinary staffs to do after-service investigation, customers generally responds at random. To improve our work, we assign senior managers to communicate with customers, and they are more willing to give sincere response.

Q4: I think innovation is to solve practical problems with new ways in work rather than just hold up a banner. Innovation is not a goal but a process. The key to innovation is to find which aspect we need to innovate.

Q5: I think they, different aspects of a company, are all important. The importance of each one varies in different projects. When I get a new project I have never done before, I think technological innovation is most important.

Q6: Exchange and cooperation with counterparts are exceptionally important. Without cooperation, innovation is impossible.

Q7: I agree with your conclusion. Customer knowledge management is important, because it is a process of recollecting information and the basis of innovation.

Q8: I am looking forward to the result, and I think it must be helpful.
Interviewee profile:
Qin is the general manager of Beijing Iixin Architects and Engineers (Architectural company with 20 staffs, ranks 501-5000, annual output value: CNY 10 million).

Interview summary:
Q1: Our company is not big and focuses on original design, so our business operation is significantly different from that of large-scale design enterprises. Our own strong point and customers’ recognition are fundamental. Our design is original, so it is impossible to cater to all customers, but it is also our strong point. We are mutually picked based on our original design, so we enjoy a reputation both at home and abroad.

Q2: We do not do much in this regard because of our character of original design. But we are concerned about our position in our customers’ database. Actually, some of our customers are attracted by our original design. Of course, we understand the importance of customer knowledge database, but ours should be small and fine.

Q3: This is very simple for us because our projects are not so much. In-depth communication should be for exchange of thinking and project result. We are small, so it is easy to share information in the process of communication.

Q4: Enterprises of different size differ in the way of innovation. Our innovation is to ensure all the items we design are original. In contrast, large and medium enterprises cannot do this.

Q5: For large enterprises, technological innovation is the basic, and organizational and market innovations are the guaranteed conditions. We are small, so we don’t need to pay much for management. Our innovation is mainly in original design.

Q6: It is definitely important. There are a variety of ways to communicate, and we like to invite several masters to participate in one design. I think this is a good way to exchange and cooperate.

Q7: I agree with the conclusion. Different sized enterprises improve themselves in different ways and our way is to be original and forward-looking.

Q8: Innovation helps an enterprise maintain vitality. For large-scale enterprises, innovation may be complex, and for small businesses, they need to seize the key task.
### Interviewee profile:

Sun is the board chairman of Beijing Victory Star Architectural & Civil Engineering Design Co., Ltd (large private design institute with 1,000 staffs, ranks the 286th in China, annual output value: 400 million).

### Interview summary:

**Q1:** From the perspective of business, the first thing we consider is the matching degree of our ability and the business volume. This is generally involved with VIP customers. The second is customers’ brand like the national top 100 enterprises. It is important for us. The third is customers’ idea of management. Advanced management idea and corporate culture often inspire us to work better. Besides, customer background, interest, etc. count too.

**Q2:** Customer database management is very important, but we still have a long way to go in this aspect. If we can better manage such information as customer background and corporate culture, it is certainly very useful.

**Q3:** In-depth communication with customers, especially with decision-makers, is very important. Customers are hierarchical, so communication between customers at different levels is in different ways. For example, exchanges between executives and common employees are different. If the exchange is open, it will be helpful.

**Q4:** The more important is the innovation of thinking way. As architectural design is a conventional service industry, architects are easy to treat business with the same or similar thinking way. We need to promote the spirit of sharing and cooperation, and enhance design.

**Q5:** All the three factors are indispensable. Without technological innovation, market and organizational innovations are not viable. Thus, technological innovation is the foundation, and market and organizational innovation are also necessary.

**Q6:** Exchange and cooperation with counterparts reflects the ability of leaders, which is a vital part of their work. In this era, we should learn to integrate a variety of resources, especially the external to better complete a task.

**Q7:** I agree with this conclusion. I think if we can find customers’ needs from customers’ knowledge, the innovation in our work will be surely improved. Customers are the source of innovation.

**Q8:** Through the questionnaire, I think the framework of your research has been basically formed. But I have to say the actual workload of research may be relatively large. In practical work, managing customer knowledge is not easy, maybe because we do not enforce it strictly and some information is confidential. I am really looking forward to the ways of using the information.
**Interviewee:** Jian Zhang  
**Interviewer:** Wei Wang  
**Interview time:** December 13, 2016  
**Interview location:** Zhang’s office, Beijing  
**Interview form:** face to face

<table>
<thead>
<tr>
<th>Interviewee profile:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zhang is the director of Institute of Architectural Exploratory and Design of Beijing University of Technology (school-run design institute with 90 staffs, ranks 501-5000, annual output value: CNY 30 million).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interview summary:</th>
</tr>
</thead>
</table>
| Q1: I think we should understand both customers and ourselves, including all possible information about customers and our ability to match the project.  
Q2: It is certainly important to collect customer information and build a customer database. The key to use the database is to build a complete system.  
Q3: It is indeed important. Through in-depth communication with customers, we can get insight into the deep information. And we can also put it into our practice by sharing.  
Q4: We are a school-run institute, so continuous innovation is essential. I suppose that innovation occurs bit by bit in daily work, and magnificent innovation is hard to achieve.  
Q5: I think the three aspects are interdependent and mutually driven. Market innovation means to better meet customers’ needs, which guides our technological and organizational innovations.  
Q6: I think external communication includes the exchange between our design institute and the faculty of the university, between the university and other universities, and between the institute and the market, other design institutes and customers. External communication is the source of power and wisdom.  
Q7: I believe that customer knowledge management can greatly enhance our capacity of innovation. Customers’ needs are the source of driving force and innovation.  
Q8: Our university calls for industry-university-research cooperation, so does other universities. Our advantage is the support of Beijing University of Technology, so one of our priorities is to exchange and cooperate with various schools and departments. |
Interviewee profile:

Yang is the director of Beijing Urban Engineering Design & Research Institute Co., Ltd (large state-owned design institute with 4,000 staffs, ranks 71st, annual output value: CNY 10 billion).

Interview summary:

Q1: The most important is to understand customers’ needs, both explicit and implicit. Some customers’ needs are demanding, so we need to make preparation for knowledge and resource.

Q2: The most effective way is to classify customers. Sorting out customers’ background and needs to build the database is helpful for the following projects.

Q3: In-depth communication is for acquiring and sharing with designers the customers’ explicit needs. The biggest problem is that we don’t get the customers’ real needs in after-service investigation, which seriously affects customers’ satisfaction.

Q4: At present, the most pressing issue is to innovate the model, because most of the design institutes in China have been using the former Soviet Union’s model. In the context of globalization, many issues need to be changed like the organizational form and performance appraisal.

Q5: Organizational innovation is the most important among all others. It reflects the capacity of business management. At the same time, technological innovation and organizational innovation are also important. Technological innovation can be achieved by introducing talents, but organizational innovation is relatively difficult.

Q6: It is important. It is what we often say “borrowing others’ wisdom”. It is an effective way to rethink the internal organization of our enterprise through external exchanges. For example, the broad application of BIM design is a question that needs to be exchanged.

Q7: I agree with the conclusion. We can learn the needs of customers and our own shortcomings by managing customers’ knowledge. It pushes innovation of enterprises. Needs, customers, market and enterprises are led one by one, and needs finally decide the development of enterprises.

Q8: The greatest pressure for business leaders comes from the market. Our immediate problem is that our ability cannot match the project. Through managing customer knowledge, the comprehensive capacity of enterprises will be enhanced. Every enterprise should think about how to improve its efficiency and implementation capacity.
BIBLIOGRAPHY


Cooper, Alan. The Inmates Are Running the Asylum: Why High Tech Products Drive Us Crazy and How to


Gandhi, Smiti. "Knowledge Management and Reference Services." Journal of Academic Librarianship 30,


Hahnke, J. "The Critical Phase of the Crm Lifecycle. Without Crm Analytics, Your Customer Won’t Even Know You’re There (2001)."


Jayachandran, Satish, Kelly Hewett, and Peter Kaufman. "Customer Response Capability in a


Schwabe, G. Understanding and Supporting Knowledge Management and Organizational Memory in a City Council. 1999.


Chen Litian, Zhao Xiaqing, Wei Zhishan. The Connotation and Evolution of Enterprise’s Innovation

Chen Zhen, Innovation is the eternal theme of architectural design enterprises [J]. Architectural Design Management, 2011, 28(9): 15


JIANG Yue-jin, LIANG Liang. The Study on Knowledge Customer Relationship Management [J]. East


DECLARATION

I solemnly declare: the submitted thesis is the result of independent research work under the guidance of my supervisor. To the best of my knowledge, unless already noted the contents of references, the research results of this thesis does not contain any copyright content enjoyed by other people. Other individual and collective, who contributed to the research work of the thesis, have been clearly indicated in the document.

Signature:______________ Date:______________
RESUME

Wang Wei

Vice President of Beijing University of Civil Engineering and Architecture Asset Management Co., Ltd.

President of Beijing University of Civil Engineering and Architecture Urban Planning and Design Institute

Vice President of Beijing Jiangong Architectural Design and Research Institute

Vice President of Beijing University of Civil Engineering and Architecture Ancient Bridge Research Institute

1983-1987, Bachelor's Degree, Department of Civil Engineering, Beijing University of Technology

1987-1990, Master's Degree, Department of Civil Engineering, Beijing University of Technology

National Registered Structural Engineer, Level 1

Senior Engineer

PUBLICATIONS:

