Identification and classification of shareable tacit knowledge associated with experience in the Chinese software industry sector

This item was submitted to Loughborough University's Institutional Repository by the/an author.

Additional Information:

- A Doctoral Thesis. Submitted in partial fulfilment of the requirements for the award of Doctor of Philosophy of Loughborough University.

Metadata Record: [https://dspace.lboro.ac.uk/2134/19659](https://dspace.lboro.ac.uk/2134/19659)

Publisher: © Hui Chen

Rights: This work is made available according to the conditions of the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0) licence. Full details of this licence are available at: [https://creativecommons.org/licenses/by-nc-nd/4.0/](https://creativecommons.org/licenses/by-nc-nd/4.0/)

Please cite the published version.
Identification and Classification of Shareable Tacit Knowledge
Associated with Experience in the Chinese Software Industry Sector

Hui Chen, BSc, MSc

July 2015

A Doctoral Thesis Submitted in Partial Fulfilment of the Requirements for the Award
of the Degree of Doctor of Philosophy of Loughborough University

@ Hui Chen 2015
In Memory

of

Dr Ann O’Brien
Acknowledgements

First, I would like to thank my supervisors Dr Gillian Ragsdell and Dr Ann O’Brien, for their encouragement, patience, constructive criticism and invaluable support during the entire process of my study. I have greatly benefited from their deep academic knowledge and experience.

My thoughts and prayers are always with Dr O’Brien to whom I owe a debt of gratitude for the great kindness and understanding she has always shown to me. She will always be alive in my heart and memory. I owe similar debt to Dr Ragsdell who has supported me through this study with equal kindness and helped me overcome the worst moments of this process.

I would also like to thank my husband, Dr Miguel Nunes, for his constant fortitude support, and encouragement. This thesis would not be possible without his support.

For enlarging my worldview and making me feel part of a vibrant and successful academic environment, I would also want to thank all my colleagues and members of staff at Loughborough University and specially Prof Guy Fitzgerald for his constructive comments and support.

For always pushing me beyond the average and making me believe that I had the capacity to pursue further academic studies, I would like to thank Prof Xiaomi An, my former supervisor at Renmin University of China in Beijing.

Finally, my deep thanks to my family, most and foremost my mother Chen Guangying (陈光英) and father Yan Guangjin (严光金), but also my sister Chen Han (陈晗) for believing in me and making it possible to pursue my dreams.
Abstract

The study reported in this thesis aimed to provide an ontology of professional activities in the software industry that require and enable the acquisition of experience and that, in turn, is the basis for tacit knowledge creation. The rationale behind the creation of such an ontology was based on the need to externalise this tacit knowledge and then record such externalisations so that these can be shared and disseminated across organisations through electronic records management. The research problem here is to conciliate highly theoretical principles associated with tacit knowledge and the ill-defined and quasi-colloquial concept of experience into a tool that can be used by more technical and explicit knowledge minded practitioners of electronic records management.

The ontology produced and proposed here provides exactly such a bridge, by identifying what aspects of professional and personal experience should be captured and organising these aspects into an explicit classification that can be used to capture the tacit knowledge and codify it into explicit knowledge. Since such ontologies are always closely related to actual contexts of practice, the researcher decided to choose her own national context of China, where she had worked before and had good guarantees of industrial access.

This study used a multiple case-study Straussian Grounded Theory inductive approach. Data collection was conducted through semi-structured interviews in order to get direct interaction with practitioners in the field and capture individuals’ opinions and perceptions, as well as interpret individuals’ understandings associated with these processes. The interviews were conducted in three different and representative types of company (SMEs, State Owned and Large Private) in an attempt to capture a rich variety of possible contexts in the SW sector in a Chinese context. Data analysis was conducted according to coding the procedures advocated by Grounded Theory, namely: open, axial and selective coding. Data collection and analysis was conducted until the emergent theory reached theoretical saturation.

The theory generated identified 218 different codes out of 797 representative quotations. These codes were grouped and organised into a category hierarchy that includes 6 main categories and 31
sub-categories, which are, in turn, represented in the ontology proposed. This emergent theory indicates in a very concise manner that experienced SW development practitioners in China should be able to understand the nature and value of experience in the SW industry, effectively communicate with other stakeholders in the SW development process, be able and motivated to actively engage with continuous professional development, be able to share knowledge with peers and the profession at large, effectively work on projects and exhibit a sound professional attitude both internally to their own company and externally to customers, partners and even competitors.

This basic theory was then further analysed by applying selective coding. This resulted in a main theory centred on Working in Projects, which was clearly identified as the core activity in the SW Industry reflecting its design and development nature. Directly related with the core category, three other significant categories were identified as enablers: Communication, Knowledge Sharing and Individual Development. Additionally, Understanding the Nature of Experience in the SW Industry and Professional Attitude were identified as drivers for the entire process of reflection, experience acquisition and tacit knowledge construction by the individual practitioners.

Finally, as an integral part of any inductive process of research, the final stage in this study was to position the emerged theory in the body of knowledge. This resulted in the understanding that the theory presented in this study bridges two extremely large bodies of literature: employability skills and competencies. Both of these bodies of literature put their emphasis in explicit knowledge concerning skills and competencies that are defined so that they can be measured and assessed. The focus of the theory proposed in this thesis on experience and resulting acquisition of tacit knowledge allows a natural link between the employability skills and competencies in the SW industry that was hitherto lacking in the body of knowledge.

The ontology proposed is of interest to academics in the areas of knowledge management, electronic records management and information systems. The same ontology may be of interest to human resources practitioners to select and develop experienced personnel as well as knowledge and information professionals in organisations.
# Table of Contents

Acknowledgements............................................................................................................. II
Abstract............................................................................................................................... III
Table of Contents ................................................................................................................ V
List of Figures ....................................................................................................................... IX
List of Tables ....................................................................................................................... XIV

Chapter 1. Introduction ........................................................................................................ 1
   1.1 Research Background............................................................................................... 1
   1.2 Research Questions and Objectives ........................................................................ 5
   1.3 Overview of Research Methodology......................................................................... 7
   1.4 Structure of the Thesis............................................................................................. 9

Chapter 2. Literature Review .............................................................................................. 11
   2.1 Introduction and Rationale for Knowledge Management ........................................ 11
   2.2 Organisational Learning ......................................................................................... 13
      2.2.1 Data, Information and Knowledge .................................................................. 13
      2.2.2 Types of Knowledge ....................................................................................... 19
      2.2.3 Organisational Learning Processes and Memory ........................................... 27
   2.3 Knowledge Management ......................................................................................... 31
      2.3.1 Tacit Knowledge Codification ......................................................................... 32
      2.3.2 Explicit Knowledge and Databases ................................................................ 34
      2.3.3 Knowledge Sharing and Dissemination ......................................................... 35
      2.3.4 Knowledge Management Models ................................................................... 37
   2.4 Knowledge Management in the Information Technology/Information System/Software Sector ................................................................. 42
      2.4.1 The Nature of the Information Technology/Software Sector ........................... 42
      2.4.2 Main Operational and Management Activities ................................................ 43
      2.4.3 Survey of Case Studies .................................................................................... 49

Chapter 3. Research Methods ............................................................................................ 54
   3.1 Introduction .............................................................................................................. 54
   3.2 Research Philosophies ............................................................................................ 55
      3.2.1 Positivism ....................................................................................................... 55
      3.2.2 Realism .......................................................................................................... 56
      3.2.3 Interpretivism .................................................................................................. 57
   3.3 Research Approaches .............................................................................................. 58
      3.3.1 Deduction ...................................................................................................... 58
      3.3.2 Induction ....................................................................................................... 60
   3.4 Research Paradigms ............................................................................................... 61
      3.4.1 Quantitative Paradigm .................................................................................... 62
      3.4.2 Qualitative Paradigm ..................................................................................... 62
   3.5 Research Strategies ............................................................................................... 64
      3.5.1 Experiment ..................................................................................................... 64
      3.5.2 Survey .......................................................................................................... 65
### Chapter 4: Research Process and Design

#### 4.1 General Research Design

- **4.1.1 Literature Review**
- **4.1.2 Pilot Study**
- **4.1.3 Main Study**
- **4.1.4 Theory Proposition and Reporting**

#### 4.2 Case Studies

- **4.2.1 Pilot Study Company**
- **4.2.2 Main Study Companies**
- **4.2.3 Negotiating Access and Fieldwork Setting**

#### 4.3 Procedures of Data Collection

- **4.3.1 Interview Process**
- **4.3.2 Interview Type**
- **4.3.3 Interview Design**
- **4.3.4 Pre-Testing Interview**

#### 4.4 Procedures of Data Analysis

- **4.4.1 Open Coding**
- **4.4.2 Axial Coding**
- **4.4.3 Selective Coding**
- **4.4.4 Constant Comparison**
- **4.4.5 Memoing**

#### 4.5 Ethical Considerations

#### 4.6 Summary

### Chapter 5: Research Findings

#### 5.1 Introduction

#### 5.2 The Evolution of Research Findings

- **5.2.1 Preliminary Findings from Pilot Study**
- **5.2.2 Findings from Main Study**

#### 5.3 Understanding the Nature of Experience

#### 5.4 Communication

- **5.4.1 Understanding the Importance of Communication**
- **5.4.2 Communication with Different Agents in the Development Process**
- **5.4.3 Ability to Use Different Communication Modes**

#### 5.5 Individual Development

- **5.5.1 Motivation for Continuous Professional Development**
Chapter 7.

5.5.2 Modes of Learning for Continuous Professional Development .................................. 171
5.5.3 Specific Learning Resources ..................................................................................... 194

5.6 Knowledge Sharing ........................................................................................................ 197
5.6.1 Motivation for Knowledge Sharing .......................................................................... 199
5.6.2 Awareness of Benefits of Knowledge Sharing ......................................................... 202
5.6.3 Knowledge Sharing with Different Agents ............................................................... 207

5.7 Working in Projects ....................................................................................................... 227
5.7.1 Management of Projects ......................................................................................... 228
5.7.2 Management of Projects Teams ............................................................................. 269
5.7.3 Working in Project Teams ....................................................................................... 290
5.7.4 Interacting with Customers ...................................................................................... 301
5.7.5 Building and Maintaining Customers’ Trust ............................................................ 324
5.7.6 Providing Training to Customers ............................................................................. 332

5.8 Professional Attitude ...................................................................................................... 340
5.8.1 Self-Motivation ......................................................................................................... 341
5.8.2 Self-Adjustment ........................................................................................................ 343
5.8.3 Self-Stress Management .......................................................................................... 347
5.8.4 Self-Confidence ........................................................................................................ 349

5.9 Summary of Findings .................................................................................................... 354

Chapter 6.

6.1 Discussion of Research Findings .................................................................................. 360
6.2 Reflection on the Nature of the Findings ...................................................................... 363
6.2.1 A New Ontology to Express and Categorise Experience in Terms of Tacit Knowledge ....................................................................................................................... 363
6.2.2 The Nature of the Theory Proposed ......................................................................... 366
6.2.3 Transferable and Chinese Specific Aspects of the Theory Proposed ....................... 369
6.2.4 Challenging of Traditional Perceptions of Compartmentalisation of Experience in SW Development ........................................................................................................... 371

6.3 Positioning in the Body of Knowledge ......................................................................... 374
6.3.1 Comparison with Competency Models .................................................................... 376
6.3.2 Comparison with Employability Models .................................................................. 381
6.3.3 Positioning of the Theory Proposed ......................................................................... 388

Chapter 7.

7.1 Summary of the Study .................................................................................................... 392
7.2 Reflections on the Study Process .................................................................................. 397
7.2.1 Response to the Research Questions ........................................................................ 397
7.2.2 Reflection on the Research Process .......................................................................... 399
7.2.3 Limitations of the Research ..................................................................................... 404

7.3 Contribution of Findings to the Body of Knowledge .................................................... 405
7.3.1 Theoretical Contributions ....................................................................................... 406
7.3.2 Practical Contributions ............................................................................................. 408

7.4 Future work .................................................................................................................. 409

References .......................................................................................................................... 416

Appendices .......................................................................................................................... 442

VII
Appendix 1: 2007 NAICS Search Results for Software .................................................. 442
Appendix 2: KOMPASS Search Results for Software .................................................. 443
Appendix 3: Research Information Sheet .................................................................. 453
Appendix 4: Consent Form ......................................................................................... 456
Appendix 5: Interview Script ....................................................................................... 457
Appendix 6: Presentation of Findings from the Pilot Study ........................................ 471
Appendix 7: Concept Map with Main Categories and Sub-Categories ...................... 475
Appendix 8: Presentation of Findings from the Main Study ........................................ 476
List of Figures

Figure 2.1. The Data-Information-Knowledge Hierarchy (Braganza 2004, p.348 Adapted from Grover & Davenport 2001) .................................................................................................................................................. 14

Figure 2.2. The Knowledge-Information-Data Model (Braganza 2004, p.349) ................................................................. 15

Figure 2.3. Data, Information and Knowledge (Jashapara 2004, p.17) ................................................................................ 16

Figure 2.4. Extended Data, Information and Knowledge Model Proposed by this Research .............................................. 18

Figure 2.5. Procedural Knowledge Diagram (Modified from an Initial Proposition by Nickols 2000, p.18) ................................................................................................................................................................... 26

Figure 2.6. Three Levels between Organisational Learning (Crossan et al. 1999, p.525) ........................................................ 28

Figure 2.7. The Framework of Organisational Learning (Huber 1991, p.90) ............................................................ 30

Figure 2.8. SECI Model (Nonaka et al. 2000, p.12) ..................................................................................................................... 37

Figure 2.9. Hedlund and Nonaka’s Knowledge Management Model (McAdam & McCreedy 1999, p.96 Adapted from Hedlund & Nonaka 1993, p.119) ......................................................................................... 38

Figure 2.10. Knowledge Management Cycle (Jashapara 2004, p.5) ............................................................................... 39

Figure 2.11. McAdam and McCreedy’s Knowledge Management Model (McAdam & McCreedy 1999, p.98) ............................................................................................................................................. 40

Figure 2.12. The Knowledge Intensive Knowledge Management (KIKoM) Model (Nunes et al. 2006, p.110) ........................................................................................................................................................................ 41

Figure 2.13. Users of Requirements Specification (Sommerville 2007, p.137) ................................................................. 45

Figure 2.14. Steps of Testing a System (Pfleeger & Atlee 2008, p.456) ........................................................................... 47

Figure 3.1. The Research Process “Onion” (Modified from Saunders et al. 2003, p.83) ........................................... 54

Figure 3.2. The Process of Deduction (Bryman & Bell 2007, p.11) .............................................................................. 59

Figure 3.3. The Process of Induction (Trochim 2006) ................................................................................................................. 61

Figure 3.4. The Coding Products in Data Analysis (Daengbuppha et al. 2006, p.376) ......................................................... 86

Figure 3.5. Example of a Concept Map (Novak & Canas 2006) ......................................................................................... 91

Figure 3.6. Example of a Cognitive Map (Wilk & Fensterseifer 2003, p.1006) .......................................................... 92

Figure 3.7. Example of Concept Map used in this Research .............................................................................................. 93

Figure 4.1. The Sequence of General Research Process .................................................................................................... 99

Figure 4.2. The Position of YIRONG Info in State Grid .................................................................................................. 105

Figure 4.3. An Example of Interview Script Design ........................................................................................................ 114
Figure 4.4. Main Operational and Management Activities as Identified in the Literature Review ................................................................. 115

Figure 4.5. The Process of Conducting Grounded Theory in this Study ...................... 118

Figure 4.6. An Example of a Concept Map .......................................................... 122

Figure 5.1. Concept Map for Core Category and Main Categories ............................. 128

Figure 5.2. Interview Strategy of Pilot Study (Baiduchuan) ........................................ 130

Figure 5.3. An Example of Manually Coding .......................................................... 131

Figure 5.4. Emerging Codes and Categories during the Pilot Study ............................. 132

Figure 5.5. Concept Map for Main Categories ......................................................... 133

Figure 5.6. Interview Strategy of SOE (Yirong) ....................................................... 134

Figure 5.7. Interview Strategy of Large Private Company (Bosi) ................................. 135

Figure 5.8. A Screenshot of NVivo Platform ........................................................... 138

Figure 5.9. A Screenshot of NVivo Hierarchical Codes Structure ............................... 139

Figure 5.10. Emerging Codes, Sub-categories and Theoretical Saturation .................... 140

Figure 5.11. Concept Map for Understanding of the Nature of Experience ................... 142

Figure 5.12. Concept Map for Communication ....................................................... 146

Figure 5.13. Concept Map for Communication with Different Agents in the Development Process ........................................................................ 148

Figure 5.14. Concept Map for Communication with Colleagues .................................. 150

Figure 5.15. Concept Map for Communication with Leaders ...................................... 154

Figure 5.16. Concept Map for Communication with Business Partners and Competitors .... 158

Figure 5.17. Concept Map for Communication Mode ............................................... 161

Figure 5.18. Example of Long Bench Seating Area at Bosi ......................................... 163

Figure 5.19. Example of Individual Working Areas (or Pigeon Boxes if Directly Translated from Mandarin) at the Shanghai Electric Power Company Facilities Where Some of the Bosi’s Employees are Placed ......................................................... 164

Figure 5.20. Example of Individual Working Areas Where Another Department of Bosi’s Employees are Placed ........................................................................ 164

Figure 5.21. Concept Map for Individual Development ............................................. 167

Figure 5.22. Concept Map for Motivation for Continuous Professional Development ........ 168

Figure 5.23. Concept Map for Modes of Learning for Continuous Professional Development ... 172
Figure 5.24. Concept Map for Individual Learning .......................................................... 173
Figure 5.25. Concept Map for Learning from Others ...................................................... 180
Figure 5.26. Concept Map for Taking Notes and Memoing ........................................... 187
Figure 5.27. Concept Map for Ability to Use Different Annotation Tools ......................... 188
Figure 5.28. Concept Map for Annotating Different Types of Knowledge ......................... 191
Figure 5.29. Concept Map for Specific Learning Resources ........................................... 194
Figure 5.30. Concept Map for Knowledge Sharing .......................................................... 198
Figure 5.31. Concept Map for Motivation for Knowledge Sharing ...................................... 199
Figure 5.32. Concept Map for the Awareness of Benefits of Knowledge Sharing Sub-category and its Close Relationship to Motivation for Sharing Knowledge .......................... 203
Figure 5.33. Concept Map for Knowledge Sharing with Different Agents ......................... 207
Figure 5.34. Concept Map for Knowledge Sharing with Internal Colleagues ....................... 209
Figure 5.35. Concept Map for Knowledge Sharing through Formal Mechanisms ................ 210
Figure 5.36. Concept Map for Informal Knowledge Sharing ........................................... 214
Figure 5.37. Concept Map for Knowledge Sharing with External Parties ........................... 218
Figure 5.38. Concept Map for Knowledge Sharing with Social Circle ............................ 219
Figure 5.39. Concept Map for Knowledge Sharing with Professional Circles ...................... 224
Figure 5.40. Concept Map for Working in Projects ......................................................... 227
Figure 5.41. Concept Map for Management of Projects .................................................. 228
Figure 5.42. Concept Map for Project Creation ................................................................. 231
Figure 5.43. Concept Map for Project Feasibility Assessment ........................................... 236
Figure 5.44. Concept Map for Task Assignment .............................................................. 239
Figure 5.45. Concept Map for Task Estimation and Scheduling ....................................... 243
Figure 5.46. Concept Map for Project Monitoring and Control ......................................... 246
Figure 5.47. Concept Map for Quality Assurance ............................................................ 251
Figure 5.48. Concept Map for Reuse of Information and Resources .................................. 257
Figure 5.49. Concept Map for Risk Assessment and Management .................................... 261
Figure 5.50. Concept Map for Summative Evaluation of a Completed Project .................... 266
Figure 5.51. Concept Map for the Management of Project Teams ..................................... 270
Figure 5.52. Concept Map for Leadership ...................................................................... 271

XI
Figure 5.53. Concept Map for Scheduling and Monitoring ................................................................. 272
Figure 5.54. Concept Map for Enabling Individual Development ...................................................... 281
Figure 5.55. Concept Map for the Management of Teams ................................................................. 284
Figure 5.56. Concept Map for Working in Project Teams ................................................................. 290
Figure 5.57. Concept Map for Team Bonding .................................................................................... 291
Figure 5.58. Typical Isolationist Programmer Forced into a Mandatory Communal Work Area. 294
Figure 5.59. Concept Map for Being a Responsible Team Member .................................................... 297
Figure 5.60. Concept Map for Interacting with Customers ............................................................... 302
Figure 5.61. Concept Map for Understanding of Customers’ Characteristics ..................................... 303
Figure 5.62. Concept Map for Understanding the Business ............................................................... 304
Figure 5.63. Concept Map for Understanding the Organisation ........................................................ 308
Figure 5.64. Concept Map for Understanding the Individuals .............................................................. 310
Figure 5.65. Concept Map for Understanding Requirements ............................................................. 315
Figure 5.66. Concept Map for Negotiating with Customers ............................................................... 319
Figure 5.67. Concept Map for Building and Maintaining Customers’ Trust ......................................... 325
Figure 5.68. Documents being Manually Processed before being Archived ....................................... 331
Figure 5.69. Concept Map for Providing Training to Customers .......................................................... 333
Figure 5.70. Concept Map for Written Operation Guidelines ............................................................. 334
Figure 5.71. Concept Map for Face-to-face Demonstration ............................................................... 336
Figure 5.72. Concept Map for Professional Attitude .......................................................................... 340
Figure 5.73. Concept Map for Self-Motivation .................................................................................... 341
Figure 5.74. Concept Map of Self-Adjustment ................................................................................... 344
Figure 5.75. Concept Map for Self-Stress Management ..................................................................... 347
Figure 5.76. Concept Map for Self-Confidence .................................................................................... 350
Figure 5.77. Main Theory of Professional Areas that lead to Experience in the SW Development Industry in China .................................................................................................................. 354
Figure 5.78. Evolution of Conceptualisation of Experience in the SW industry in China ................. 356
Figure 6.1. Representation of the Integrated Theory of Experience Acquisition in the SW Industry (ITEA Model) ........................................................................................................................................... 367
Figure 6.2. Experience Bridging Employability and Competencies in of SW Development Practice ........................................................................................................................................................................... 389
Figure 6.3. Experience Bridging between Employability and Competencies in SW Development Practice (EBEC) Model

Figure 7.1. Main Ontology of Professional Areas that lead to Experience in the SW Development Industry in China

Figure 7.2. Representation of the Integrated Theory of Experience Acquisition in the SW Industry (ITEA Model)

Figure 7.3. Detailed Model of How Experience Bridges Employability and Competencies in SW Development Practice Theory of Experience Acquisition in the SW Industry

Figure 7.4. Inductive Evolution of Conceptualisation of Experience in the SW industry in China
List of Tables

Table 2.1. Industrial and Business Knowledge Taxonomy ............................................. 21
Table 2.2. Determinative Characteristics for Knowledge Management Processes (Modified from Mishra & Bhaskar 2011, p.355) .................................................................................. 51
Table 3.1. Six types of Case Study (Adapted from Laws & McLeod 2004) ....................... 70
Table 3.2. Comparison of Glaserian, Straussian and Charmazian Constructivist Grounded Theory (Developed from Onions 2006, pp.8-9; Skeat & Perry 2008, p.99) .............. 74
Table 3.3. Comparison of Case study and Straussian Grounded Theory (Developed from Yin 2003; Strauss & Corbin 1998) ...................................................................................... 95
Table 4.1. The Summary of Three Case Studies ................................................................. 103
Table 4.2. An Example of Pre-testing Interview Questions Treatment ............................... 117
Table 4.3. The Presentation of Emerging Codes and Representative Quotation ................ 120
Table 4.4. The Presentation of Emerging Categories and Sub-categories ......................... 121
Table 4.5. The Presentation of Links between Emerging Categories and Sub-categories .... 122
Table 4.6. An Example for Constant Comparison in Open Coding ................................. 123
Table 4.7. An Example for the Use of Memo ................................................................. 125
Table 5.1. Demographic Profile of Participants ............................................................... 135
Table 5.2. Number of Transcriptions ................................................................................ 137
Table 5.3. Example of Presentation of Emerging Codes and Representative Quotations ... 139
Table 5.4. Summarisation of Aspects that Influenced by Chinese Culture ....................... 358
Table 6.1. Professional Activities that Lead to Experience in the Chinese SW Industry (ECSW) Ontology ................................................................................................................. 364
Chapter 1. Introduction

1.1 Research Background

Knowledge has played as extremely significant role in improving competitive advantage in the era of modern information society (Amalia & Nugroho 2011). As such, knowledge has long been recognised as a valuable strategic asset and its management, known in the literature as knowledge management, as a business tool. The basic principle of knowledge management is creating and sharing knowledge in organisations in both tacit and explicit formats (Renzl et al. 2005). Even though there is no absolute and commonly accepted definition for knowledge management in academic communities, this has not prevented the development of a myriad of knowledge management theories, models, strategies and applications aiming at managing and sharing knowledge in knowledge-based or learning organisations (Jashapara 2004; Hislop 2005).

Whilst explicit knowledge is well understood and highly valued, most practitioners and academics believe that the most important knowledge assets present themselves in tacit form and are internally constructed by individuals while executing their professional tasks and acquire professional experience (Bhatt 2002; Mooradian 2005). Therefore, this tacit knowledge exists in organisations though their individual members who developed and internalized it through experience (Mooradian 2005). Since tacit knowledge can only be acquired and developed through human experience during work activities (Lam 2000), it is extremely hard to capture, represent and maintain in forms that can be useful for organisations.

Wilson (2002) claimed that there is no possible way to manage knowledge that is held in people’s minds and memory. However, Nonaka and Takeuchi (1995) insisted that tacit knowledge must first be converted into explicit knowledge before it can be managed. Adding to this debate, Middleton (1999) and Srikantaiah and Koeing
(2000) claimed that human resource management could be used to help manage tacit knowledge while traditional information management can be used to manage explicit knowledge. The key issue in this discussion, however, is a lack of research aiming to define and identify how professional and work experience can be represented as tacit knowledge so that it can be codified, classified and shared in real working practice.

As discussed later in this thesis in the literature review presented in Chapter 2, there are a variety of models proposing to manage knowledge and an equal rich strand of literature proposing methods of codification. However, there is a lack of research aiming to identify, categorise and qualify professional experience as the formative aspect tacit knowledge. This gap in the literature suggests that there is a need to investigate what aspects of professional and personal experience in the mind of the employees can be codified, is useful to share across the organisation and can support processes of organisational learning. Without this type of research it is not possible to use the well-known designed approaches to support knowledge management, externalise tacit knowledge into explicit knowledge and then effectively store, use and disseminate knowledge within organisations. In fact, these knowledge management approaches are usually based on specific ontologies, classifications or typologies in order to implement the corresponding digital repositories of knowledge as well as knowledge sharing facilities and environments. Thus, this study aims to investigate in this area and focuses on identifying, characterising and expressing professional experience acquired in daily working practices so that these can then later be captured, stored and exploited through the use of more structured approaches.

Electronic records management can be used at this point to illustrate this argument. Sanderson (2001) proposed electronic records management as the best method for capturing tacit knowledge provided that, as suggested by Stover (2004), it can be structured through an effective process of codification into explicit knowledge and then managed in a digital repository. ERM as a type of explicit knowledge
management is a well-developed practice in most large organisations and includes all kind of records, ranging from earlier practices based on traditional paper-based records and today’s electronic records (Lindvall et al. 2003). This does not necessarily equate with traditional database technology, neatly structured around Boolean logic and well defined records, but may include heterogeneous document repositories, which may contain emails, training materials, internet memos, formal documents and reports (Nunes et al. 2006).

However, these concepts of electronic records management and knowledge management are often discussed in isolation. Even though some authors (e.g. Sanderson 2001, Stover 2004) and government institutions (e.g. UK government) have tried to connect electronic records management with knowledge management, these two concepts are still generally discussed independently at a theoretic level and are not always clearly integrated in the knowledge and information management processes in the world of practice. The justification for this gap seems to be problems of translation of highly theoretical principles such as, tacit knowledge, associated with not very clearly defined concepts such as experience, into tools (ontologies or classifications) that can be used by more technically minded and pragmatic practitioners of electronic records management.

This study aims to provide exactly such a bridge, by identifying what aspects of professional and personal experience should be captured and organising these aspects into an explicit classification that can be used to capture the tacit knowledge and codify it into explicit knowledge. Since such ontologies are always closely related to actual contexts of practice, the researcher needed to find a concrete context in which to apply these ideas.

The software industry sector in China was identified as ideal for this study as this researcher has had experience working in this sector in Beijing and still retains good contacts that enable access to the three case-study companies. Furthermore, as
claimed by Fagri et al. (2010), software design and development requires a collaborative and knowledge-intensive team approach that depends greatly on the experience of the individuals involved, such as analysts and programmers. Furthermore, this context seems to be highly adequate since, according to Edwards (2003), there is an active knowledge management community in software engineering, but it is interesting that much of their work is distanced from the knowledge management mainstream.

Moreover, the software industry is one of the fastest growing in the world’s economy, and has developed from being non-existent into a multi-billion dollar industry in less than a century (Statista 2015), having grown by 8.2% of compound annual growth rate (CAGR), achieving revenues of $267 billion in 2011 (Ovum 2011). This industry is expected to continue to grow steadily in the future, as estimated by one of the most prominent statistics companies on the internet (Statista 2015). In the specific case of China, the Ministry of Industry and Information Technology (MIIT) of the People’s Republic of China has published that the revenue of China’s software industry reached $23.8 billion in July 2011 (Yang 2011). IBIS World, a leading American industry research firm, has also analysed the SOFTWARE development industry in China and concluded that it has grown by 25% of average annual rate from 2011, and is expected to achieve revenues of more than $868 billion in 2016 (Taft 2012). This high growth rate will make China the fastest-growing software industry in the world, and thus, the Chinese software industry will take an increasingly important role in the global software market. This confirms that the selection of the Chinese context is particularly meaningful. Moreover, the strong demand from local software users and the experience and working practices from Chinese software developers have challenged “the way Western firms make money in China” (Asay 2014). Thus, a study involving the Chinese software industry will be of universal interest from an industrial perspective, having in mind these forecasts that claim that the Chinese software industry will take an increasingly important role in the global software market.
Furthermore, the above discussed gap between theoretical propositions of knowledge management and the actual ability to externalise tacit knowledge based on professional experience, is also particularly true in the software industry where concerns have always been on more technical issues rather than on soft issues such as knowledge sharing. This suggests that there is need to research on what aspects of professional and personal experience of practitioners, involved in software design and development, contribute to the creation of tacit knowledge in their minds, so that it can then be externalised and codified. Once codified, this knowledge can then be used to maintain the sustainability and success of software organizations. This is of particular concern in one of the industry sectors with highest staff turnover and lowest company survival rates. In fact, as in the rest of the world, in China there is “considerable” staff turnover, with skilled employees constantly leaving to join other companies or to create their own start-up companies (Merrill et al. 2010, p.32).

Therefore, from both practical and theoretical perspectives, this sector seems ideal for this study. The study itself aims at investigating, identifying, characterising and expressing what types of professional experience are acquired in daily working practices of the software development process, so that they can then later be externalised as explicit knowledge, stored and exploited through the use of information technology structured approaches. The findings of this research will be significant and useful for the industry and have potential impact in theoretical terms.

1.2 Research Questions and Objectives

As presented above, this study is grounded in the process of software development and provides a categorisation of professional experience in the field that aims to support a structured approach to the transference of tacit into explicit knowledge, so that it can then be systematically managed and exploited. In order to achieve these
general aims the following research question was established:

How can tacit knowledge related to experience within the working practices of the software industry be identified?

This main research question was subdivided into the following more specific questions:

1. What constitutes professional and personal experience in the context of the process of software development?

2. Which components of this experience can be clearly identified so that they can be captured, shared and appropriately managed?
   a) What are the relationships between these components of experience?
   b) How can this experience be explicitly represented in order to support its capture, storage and use in software companies in China and elsewhere?

In order to provide an answer to these research questions, the following research objectives were defined:

- To critically review literature related to knowledge, knowledge management and knowledge sharing. The purpose for this literature review is to provide the researcher with a sound theoretical sensitisation, that is, to identify the main theories in these fields and gain a general understanding on their core theoretical concepts;
• To establish a theoretical starting point for the research, by identifying the main stages of the software development process in order to structure the data collection processes;

• To investigate what constitutes professional and personal experience in the context of the process of software development in selected Chinese companies using a multiple case-study approach combined with an inductive research approach;

• To establish a categorisation and respective concept map of what constitutes professional and personal experience in the context of the process of software development in China;

• To disseminate and discuss both the categorisation and the process that led to it as contributions to the body of academic knowledge. This dissemination is expected to be done primarily through this thesis, but also through presentation in international conferences and publication in academic journals.

1.3 Overview of Research Methodology

In order to respond to the above research questions and meet the research objectives set, this study employed a research design based on a multiple case-study approach combined with an inductive and interpretivist overarching research approach based on Grounded Theory, as explained in Section 3.6. The decision for such an inductive approach was made based on the complete lack of literature referring to classifying and defining of professional and personal experience of individuals in the design and development of software. The lack of such previous research made a deductive approach virtually impossible and Grounded Theory emerged as a natural option for the research.

The research design itself included a literature review as an exercise in theoretical sensitisation as proposed by Glaser and Strauss (2009), in order to gain a general
understanding of the core theoretical concepts around knowledge management and knowledge sharing as well as to obtain an understanding of the structure and main stages related to the software development process. In order to understand the use and importance of tacit knowledge resulting from experience in the software development processes, the study took direct interaction with practitioners in the field in order to capture individuals’ opinions and perceptions, as well as interpret individuals’ understandings associated with these processes.

Data collection was conducted through semi-structured interviews. The interview script was designed according to the stages of software development process identified in the literature review Section 2.4.2. Furthermore, in inductive research, it is important to have variety of respondents in order to obtain fully explained theories of the phenomena being studied. Therefore, the interviews were conducted in three different companies (one SME, one state-owned and one large private company) in an attempt to capture a rich variety of possible contexts in the software sector in Chinese context.

Data analysis was conducted according to the coding procedures advocated by Grounded Theory, namely: open, axial and selective coding. This coding process was supported by specific methods proposed by this methodology, i.e. constant comparison and memoing. All coding procedures and use of the support methods are discussed in Section 4.4. Data collection and analysis was conducted until the emergent theory reached theoretical saturation and the “well-developed concepts” (Strauss & Corbin 1998, p.15) associated with experience in the Chinese SW industry were ready to be presented (Chapter 5) and discussed (Chapter 6).
1.4 Structure of the Thesis

This thesis was structured to reflect the process of research described in the previous section and consists of six chapters as described in this section.

Chapter 1 gives an overview of the background of the research problem, the reasons for undertaking this research as well as defining the research questions and objectives. This chapter also provides a brief overview of research methodology and design employed by the study.

Chapter 2 reviews the existing literature of knowledge management, knowledge sharing, and tacit knowledge. The chapter also provides a definition and description of the software development process and identifies its main stages. This literature review process aimed to enable the researcher to gain a general understanding on the core theoretical concepts of knowledge management and knowledge sharing as well as obtain an understanding of the structure and main stages related to the software development process. The results of the literature review are then used to inform the design of the interview script and provide theoretical sensitivity during the analysis process.

Chapter 3 discusses the rationale for the research methodology selected. It discusses and justifies choices made in terms of research philosophy, research approaches, research paradigms, and research strategies. Furthermore, it provides a discussion and justification for the use of a combination of an exploratory multiple case study approach with the Straussian Grounded Theory approach that is used in this study.

Chapter 4 presents the research design used by the study to implement the combination of multiple case study approach with a Straussian Grounded Theory one. It describes the design in terms of on how to apply this type of Grounded Theory and the research tools used to support data collection and data analysis, i.e. discusses in
detail the processes of coding and analysis used in this Straussian Grounded Theory approach instantiation.

Chapter 5 analyses qualitative data obtained via face-to-face semi-structured interview. This chapter discusses six main categories that emerged from data collected through the process of analysis, namely: understanding the nature of experience, communication, individual development, knowledge sharing, working in projects, and professional attitude.

Chapter 6 offers a discussion of the findings, a reflection on the nature of findings, and a positioning of theory proposed in the context of the current body of knowledge.

Chapter 7 presents a summary of the study, reflections on the study process, an identification of the contributions of this research, and recommendations for further work.
Chapter 2. Literature Review

As introduced in Section 1.3 and discussed at length in Chapter 4, this study adopted a Straussian Grounded Theory approach. The role of the literature in this type of inductive approach is one of theoretical sensitisation (see Section 4.1.1) aiming to gain a general understanding of the main concepts of knowledge management and of the software development. The rationale behind the identification of these generic core concepts is, on one hand, to guide the design of the interview script by not reinventing the wheel, but not inserting theoretical bias on the other. Therefore, the literature review presented in this chapter represents this effort of theoretical sensitisation and does not aim at being either systematic or critical at this point, so as not to introduce theoretical bias in the study.

As with any other inductive approach, these elements of critical and systematic review are included in the discussion in Chapter 6 in order to position the emergent theory in the body of knowledge. This is very different from traditional deductive approaches or even from Charmazian Grounded Theory where a literature review is used as data and influences the analysis, but it is the common practice with traditional inductive approaches, such as the one chosen for this study.

2.1 Introduction and Rationale for Knowledge Management

Knowledge, as a unique and valuable resource, has played a significant role in allowing organisations to improve the competitive advantage in any society (Gao et al. 2008; Amalia & Nugroho 2011). Specifically, when shifting into today’s knowledge-based economy age, managing knowledge brings an enormous challenge for organisations and management activities (Drucker 1992; Amalia & Nugroho 2010). Knowledge, described as “actionable information”, improves decision making and enhances the effectiveness of business actions and organisational creativity, and
therefore strengthens companies’ competitive advantage (Jashapara 2004, p.16). The characteristics of knowledge are more complex, humanistic and dynamic which makes knowledge difficult to capture, represent and maintain for any organisation (Nonaka et al. 2000). Bhatt (2002) claimed that only a small part of the knowledge used in business processes is held by the organization, the other part is internalised by the individuals. Consequently, Nunes et al. (2006) stressed the significance of the loss of knowledge assets when knowledgeable employees leave. Therefore, knowledge management is a crucial approach to strengthen the ability of organisational management in the global competitive and dynamic environments.

The management of knowledge has become important in practice and popular in academia. Bouthiller and Shearer (2002) give good examples of the practice of knowledge management in both the public and private sectors. Meanwhile, Davenport and Prusak (2000) claim every organisation gains potential value by practising knowledge management. Consequently, knowledge management, as a business tool and a valuable strategic asset, is supposed to enhance an organisation’ competitiveness and improve management with more effectiveness and efficiency. Similarly, knowledge management, as an increasingly growing issue in academic research, comprises research coming from different perspectives, such as human resource, business statistics, practitioner orientation and information systems (Jashapara 2004). Knowledge management is a vibrant and evolving field and there is still no common and universally accepted concept of knowledge management. Researchers from various disciplines (e.g. information science, computer science, management studies or information systems) are continually contributing to a negotiated common understanding of knowledge management as a discipline.
2.2 Organisational Learning

2.2.1 Data, Information and Knowledge

In order to understand the management of knowledge, it is necessary to distinguish between the related concepts: data, information and knowledge. There are numerous discussions on the conceptions of these three terms (Grover & Davenport 2001; Awad & Ghaziri 2004; Braganza 2004). It is obvious that organisations have faced problems of data inundation during the emergence of electronic data in 1960s (Grover & Davenport 2001; Gunnlaugsdottir 2003). Data, is described as “a set of discrete facts about events-structured records of transactions” (Awad & Ghaziri 2004, p.36), need to be organised, processed and reformatted, in order to be useful. Business transactions are processed, classified, aggregated and stored on a daily basis, consequently the volume of data created is very high and often requires further synthesis, aggregation and processing into information. Information refers to “shaping the data to arrive at a meaning in the eyes of the perceiver” (Awad & Ghaziri 2004, p.36) which has purpose and related to the context. Information is available to and accessed by everyone in the organisation or public by using websites, intranet or email which creates over-abundance and redundancy. Thus, deriving knowledge from retrieving and separating information is a crucial approach to manage information (Kogut & Zander 1992; Awad & Ghaziri 2004). Knowledge is more than just the processing of information and should be considered as “the highest value, the most human contribution, the greatest relevance to decision and actions, and the greatest dependence on a specific situation or context” and “the most difficult of content types to manage” (Grover & Davenport 2001, p.6). This data-information-knowledge hierarchy has been used to describe the relation between data, information and knowledge (Figure 2.1).
This hierarchical model is centred on an information technology perspective, which proposes that technologies facilitate the processing of data and information. The basic concept behind the model is a bottom-up view that starts with static data and data structures that were defined by the specification of information systems requirements. These are then processed into information, and finally into knowledge. Awad and Ghaziri (2004) also advocated the hierarchy model from the cognitive perspective which goes to a highest level of wisdom. This concept of wisdom is controversial and not well defined. Bellinger et al. (2004) define it as an “extrapolative and non-deterministic, non-probabilistic process” grounded on human consciousness and moderated by cultural, moral and ethical codes. Wisdom is the “essence of philosophical probing […] and it asks questions to which there is no (easily-achievable) answer, and in some cases, to which there can be no humanly-known answer period.” (Bellinger et al. 2004). In sum, wisdom is “a uniquely human state” (Bellinger et al. 2004) and, therefore, beyond the possibility of being managed in organisations. Thus, wisdom will not be addressed in this thesis, but still uses Awad and Ghaziri (2004, p.40) proposition that knowledge is more than information and is contained in “human understanding of a specialized field of interest that has been acquired through study and experience”. Hence, the
professional skills, perspectives, concepts, senses, and experiences are constituents of knowledge.

There are opposing views to this data-information-knowledge hierarchy. There is another school of thought that uses a reverse pyramid named the knowledge-information-data model. This top down model emerged from case-based research (Figure 2.2) and proposes that knowledge at the top originates the need for the retrieval and processing of data and information.

![Figure 2.2. The Knowledge-Information-Data Model (Braganza 2004, p.349)](image)

This model takes a very pragmatic view that information “is what people or systems need to be able to carry out work practices” and that data, as a constituent part of information, is captured because of the information needs created by the work practices (Braganza 2004, p.349). Importantly, and contrary to the previous model, it is proposed that data should be acquired, structured and maintained to serve information needs. Information has its meaning and value grounded in the context of work practices, and it is in the light of these practices that it needs to interpreted, shared and disseminated (Braganza 2004). However, disappointingly the concept of knowledge used by Braganza (2004) is reduced to explicit knowledge, which can
easily be preserved and captured from the business process to achieve basic organisational needs and requirements. This model presents a good contribution to theory from the perspective of purposeful action based on organisational practices. However, the reductionist conceptualisation of knowledge presents severe problems in terms of understanding the nature of knowledge in human activity systems such as organisations and leaves behind important concepts such as tacit knowledge, experience and implicit knowledge that are important for this study.

Jashapara (2004) partly agrees with the knowledge-information-data model from the view of purposeful action. Based on the two discussions above (data-information-knowledge vs. knowledge-information-data), Jashapara (2004) provided a more elaborate explanation of the relations among data, information and knowledge (Figure 2.3).

![Figure 2.3. Data, Information and Knowledge (Jashapara 2004, p.17)](image)

Data is described as signal and defined as “meaningless out of context and requires an association with something else” (Jashapara 2004, p.15). This view is also subscribed to by other authors such as Meadow et al. (2000, p.35), who define data as a “string of elementary symbols, such as digits or letters”. Referring to information, Jashapara (2004, pp.15-16) claimed that information was “systematic” and adopted the example of bibliographic classification scheme to illustrate the essence of information. Information itself carries the connotation and association with purpose and meaning, but this implies that it is subjective in nature and not always universal.
Therefore, information for one organisation may not make sense or be at all useful for another. On the other hand, knowledge represents “true and justified belief” (Welbourne 2001, p.20) and therefore is centred on the individuals inside the organisation. Knowledge is used to understand, predict and make sense of subjective or objective information. The beliefs in the mind and assumptions about what can be taught and shared are all knowledge (Jashapara 2004; Welbourne 2001). By distinguishing knowledge from information, Nonaka and Takeuchi (1995, p.58) claim that “information is a flow of message, while knowledge is created by that very flow of information anchored in the beliefs and commitments of its holder”. This statement pointed out the elemental constitution for knowledge, and the action connected with human cognition and supports the bottom-up propositions by Braganza (2004) and Grover and Davenport (2001).

Therefore, Jashapara’s (2004) proposition illustrated in Figure 2.3, aims at capturing the complexity of the relationships between data, information and knowledge. It is a useful view that tries to combine the two other propositions discussed above. It uses the reality of practice encountered in organisations. Knowledge needed to be efficient in work practices determines what information and data is produced, stored and maintained in the organisation over the time of its existence – the organisational memory as defined by Klemke (2000). Conversely, very often the knowledge available and developed depends strongly on the information and data facilities that to a certain extent limit the individual’s cognition.

However, Jashapara’s (2004) proposition includes the concepts of wisdom and truth. The first concept of wisdom was already discussed in this section. Truth as a manageable organisational asset is even more difficult to operationalise. In fact the very concept of truth is controversial and different philosophical epistemological schools of thought, which will have very different views on what it means. What seems to be less controversial is that different individuals “who have accumulated information about parts of the objective reality bargain about the truth” (Venzin et al.
This means that different individuals within the organisation may have different views on what truth is, let alone different organisations. Therefore, and for the purpose of this study, the concept of truth will not be considered.

When considering knowledge as a product of information processing and information as an output of data interpretation (Uotila & Melkas 2007), then clearly knowledge is the result of a defined body of information in a particular context which determines its meaning and value (Brooking 1999). However, understanding, evaluating, interpreting and processing information requires more than just applied cognitive exercise, it requires the use of related experiences as well as procedural and implicit knowledge of related fields of science, practice and legal frameworks.

Bearing this in mind and taking advantage of the insights of Jashapara’s (2004) proposition, this study developed the following model:

![Figure 2.4. Extended Data, Information and Knowledge Model Proposed by this Research](image)

This model incorporates Jashapara’s (2004) dual relationship between knowledge generation and information, but adds complexity to the knowledge component that is
required by this study. It is assumed that the implicit knowledge are forms of explicit knowledge and that experience and tacit knowledge are fundamental elements in individual’s cognition alongside explicit knowledge. The following sections will discuss and attempt to characterise these different types of knowledge and relate them to the work practice in organisations.

In sum, these definitions either emerging from theoretical propositions or practitioner experiences and needs, all highlight the importance and value of knowledge and its relationship with the more established manageable organisational assets of information and data. However, knowledge is a more complex and dynamic concept, one that philosophers have been debating, describing and explaining for over two millennia. Hence, there is still no commonly agreed definition on how individual cognition results in knowledge and or even the nature of knowledge in itself. Therefore, it is important for the purpose of this study to establish a clear position on these issues. This is done in the next sections.

2.2.2 Types of Knowledge

There is consensus on the typology of knowledge in knowledge management literature which can be traced from the logical behaviourist school of thought. From this perspective, knowledge can be categorized into two main types: explicit knowledge (know-what) and tacit knowledge (know-how) (Polanyi 1966; Nonaka & Takeuchi 1995). However there are other propositions, such as Choo (1998) who has identified three types of knowledge: tacit knowledge, explicit knowledge and cultural knowledge. On the other hand, Nunes et al. (2006) identified a different set of knowledge which includes tacit knowledge, explicit knowledge and implicit knowledge. Furthermore, Awad and Ghaziri (2004) introduced another approach of categories into knowledge which contains procedural knowledge, declarative knowledge, semantic knowledge, and episodic knowledge. On a more pragmatic note, Boisot (1998) developed a knowledge typology based on four different types
which consists of personal, proprietary, public knowledge and common sense. Wiig (1993) proposes yet another variant classifying knowledge into four types: factual, conceptual, expectational, and methodological. From all these propositions it became clear that authors differentiate knowledge types according to the contexts of their studies, the needs created by specific research questions and their own epistemological positioning. Another conclusion that clearly emerges from these very different propositions is that the different types of knowledge are not necessarily different from each other, but are rather overlapping and at times complementary. Moreover the two generic types (explicit and tacit knowledge) proposed by Nonaka and Takeuchi (1995) seem to be a very broad dichotomy that encompasses almost all of the other types, but exactly because of this broad nature lacks in detail and fine gradation that is required in most research projects. That then justifies why so many emerging typologies have been proposed in the knowledge management literature.

This research aims at studying knowledge management in an industrial sector and therefore, as proposed by Nunes et al. (2006, p.106) to study the knowledge that is contained and “hidden within procedures, management and work practices of the organisations” of that sector. This implies three different types of knowledge:

1. The knowledge that was built through social negotiation within the sector and represents the collective understanding of how work is done in that sector.
2. The knowledge that is specific to organisation within the sector and is both explicit and tacit in nature.
3. The individual knowledge of the employees within the organisation that emerges from experience and work practices.
Table 2.1. Industrial and Business Knowledge Taxonomy

<table>
<thead>
<tr>
<th>Types of knowledge</th>
<th>Tacit Knowledge</th>
<th>Explicit Knowledge</th>
<th>Responsibility</th>
<th>Epistemological Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implicit Knowledge</td>
<td></td>
<td>✓</td>
<td>Sector</td>
<td>What is the knowledge that is necessary to work in a sector? (e.g. quality standards, methodologies, methods, tools, etc)</td>
</tr>
<tr>
<td>Procedural Knowledge</td>
<td>✓</td>
<td>✓</td>
<td>Organisation</td>
<td>What is the knowledge that is necessary to work in an organisation? (e.g. process handbook, organisational norms, organisational culture, etc)</td>
</tr>
<tr>
<td>Experience</td>
<td>✓</td>
<td></td>
<td>Individual</td>
<td>What is the knowledge that individuals recall and use to work?</td>
</tr>
</tbody>
</table>

Table 2.1 synthesizes the basic epistemological position of this study and relates this to Nonaka and Takeuchi’s (1995) propositions. The three subsequent sections will address their basic dichotomy (explicit vs tacit knowledge) and then under this basic lens develop the three types of knowledge is proposed as the underpinning for this study, namely implicit knowledge, procedural knowledge and experience. Each type of knowledge will be discussed in details as follows:

**2.2.2.1 Explicit Knowledge**

Explicit knowledge is knowledge presented and codified in language, data, memos, instruction manuals, reports, standard operating procedures, documents, database and records (Koskinen 2003; Awad & Ghaziri 2004). Once codified this type of knowledge can be processed, transferred and transmitted from individual to individual, and from organisation to organisation.

Explicit knowledge serves individuals in the performance of well-known tasks, operations and social activities and it has the competence to illustrate what to do to fulfil these achievements (Polanyi 1966; Koskinen 2003). Therefore, explicit
knowledge as an organisational asset is an articulated approach to teach and learn what is needed to perform organisational activities. Simultaneously, by using information systems, explicit knowledge (e.g. documents, instruction manuals, and memos, organisational information in digitised forms, electronic records, etc) can be disseminated over the organisation without the restriction of time and place (Sanchez 2005).

The potential risk in the use of information systems and systematised explicit knowledge resources in organisations lies in the fact that the information may be leaked to or hacked by others, possibly competitors (Sanchez 2005; Smedlund 2008). Therefore, security systems aiming to protect the knowledge assets are crucial considerations for organisational management. As Smedlund (2008) suggested, a set of clear and defined rules for the safeguard of explicit knowledge needs to be implemented. Moreover, Smedlund (2008, p.71) proposed the need for a “centralized social network structure” to manage and implement explicit knowledge. The knowledge manager becomes the focal actor in the control of this centralized structure and should be responsible for quality of knowledge, take the responsibility to satisfy the knowledge demands and assign access to knowledge resources, and identify required external and internal knowledge providers (Smedlund 2008).

2.2.2.2 Tacit Knowledge

The philosopher Polanyi (1958) was the first one who advocated human knowledge has a dimension other than the usually acknowledged explicit knowledge - tacit knowledge. He related this type of non easily represented knowledge to individuals, their experiences and their personal senses. In addition, he interpreted the tacit knowledge as that “we know more than we can tell” (Polanyi 1966, p.4) which he pointed out as the essence of understanding. Based on his opinion, the characteristics of tacit knowledge are unformulated, personal, resulting from human activity and experience, and importantly, difficult to transfer. Berman et al. (2002)
formulated tacit knowledge as subjective, difficult to formalize and related to values, ideas, emotions and experiences. This type of argumentation led Wilson (2002) to state that it is not possible to manage this type of knowledge which is held mostly in people’s own memories. Wilson’s position is that in this case, knowledge that resides exclusively in human’s mind can never be externalized.

On the contrary, Nonaka and Takeuchi (1995) defend that this externalisation is not only possible, but also desirable. They described tacit knowledge from an organizational management perceptive in order to apply it to knowledge-creating processes in organisations. Tacit knowledge represents the experience from the individual, expressions of dynamic human actions from “evaluation, attitude, point of view, commitments and emotion” (Pathirage et al. 2007, p.116). Since tacit knowledge is related to the individual and dynamic human processes, it is hard to capture, represent and maintain by the organisation. However, most practitioners and academics believe that the most valuable knowledge assets are embedded in the tacit form and developed and internalized by the individual (Bhatt 2002; Mooradian 2005). Therefore, tacit knowledge must firstly be converted into explicit knowledge before it can be managed (Nonaka & Takeuchi 1995, Nonaka et al. 2000). However, Brown and Duguid (1998) warned against a simplistic view of translation by proposing that tacit knowledge has many complex characteristics which make the total and absolute conversion into explicit or documented instruments difficult and complex.

Despite these difficulties and in order to gain the desired competitive advantages from all types of organisational knowledge, tacit knowledge, as a functional and intangible resource in the organisations, it is necessary to translate tacit into explicit instruments that allow its storage, sharing and use. Hence, the conversion from tacit into explicit can make knowledge that is often only accessible through direct contact with an individual available to all concerned in the organisation both geographically and temporarily independent (even if the individual left the organisation). Moreover,
codified tacit knowledge is much more convenient to be communicated, assimilated and exploited in the organisation as whole.

2.2.2.3 Experience, Procedural and Implicit Knowledge

2.2.2.3.1 Experience

Tacit knowledge can only be acquired and obtained through human experience (Nonaka 1994; Lam 2000). Experience leads to experienced individuals or experts, who can deal with complex situations much more efficiently and effectively. When an individual or group participates in organisational event or activities, experience as an outcome is acquired through the practitioner’s actions and an increased understanding and reflection on what factors led to success and those which put the activity at risk. Experience is accumulated when action happens in a series of events. Knowledge which is derived from this experience then affects and helps to improve the performance of the next action or series of events (Awad & Ghaziri 2004). The experience of a specific practitioner is normally acquired continuously and through repetitive series of events. Based on the argument from American philosopher Dewey John (1938, p.35), experience “takes up something from those which have gone before and modifies in some way the quality of those which come after”. Furthermore, in Dewey’ theory of experience, “As an individual passes from one situation to another, his world, his environment, expands or contracts. He does not find himself living in another world but in a different part or aspect of one and the same world. What he has learned in the way of knowledge and skill in one situation becomes an instrument of understanding and dealing effectively with the situations which follow” (Dewey 1938, p.44). Consequently, the present experience is also influenced by the interaction between previous experience and current situation. Furthermore, psychologists introduced a term of “psychological space” which is a region in the brain especially for placing, constructing and classing the experience (Shaw & Gaines 1992). Therefore, experience in this research includes the experience accumulated during current work practice as well as knowledge and
understandings used in previous environments. As such, experience is in individuals’ minds, is very complex by nature and therefore difficult to share. Knowledge emerging from experience is therefore tacit and a fundamental success factor in organisational activities and, as such, should be captured, codified and shared across the organisation.

2.2.2.3.2 Procedural Knowledge

Procedural knowledge is considered as “an understanding of how to do a task or carry out a procedure” (Awad & Ghaziri 2004, p.44). As defined by the cognitive psychologists, the notion of declarative knowledge, in contrast to procedural knowledge, is often used for “descriptions of facts and things or of methods and procedures” (Nickols 2000, p.15). Meanwhile, neuroscientists such as Yamadori et al. (1996) claimed that procedural knowledge evolves into skills to enable and monitor tasks. More specifically, procedural knowledge is often related to information technology in order to enable activities such as “design modelling, problem solving, system approaches, project planning, quality assurance and optimisation” (McCormick 1997, p.144). Therefore, practitioners in organisations require procedural knowledge that informs them how to perform organisational tasks or carry out professional activities in the context of the organisation they are working with. As illustrated in Figure 2.5 this procedural knowledge has clearly distinct aspects that combine to enable practitioners to perform their organisational activities. On the one hand the practitioner needs to use what some authors named declarative knowledge (e.g. Nickols (2000) or Awad & Ghaziri (2004)) that consists of well known and available sets of facts, data combined with explicitly organisational approved methods and approaches. On the other hand, practitioners use data, methods and tools in appropriated ways that depend on their understandings and experience, that is, they use methods in ways they believe they work well to attain their professional objectives. This second component is clearly tacit knowledge.
However, procedural knowledge in use in an organisation depends closely on the knowledge that exists in the particular sector where the organisation operates. This sector specific knowledge is used by the organisation as implicit knowledge, i.e. knowledge is taken for granted in the sector and “which is hidden within procedures, management and work practices of the organisation” (Nunes et al. 2006, p.106). This implicit knowledge directly influences, informs and limits procedural knowledge (e.g. quality standards, universally adopted methods, ethical constraints, etc).

2.2.2.3.3 Implicit knowledge

The knowledge dichotomy into tacit and explicit first proposed by Polanyi (1958, 1966) and subsequently reformulated and used by Nonaka and Takeuchi (1995) fails to make any clear difference between tacitness and implicitness (Li & Gao 2003). Actually, in the knowledge creating process proposed by Nonaka and Takeuchi (1995), tacit knowledge contains a clear component of implicitness which underlies professional activities and can be translated into explicit knowledge through externalisation. The awareness of the role of implicit knowledge in actions, judgements and professional behaviours is fundamental in actually understanding pure tacit knowledge that operates over this layer of implicitness. That is, many behaviours exhibited by one particular professional group usually depend on a combination of tacit knowledge that emerges from collective and individual practitioner experiences combined with the implicit knowledge that is associated with
taken for granted sector specific methods, approaches, quality standards, ethical behaviours and professional attitudes.

Implicit knowledge in this research refers to underlying knowledge and understandings pertaining to the subject domain(s) of a specific sector. This knowledge is usually well understood by individuals and groups in operational conditions, but very often neither specifically explained or described. Moreover, practitioners in a particular field take this knowledge for granted and do not have the awareness of or feel the need to express it explicitly. This knowledge is contained in the routines of professional activities from a group and, as a knowledge asset, has the explanatory potential to help the organisations to create, understand and exploit successful innovations both in product and in procedures (Smedlund 2008). Organisations need to be more careful in the process of codification and articulation of implicit knowledge according to Smedlund (2008, p.68), who proposes a “decentralized network structure” for managing this type of knowledge. In fact, implicit knowledge may become a severe problem if internal perceptions of what is used in a particular sector does not follow closely the evolution of the sector and becomes outdated. This could trigger a mismatch between what is perceived to be accepted practice in the organisation and what is actually required in the sector. Importantly, the more experienced the practitioner, the more convinced they are that they are aware of accepted practices. This assumption can very often be incorrect.

2.2.3 Organisational Learning Processes and Memory

Experienced individuals and the tacit knowledge they accumulated during their professional practice are key contributors to the good performance of organisations. Therefore, when people leave and this tacit knowledge is lost, organisational memory is reduced (Carley 1992). Organisational learning is identified as a functional solution in dealing with personnel turnover and loss of tacit knowledge. This type of learning is usually considered as a strategic renewal of knowledge and a solution for
the organisation to face and adapt to the dynamic and changeable environments of today’s information society (Crossan et al. 1999).

In more depth, Huysman (2004, p.34) defined organisational learning as the “process through which knowledge in an organisation is constructed or existing knowledge is reconstructed”. However, this definition only stresses the construction of collective knowledge in the face organisational change. Conversely and taking a social constructivist perspective of this phenomenon, the focus should be on social negotiation of meanings between interacting individuals and lead to a view of organisational learning as an “institutionalising process” in which individual knowledge is made explicit and becomes organisational knowledge (Huysman 2004, p.34). Consequently, authors such as Kim (2004) claim that organisational learning is essentially grounded in individual learning.

In order to operationalise these theoretical concepts, Crossan et al. (1999) proposed a framework of organisational learning that encompasses three different levels: individual, group and organisation (Figure 2.6).

<table>
<thead>
<tr>
<th>Level</th>
<th>Process</th>
<th>Inputs/Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual</td>
<td>Intuiting</td>
<td>Experiences, Images, Metaphors</td>
</tr>
<tr>
<td></td>
<td>Interpreting</td>
<td>Language, Cognitive map,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conversation/dialogue</td>
</tr>
<tr>
<td>Group</td>
<td>Integrating</td>
<td>Shared understandings, Mutual</td>
</tr>
<tr>
<td></td>
<td></td>
<td>adjustment, Interactive systems</td>
</tr>
<tr>
<td>Organization</td>
<td>Institutionalizing</td>
<td>Routines, Diagnostic systems,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rules and procedures</td>
</tr>
</tbody>
</table>

Figure 2.6. Three Levels between Organisational Learning (Crossan et al. 1999, p.525)

Intuition, as a human attribute, is a unique process developed at the individual level
(Crossan et al. 1999). The intuiting process, as a subconscious process, involves pattern of recognition which is intent to develop new insights. This process could lead to, as well as emerge from, aspects of exploitation and exploration in professional practice. Interpretation happens both by individual and in groups. In individual terms, practitioners reflect and make sense of their practices by trying to explain professional events in words and in doing so build cognitive maps that represent their interpretation of these events. Thereafter, as a social activity, group interpretation “creates and refines common language, clarifies images, and creates shared meaning and understanding” within organisational group situations (Crossan et al. 1999, p.528). Integration is a process to develop deeper shared understandings by using mechanisms such as conversation and storytelling (Jashapara 2004). Institutionalisation is the process by which the organisation produces its routines, rules and operational procedures. For the purpose of collective learning, the institutionalising is the formal process in which coded tacit knowledge is transformed into explicit and shareable knowledge in the form of rules, procedures, strategies, activity guidelines, technologies, conditions, paradigms and frames of reference (Huysman 2004).

It is universally accepted that organisational learning is a process for transforming professional experience into knowledge, in order to improve the organisational performance (Mehra & Dhawan 2003; Dimovski et al. 2008). This conceptualisation of organisational learning as a process was originally proposed by Huber (1991), who divided the process into four parts: knowledge acquisition, information distribution, information interpretation and organisational memory (Figure 2.7).
The framework in Figure 2.7 suggests that in order to share and store information and create an organisational memory, knowledge acquisition is required as a process of codification of tacit knowledge. Once this codification is performed explicit knowledge can be stored in the form of information and data and can be distributed across the organisation. This shared explicit knowledge can be used to gain new understandings and support new professional experiences (Jashapara 2004) that, in turn, require new interpretations.

Organisational memory results from this process of explicit knowledge storage and formal and informal channels of distribution, communication and sharing. Jashapara (2004) distinguishes two types of organisational components. Computer-based memory composed of databases and content management systems from what Jashapara (2004, p.73) names “hard” memory. On the other hand people’s mind and
social networks are also active repositories of knowledge (Cross & Baird 2000) and form the “soft” component of the organisational memory. This “soft form” is the most vulnerable to employees’ turnover and therefore this is what makes it more significant and valuable (Sanchez et al. 2010; Jashapara 2004, p.73).

Consequently, organisational learning concentrates on generating and developing new knowledge continuously and requires the support of knowledge management processes that enable discovering, generating, evaluating, sharing and leveraging knowledge (Pemberton & Stonehouse 2000; Jashapara 2004). The two concepts are integrally related with the sharing, understanding and producing of new knowledge. These two processes are often discussed and addressed in isolation, however none of these actually occurs in isolation in organisations and, as proposed by Pun and Balkisson (2011), it is necessary to investigate knowledge management by using integrative thinking in relation to organisational learning.

2.3 Knowledge Management

Knowledge management, as an emerging discipline, has a multidisciplinary nature. As defined by Jashapara (2004, p.12) from an integrated perspective, knowledge management could be considered as “the effective learning processes associated with exploration, exploitation and sharing of human knowledge (tacit and explicit) that use appropriate technology and cultural environments to enhance an organisation’s intellectual capital and performance”.

Knowledge in this definition has two different types: explicit and tacit. Explicit knowledge is easily verbalisable and can be faithfully codified into a tangible manifestation in either digital, audio or paper based form. Therefore, it is easily processed, transferred and transmitted. Explicit knowledge is ideal for operational use and knowledge sharing. In contrast, tacit knowledge results from professional experience and actual interaction with professional environments and is more
complex. It exists mostly in people’s minds and is not easily codified or transformed into explicit knowledge (Nonaka et al. 2000). Nonetheless, it is a crucial element in organisation success and competiveness. Knowledge management results from management processes of these two types of organisational assets. Therefore, this section aims first at discussing the general high level stages of knowledge management (i.e. the codification of tacit knowledge, the storage of explicit knowledge, and the organisational sharing of this knowledge) followed by an integration of these general stages into formal knowledge management models that are then critically reviewed.

2.3.1 Tacit Knowledge Codification

The notion of “codification” originates in economics (Ancori et al. 2000). The concept derived from the attempt to deal with knowledge as an organisational asset. If seen as such then knowledge must be put in a form that allows it to “circulate and be exchanged” (Ancori et al. 2000, p.256). These same authors assert that for this reason “the main transformation investigated by economists is the transformation of knowledge into information, i.e. the codification of knowledge” (Ancori et al. 2000, p. 256). This tangible format can then be measured and assessed knowledge objectively by economists and even accountants.

Codification has therefore been translated very mechanistically as “the process of conversion of knowledge into messages which can be processed as information” (Cowan & Foray 1997, p.596). From a more information systems perspective, codification is described as “converting undocumented to documented information” (Awad & Ghaziri 2004, p.186).

In such definitions information is equated with explicit knowledge. This interchangeable use of these two terms has since been widely accepted and in a field of research where general agreements are very rare, even Wilson (2002) accepts that
“explicit knowledge’, of course, is simply a synonym for ‘information’”. On the other hand, the meaning of codification and the processes that enable the transformation of tacit into explicit knowledge are not at all widely agreed upon. Wilson (2002) proposes that this codification is not possible. The majority of knowledge management authors, however, defend the contrary. But, no matter how different the perspectives of codification may be from the multitude of definitions available, the essential principle of knowledge codification is well illustrated by Awad and Ghaziri (2004) the process of making corporate specific knowledge accessible, usable and visible. Therefore, knowledge codification encompasses activities identifying, leveraging and expressing tacit knowledge, followed by organising, categorizing and indexing the resulting explicit knowledge. Hence, codification could, in general terms, be considered as an effective strategy to facilitate knowledge flow in the organisation (Schulz & Jobe 2001) and its purpose should not be merely an exercise of expressing, storing and retrieving knowledge conveniently, but also aim at reusing and generating new knowledge in a different professional practices, environments and contexts (Choo 2000).

Finally, from a knowledge management perspective knowledge codification is much more centred in the individual practitioner in the organisation. The process “originates with people and is interpreted by the people” (Awad & Ghaziri 2004, p.186). In this sense knowledge, as the element being transformed, “involves the mental processes of comprehension, understanding and learning that go on in the mind and only in the mind, however much they involve interaction with the world outside the mind, and interaction with others” (Wilson 2002). Therefore, codifying tacit knowledge is at times an overwhelmingly difficult and complex task because not only it is embedded within human’s mind but also because it results in professional practices, behaviours, attitudes and interactions with others which are subjective. Moreover, individuals may not be readily willing to either express or share their experience and tacit knowledge. In competitive organisational environments, employees who have experience or specialised expertise might be afraid that they may
lose their potential status if they express and formalize their knowledge (Stover 2004).

In order to support the codification process, academics and practitioners have developed tools such as knowledge maps, decision tables, decision trees, frames, production rules, case-based reasoning and knowledge-based agents (Awad & Ghaziri 2004). Therefore, the codification of tacit knowledge often requires experienced experts who are capable of using such tools to represent knowledge as well as the ability to interact with professionals and to gain their trust.

2.3.2 Explicit Knowledge and Databases

After tacit knowledge is transformed into explicit knowledge, then it can be easily “shared, stored, combined, and manipulated in a variety of ways” (Davenport & Prusak 1998, p.87). As discussed above the codification of tacit knowledge is a procedure that includes organising, categorizing and indexing the resulting explicit knowledge according to organisational and sector specific standards and systematic guidelines. This process results in explicit knowledge that can easily be structured and retained in organisational repositories such as filing systems, document repositories or databases (Stover 2004). As claimed by Lindvall et al. (2003), all documents produced by an organisation could be seen as explicit knowledge and managed via document management system. Besides traditional documents, explicit knowledge also includes a variety of other types of like multimedia files, e-mail messages, logged chats, and database records, etc. (Lindvall et al. 2003). All the types of this explicit knowledge can be managed in digital form through the creation of computer based knowledge repositories and database management.

The design of these databases needs to be carefully considered so that in addition to data and information, natural relationships and contextual and semantic information is embedded in the repository. In fact, if the documented knowledge in the database does not include information on the context and relationships between different
aspects, areas and clusters of information, the “database of explicit knowledge is meaningless” (Stover 2004, p.167). Therefore, in order to make sure of the usability and validity of knowledge stored, the database should be developed in close association with working practice and ensure close relationships between naturally related knowledge in the organisation.

These knowledge repositories and databases are often referred to as the main vehicles to support knowledge sharing. However, Stover (2004) points out that it is far more difficult to ask people to express knowledge into a database and ask others to make sense of this stored knowledge, than to engage in knowledge sharing and the exchange of ideas face to face. Discovery and creation of new knowledge from a database is a well-known activity that results from interactive and iterative processes of data mining, data extraction and data analysis, which have a direct relation with knowledge use (Li & Ruan 2007).

This area of knowledge management is well researched and established and spans across a number of disciplines such as information management, database design, information retrieval and software engineering. As such, it is a related but not a main area of interest to this study.

2.3.3 Knowledge Sharing and Dissemination

Knowledge sharing is an essential process and potentially the most important activity in knowledge management (Davenport & Prusak 1998; Ryu et al. 2003). It can be simply expressed as the organisational process of making knowledge available to others (Ipe 2004). Exploring this concept of ‘others’, Lee (2001) proposes that knowledge sharing is the activity of transferring or disseminating knowledge between individuals, groups, or even organisations. Al-Hawamdeh (2003, p.81) further elaborates stating that “knowledge sharing, in its broadest sense, refers to the communication of all types of knowledge, which includes explicit knowledge or
information, the ‘know-how’ and ‘know-who’ which are types of knowledge that can be documented and captured as information” as well as less well defined and structured knowledge such as skills and competencies.

However, this process of knowledge sharing is also linked with inherent aspects of organisational life such as organisational behaviour and culture. As proposed by Lin (2007, p.315), knowledge sharing results from “a social interaction culture, involving the exchange of employee knowledge, experiences, and skills through the whole department or organization”. Therefore, the culture of an organisation is one of the major factors in people’s attitude towards sharing and disseminating knowledge (Ardichvili et al. 2006; Suppiah & Sandhu 2011). Additionally, knowledge sharing happens between individuals or groups (Awad & Ghaziri 2004), and therefore is highly dependent on the individual’s willingness to represent and exchange their experiences, practices and other forms of tacit knowledge (Nonaka 1994).

Knowledge sharing should not only be seen as a way to help colleagues to improve their job performance, but also a strategy for an organisation to manage efficiently and effectively difficult aspects of organisational life, such as high turnover of staff, fast evolution of technologies or constant changes in socio-technical environments.

Finally, it is important to highlight that the processes of knowledge management are closely related with availability and adoption of particular technological solutions. For instance, the recently emerged and now widely adopted Web 2.0 technologies have a “more collaborative, interactive and dynamic nature” and therefore afford improved sharing of knowledge (Patrick & Dostsika 2007, p.400). Therefore, in order to facilitate knowledge sharing, it is critical to consider the interaction between organisation, individual and technology.
2.3.4 Knowledge Management Models

Based on the statistics from Hislop (2005), during the late 1990s there was an increasing potential enthusiasm on researching knowledge management, as showed in the growing number of academic and empirical publications. As a consequence, a number of authors have proposed comprehensive and integrated knowledge management models aiming to support and operationalise knowledge management theoretical concepts. In the literature today, there are a wide range of such knowledge management models. This section revises a selected number of such models.

The traditional starting point in discussions on knowledge management models is Nonaka’s *et al.* (2000) SECI model which was shaped having in mind knowledge creating process in Japanese organisations.

As shown in Figure 2.8, the model is predicated on the notions of tacit and explicit knowledge, and attempted to formalise knowledge management as a dynamic process resulting from multiple aspects of the conversions of tacit into explicit knowledge and vice versa. The transformation between tacit and explicit knowledge happens at Socialisation, Externalisation, Combination, and Internalisation (Nonaka *et al.* 2000).

![Figure 2.8. SECI Model (Nonaka et al. 2000, p.12)](image)
Importantly, Nonaka et al. (2000) claimed that tacit knowledge could be converted into explicit knowledge during the process of externalisation by formalising knowledge. Meanwhile, the explicit knowledge also can be transmitted into tacit knowledge through internalisation. Generally speaking, this model described simply the process of knowledge transfer, and only gave a mechanism of organisational knowledge transaction.

![Figure 2.9. Hedlund and Nonaka’s Knowledge Management Model (McAdam & McCreedy 1999, p.96 Adapted from Hedlund & Nonaka 1993, p. 119)](image)

Hedlund and Nonaka (1993) proposed an earlier model that contained a higher level of detail (Figure 2.9) which divided knowledge “carriers” into four types: individual, group, organisation, and interorganisational domain (e.g. suppliers, customers). The different levels of knowledge “carriers” are associated with distinct types of knowledge. This model seems to be much more useful in terms of support for management of different types of knowledge, as well as the assigning and tracing of the responsibilities.

More recently and focusing specifically on those internal organizational processes that are related to the managing of knowledge, Jashapara (2004) proposes another representation of the knowledge management process.
As seen from Figure 2.10, knowledge management is viewed as a “continuous cycle” and integrated activities which include discovering knowledge, generating knowledge, evaluation knowledge, sharing knowledge and leveraging knowledge (Jashapara 2004, p.5). The knowledge management cycle mode adopts an integrated view of knowledge management and concentrates more on the generic knowledge related activities, rather than actors in the process and types of data as the two previous models. As such it seems an easier to implement knowledge management model and one that could be better understood by practitioners.

Another view for knowledge management models is specifically related with “social and learning processes within the organisation” (McAdam & McCreedy 1999, p.98) rather than knowledge activities. The social construction model proposed by those two authors was an attempt to balance the processes of the social construction knowledge with organisational learning processes. The model proposed by McAdam and McCreedy (1999, p.98) tries to combine both a scientific and a social
constructed knowledge paradigm in knowledge construction.

**Figure 2.11.** McAdam and McCreedy’s Knowledge Management Model (McAdam & McCreedy 1999, p. 98)

As shown in Figure 2.11, the model identifies four main activities of knowledge management: knowledge construction, dissemination, embodiment and use, and proposes that, rather than cyclical, these are all inter-related to each other. Moreover, the concept of the use of knowledge has been extended in order to incorporate both business and employee motivations. Importantly, and in contrast with the knowledge management cycle, this model claims that knowledge flows are recursive (Figure 2.11) rather than sequential (Figure 2.10).

Nunes *et al.* (2006) proposed an improvement and development of the previous model that they called the KIKoM model, which explicitly attempts to contextualise knowledge management within the organisational environment and organisational learning.
As shown in Figure 2.12, the KIKoM model was designed for knowledge intensive SMEs, which combined the recursive processes of knowledge management within their organisational context. Based on this point of view, there are several critical elements in the processes of knowledge management, which consist of knowledge construction, knowledge embodiment, knowledge use, knowledge dissemination, business value, organizational learning and knowledge management barriers (Figure 2.12).

In sum, knowledge management is certainly an essential business tool aiming at managing a valuable strategic asset which could help the organisation to enhance its ability for competitiveness and make management more effective and successful. All the models presented provide insights into ways of applying very complex...
principles of knowledge management in organisational environments. However, and apparent in all of them, is the basic principle that knowledge is valuable and should be shared across the organisation. Also implicit in all of the models, is the belief that the value of knowledge is essential dependent of the context and the organisation where it is used. Therefore, knowledge that is crucial in an organisation in one particular sector, may be useless in another in a different sector. Since, the focus of this research is IT/SW industry it is important to consider the suitability of the principles discussed above in this sector.

2.4 Knowledge Management in the Information Technology/Information System/Software Sector

2.4.1 The Nature of the Information Technology/Software Sector

The software industry is the business aiming at developing, maintaining and producing computer based applications and products. As defined by Sommerville (2007, p.5), software as a product is not just the executable programs, but also includes the “documentation and configuration data that is needed to make these programs operate correctly.” The software corporations in the software sector may have very different missions and aims as well as target very different types of environments and business markets.

According to the North American Industry Classification System (NAICS 2015), the industries which are associated with the software sector include circa 36 types of businesses (see Appendix 1). The classification of the software sector comprises companies which are mainly selling, planning, and designing software systems (Code 423430, 541511), companies which are retailing pre-packaged computer software (Code 443120), and the companies which also integrate the service and training users to support the system application (Code 541519, 611420). On the other hand, according to the European based KOMPASS (KOMPASS 2015), this classification is even more complex. As shown in Appendix 2, there is a large number of business
and services which are associated with the software sector in terms of both products and services. Nonetheless, the specification of requirements, design, development, installation and maintenance of software seem to be the activities that bind all these different types of organizations together.

2.4.2 Main Operational and Management Activities

This research aims to identify and define different types of tacit knowledge associated with experience acquired in the process of software development. Therefore, it is necessary to understand how the systematic approach adopted by the sector that is often recognised as software engineering, which includes well accepted stages ranging from system specification to the end of the process in terms of maintaining the system (Sommerville 2007). Darnell and Margolis (1996, p.11) specify these stages of software development as: “product specification, architectural design, project planning, detailed design, coding, debugging, testing and maintenance”. Another proposition by Pfleeger and Atlee (2008, p.47) proposes: “requirement analysis and definition, system design, program design, writing the programs (program implementation), unit testing, integration testing, system testing, system delivery and maintenance”. However, in the real world these processes are not easily separate from each other and they often occur in parallel (Darnell & Margolis 1996; Pfleeger & Atlee 2008). Nonetheless, the process model of software development is very useful to understand the complexities of software engineering and identify the very different skills, competencies and experiences necessary in the sector. This view is supported by Pfleeger and Atlee (2008, p.47), who claim that the processes were “important for enabling us to capture our experiences and pass them along to others”. Therefore, in order to identify the experience and tacit knowledge in the process of developing software, it is significant to investigate the activities, constraints, and resources through the series of steps. This section will illuminate the activities in detail which involve the procedures and process of software development as follows:
2.4.2.1 Stage 1: Planning and Managing the Project

Most project managers take responsibility for “proposal writing, project planning and scheduling, project cost, project monitoring and reviews, personal selection and evaluation, and report writing and presentation” (Sommerville 2007, p.94). Some of these activities are iterative processes which happen during the whole process of software development, e.g. planning and monitoring.

Before starting a software project with the customer, it is essential to write a proposal to gain the contract. The proposal will make estimation of “how long” and “how much” of project (Pfleeger & Atlee 2008, p. 82) and the justification for starting this business with a “particular organisation or team” (Sommerville 2007, p.94). Project planning is used to identify the activities, milestones and project deliverables (e.g. “documents, demonstrations of function, demonstrations of subsystems, demonstrations of accuracy, and demonstrations of reliability, security, or performance” (Pfleeger & Atlee 2008, p.83)). Project scheduling decides the separate activities and the time required to finish these activities. Moreover, risk management is another critical job for the project manager. This suggests that tacit knowledge and experience necessary at this stage are related with management processes and contract negotiation.

2.4.2.2 Stage 2: Capturing the Requirements

The requirements are the definition and expression of customers’ needs for a system. It should be documented for both customers and software developers/team. However, a requirements definition is expressed in the customers’ terms and language, referring to “objects, states, events, and activities in the customer’s world” (Pfleeger & Atlee 2008, pp.193, 195). Therefore, there is need to write the requirements in terms of the systems’ interface, and this is called the requirements specification. The requirements specification is used from senior management to the software developer.
(Figure 2.13). In turn, this suggests the need for experience in communication with users, abstraction and writing of requirements at both business and technical levels.

![Diagram](image)

**Figure 2.13. Users of Requirements Specification (Sommerville 2007, p. 137)**

### 2.4.2.3 Stage 3: Designing the General SW Architecture

Based on the requirements specification, it is necessary to consider the general architecture of the system that can satisfy customer’s needs. The architecture represents the overall structure of “program components”, the mode in “which these components interact”, and the structure of data “that are used by the components” (Pressman 2005, p.266). It is high-level architectural design which provides the strategy and pattern for building the system (Pfleeger & Atlee 2008). In this stage, the activities involve the data design and selection of architectural style. This stage requires experience in project scoping, technical understanding and work division.
2.4.2.4  **Stage 4: Designing the Modules**

In this stage, system module is about to design the details of components which can help with coding and implementing the design. There are several types of system models which might be produced in the analysis process, such as a data-flow model, composition model, architectural model, classification model, and stimulus-response model (Sommerville 2007). A system model is a clear representation of the nodes of entities and the relationship between these entities (Sommerville 2007). This is a more technical stage, requiring more technical experience in defining and designing software modules, components and source libraries, as well as their links and relationships.

2.4.2.5  **Stage 5: Writing the Programs**

There are many languages available for programming and guidelines applicable to implement the design. Concerns here are related to writing efficient and error free code as well as planning maintenance and re-use of the code produced. In fact, the code written for one particular application or module may be used in many other modules in the same system or even in another application. Coding often involves teamwork. This requires good communication channels, efficient work division as well as good leadership. Furthermore, organisations usually develop their own specific jargons and methods, which involve the development and maintenance of a common language that can be understood by all. Therefore, apart from sector specific quality and ethics standards, organisations also have their own standards and procedures, for their own “style, format, and content standard” of code and the related documentation (Pfleeger & Atlee 2008, p.374). This related documentation is written to explain “what the programs do and how they do it” (Pfleeger & Atlee 2008, p. 387). Programming in itself may be an individual activity but it requires management, the use of information and experience related to both the sector and
organisational standards as well as established and socially constructed patterns of programming techniques and strategy (Pfleeger & Atlee 2008).

### 2.4.2.6 Stage 6: Testing

Testing is the way to identify the code components which cause faults. Organisations may use an independent team for testing, which aim to discover and mitigate as many faults as possible (Pfleeger & Atlee 2008). This action is taken by both individuals and groups. Unit testing addresses each component separately (Pfleeger & Atlee 2008). On the other hand, integration testing aims at “choosing an integration strategy, planning your tests, generating test cases, and running the tests” (Pfleeger & Atlee 2008, p.449). System testing often involves an entire development team. There are four steps in testing the system which include function testing, performance testing, acceptance testing and installation testing (Pfleeger & Atlee 2008).

![Figure 2.14. Steps of Testing a System (Pfleeger & Atlee 2008, p. 456)](image)

Because the tests and testing case are close to the requirements and design, the testers should be familiar with system specification and testing method and tools (Pfleeger & Atlee 2008). In this sense, the testers should have experience, and therefore often include “former analysts, programmers, and designers who now devote all their time to testing systems” (Pfleeger & Atlee 2008, p.465).
2.4.2.7 Stage 7: Installing and Delivering the System

Once the system is ready for use, it needs to be installed in the organisation. This may result in important changes in processes, technological infrastructures and operation of technology. These changes need to be informed by training and documentation, which are methods to present the customer with the system solution and prepare staff for its operation and exploitation in the real business context (Pfleeger & Atlee 2008). Documents, icons and online help, demonstration and classes, as well as interaction with expert users are used as training methods (Pfleeger & Atlee 2008). User manuals, operator manuals, and general system guides are used as reference guides to describe the functional details of system (Pfleeger & Atlee 2008). In fact, the training and documentation can be prepared at the beginning of requirement analysis and during the software development. This is often a crucial part in the acceptance of any new system and one that requires very experienced change managers, trainers and technical writers.

2.4.2.8 Stage 8: Maintaining the System

During the operation of the developed system, it is predictable that there will be new and emergent requirements. The maintenance of software is the way to adjust to change, enhance the satisfaction of users’ needs, or even enable the migration into new operating systems and platforms (Pressman 2005). There are four different activities involved in maintenance:

- Corrective Maintenance: control the system’s day-to-day functions;
- Adaptive Maintenance: control the modification of system;
- Perfective Maintenance: examine documents, design, code, and tests, in order to improve the existing functions;
- Preventive Maintenance: prevent failures from degrading to unacceptable levels (Pfleeger & Atlee 2008, pp.543-544).
Moreover, maintenance of systems needs all the roles of the software development team, i.e. analysts, programmers, and designers. In this stage, programmers need to change the previous code’s structure and content, which are required to make larger effect and responsibility than in the developing stage (Pfleeger & Atlee 2008).

2.4.2.9 Stage 9: Evaluating and Improving Products, Processes, and Resources

As Pfleeger and Atlee (2008, pp.662-663) proposed, “good products and effective processes depend on the way in which your team works together in cohesive ways to get the job done. And good resources are essential for you to do your job right”. Therefore, in order to enhance the quality of software development, it is critical to evaluate the techniques and strategies from the previous project, and acquire the advisable experience from the activities and working practice. This is a meta activity that requires both technical and management experience as well as contextual understanding.

2.4.3 Survey of Case Studies

From the discussion above, there is no doubt that software industry is a knowledge-intensive industry (Dingsoyr 2002). It is also evident that successful knowledge management implementation can improve the development of software, support in facing of changeable business environments, enable transitions to new and constantly emergent technologies as well as very high personnel turnovers that characterise the sector (Dingsoyr 2002; Mishra & Bhaskar 2011).

However, as claimed by Mehta (2008), before implementation of a knowledge management program in a software sector organisation, it is essential to define a clear strategic intent for the knowledge management program which needs to supported and initiated from the top management to the knowledge management users and operators.
This knowledge management strategic intent is mostly reflected by the organisational goals and specific business circumstances (Mathiassen & Pourkomeylian 2003). Mehta (2008) studied three case studies of global software firms, trying to identify their intent to use knowledge management. He identified very different intentions, namely the reduction of costs in software development, improvement of the quality of the development process and the provision of a virtual teamwork for global and geographical sales and distribution. In all these cases the support from senior management seems to be fundamental in guaranteeing the sustainability of the knowledge management initiative. In another case study, where this researcher was actively involved, the largest Taiwanese ERP company developed an elaborate story-telling knowledge base in order to encourage the sharing and managing of knowledge that would help them to accumulate knowledge and expertise and face high turnovers of SW employees (Chen et al. 2009).

Besides investigating the strategic intent, research into knowledge management in this sector also tried to study the application of models and strategies in practice. Mehta (2008) recommended the global software companies should adopt a decentralised architecture of knowledge management which assigns responsibilities for everyone engaged in knowledge intensive aspects of the organisation. This distributed mechanism is expected to strengthen the responsibility of employees and senior managers, and also encourage the participation in and contribution to knowledge management activities (Mehta 2008).

Departing from an organisational behaviour point of view, Mishra and Bhaskar (2011) analysed an Indian IS-company by evaluating the processes of knowledge management which include knowledge creation, knowledge upgradation, knowledge sharing, and knowledge retention and identified corresponding determining characteristics (Table 2.2).
Table 2.2. Determinative Characteristics for Knowledge Management Processes  
(Modified from Mishra & Bhaskar 2011, p.355)

<table>
<thead>
<tr>
<th>Knowledge Management Processes</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Creation</td>
<td>Self-learning; Both informal and formal mode of learning; Rewards for ideas generation.</td>
</tr>
<tr>
<td>Knowledge Up-gradation</td>
<td>Decentralised &amp; multi-channel interaction; Top-driven.</td>
</tr>
<tr>
<td>Knowledge Sharing</td>
<td>Training programs (external and internal); Benchmarking of best practices; Job rotation.</td>
</tr>
<tr>
<td>Knowledge Retention</td>
<td>Structured knowledge retention process; Detailed exit interview.</td>
</tr>
</tbody>
</table>

Nonetheless, there is a significant characteristic of the SW sector that seems to be a determinant in the perceived need to use knowledge management: the extremely high rate of employees’ turnover, that some authors, such as Moitra (2001, p.78), refer to as “disturbingly high”. Furthermore, this comparatively high turnover in the SW industry seems to be mostly centred in the software development and technical sectors of the organisations, which makes the retention of individual experience and expertise a seriously important issue according to Mishra and Bhaskar (2011). These authors, based on their study of two major Indian SW outsourcing companies, provide an example of a structured mechanism used in that company for the transferring of knowledge before the employees leave or state an intention to leave. The employees were asked formally to share their experience, ideas and knowledge with the project manager (Mishra & Bhaskar 2011). Moreover, one of the companies set an exit interview process which included three procedures of interview by colleagues, the project manager, and finally the managing director (Mishra & Bhaskar 2011). The responses and answers were designed to enable formalisation, expression and transfer of knowledge so that it can be retained in the company.

Although these authors seem to be very positive about this process, it seems highly improbable that such a knowledge transfer process could be very successful. In truth,
cornering an employee for 15 days in conversations with colleagues and managers in the hope that these conversations could lead to the retention of their tacit knowledge, seems more an act of desperation than one of well devised strategic thinking. According to all theoretical propositions of knowledge management, codification, storage and sharing of tacit knowledge should happen through a well supported and continual process of reflective practice and social negotiation with colleagues and managers. As stated above, this researcher studied a Taiwanese ERP company. This company had a more practice grounded approach to the codification and sharing of experiences. The company established a database, they entitled a “knowledge library”, which served to record the views and experience of practice trough reflection and the production of stories (Chen et al. 2009). Employees were encouraged to share and express their experience and lessons trough story telling using an establish format (Chen et al. 2009). Similarly, Mathiassen and Pourkomeylian (2003) describe an “Electronic Process Library” on the intranet in software operation was to be updated and developed continuously and dynamically by the software process improvement unit of a very large pharmaceutical multi-national company they studied. This library was used as a shared and centralised knowledge sharing system containing all kinds of reports and documentation on software developing projects and practices within the company. Moreover, a frequently asked question system was also placed on their intranet, which provides answers to commonly experienced problems and issues (Mathiassen & Pourkomeylian 2003). Another example in the same line of knowledge management strategy is described by Mishra and Bhaskar (2011, p.351), who report the creation of a “In-house library” by an Indian SW outsourcing company. This knowledge repository also was made available in the company's intranet allowing access to all employees, but reserving access to specific areas of the library that concerned ongoing projects, which were closed to project members only.

Therefore, there is some evidence in the literature that software companies have the awareness and understating of the need to retain experience and intangible knowledge
and retain these in documented shared repositories for later retrieval and use. Moreover, there is a great interest in the industry to develop heuristics and technology to support these repositories (Dingsoyr & Conradi 2002).

However, and importantly, what the above cited authors also recognise is that “empirical analysis of how experience sharing actually works is lacking” (Dingsoyr & Conradi 2002, p.410). In fact, most of the studies above are holistic studies at organisational level and have very little detail on how the different professionals in the company reflect on their very different professional practices and then share that knowledge. For instance, a story reflecting on the experiences of a programmer may be of very little use to an analyst and vice-versa. Dingsoyr (2002, p.384) actually clarifies his position by stating that “in order to build efficient management tools, we need a better understanding of how existing tools [and knowledge management strategies] are applied in software development”. It could be added that software development team interaction as well as interaction with customers is highly culturally dependent. Software development and knowledge sharing in European, Indian or Chinese companies may have very different facets and nuances. Therefore, this study tries to understand experience in the SW industry sector by linking it explicitly to the software development stages presented above and the context of Chinese companies. The expectation is that this approach will allow the identification and assessment of a range of different aspects of experience in this sector in China, encompassing management experience of project managers, soft skills of analysts, hard skills of programmers and training skills of trainers and documentation writers.
Chapter 3. Research Methods

3.1 Introduction

Research is not just the “gathering of facts or information”, “moving facts from one situation to another”, or “a word to get your product noticed” (Walliman 2005, p.8), it is rather a procedure that “includes the components for collective inquiry, research design, methodology, data collection and analysis, concluding with the communication of the findings” (Juznic & Urbanija 2003, p.324). Furthermore, in order to “find out things in a systematic way” (Saunders et al. 2003, p. 3), the appropriate methodology should be selected and the systematic process clearly and explicitly indicated. Therefore, this chapter provides the research methodology selected and corresponding systematic research processes designed to respond to the research questions and to achieve the research objectives which are presented in chapter one.

In order to present clearly the research methodology employed in this research project, Saunders et al.’s (2003) research “onion” (see Figure 3.1) was adopted. This visual tool illustrates the process of selection by identifying five layers of thinking, namely research philosophy, research approaches, research paradigms, and research strategies.

![Figure 3.1. The Research Process “Onion” (Modified from Saunders et al. 2003, p. 83)


3.2 Research Philosophies

According to Williams and May (1996, p.xv), philosophy can help in “sharpening our awareness of the broader context of our research plans and our findings” and “alert us to poor reasoning or to illegitimate inferences from data”. Therefore, it plays an important role in understanding social research and selecting the research methodology. There are three different philosophical stances commonly referred to in the literature, namely positivism, realism, and interpretivism. These stances indicate the assumptions researchers take in the understanding of the development of knowledge (Saunders et al. 2003).

3.2.1 Positivism

Positivism represents the application of physical and natural sciences in order to study the social reality and beyond (Saunders et al. 2003). The principles of positivism imply that:

“1. Only phenomena and hence knowledge confirmed by the senses can genuinely be warranted as knowledge;
2. The purpose of theory is to generate hypotheses that can be tested and that will therefore allow explanations of laws to be assessed;
3. Knowledge is arrived at through the gathering of facts that provide the basis for laws;
4. Science must (and presumably can) be conducted in a way that is value free;
5. There is a clear distinction between scientific statement and normative statements and a belief that the former are the true domain of the scientist.”

(Bryman & Bell 2007, p.16)

These principles indicate the relation between theory and research which is to test theory (the principle of deductivism) and to generalise the propositions based on the natural science research (the principle of inductivism). It also stresses a strictly
formulated and structured methodology (Heshusius 1996), to take a view that the “objective reality exists beyond the human mind” (Weber 2004, p. iv).

According to the research questions and objectives established in Chapter 1, this research needs to identify and categorise experience associated with tacit knowledge acquired by individuals in the SW industry. These are subjective insights, difficult to express and acquired and developed by different individuals’ behaviours and working processes. Therefore, there is not objective truth to be understood and defined and positivism was deemed not suitable for this research.

3.2.2 Realism

As defined by Bryman and Bell (2007, p.731), realism represents “a reality independent of the senses that is accessible to the researcher’s tools and theoretical speculations” and advocates “the categories created by scientists refer to real objects in the natural or social worlds”. This implies the common features with positivism, which based on the belief on a reality external to the researchers and the objective nature of science and society. Unlike positivism, realism is applied to study human subjects, to understand “people’s socially constructed interpretations and meanings” and to explore subjective reality within the environment which is influenced by human thoughts and behaviours (Saunders et al. 2003, p. 85). In addition, there are two forms of realism which are empirical realism and critical realism. Empirical realism simply proposes to use an appropriate method of observation or experiment to understand the social world as an empirical reality. Critical realism asserts that there is the need to identify the structures and mechanism of society in order to do “the practical and theoretical work of the social sciences” (Bhaskar 1989, p.2). In other words, the positivists describe the reality that is directly and explicitly reflected by the natural situations. The realists explore not only the observable social phenomenon but also the actual social structures and mechanisms that frame the phenomenon. In
doing so they aim to explore the effects and also formulate hypothesis about it (Bryman & Bell 2007).

This research does not question professional, organisational, and cultural structures nor does it criticise the quality and ethical standards associated with the SW industry. Quite in the contrary, this research aims to understand how individuals develop their professional and personal experience in the context of those structures and standards. Therefore a critical realist approach would not be appropriate in this case.

### 3.2.3 Interpretivism

Interpretivism takes an ontologically opposing stance to positivism. It believes that the social world is far too complex and cannot be just defined by “laws” (proposed by positivism). Instead, interpretivism considers that “knowledge of the world is intentionally constituted through a person’s lived experience” (Weber 2004, p. iv). Since interpretivism presupposes the existence of and the need to understand the rich insights of people as agents in social phenomena, even when they are interacting with, using or exploiting natural objects, it is important to “grasp the subjective meaning of social action” (Bryman & Bell 2007, p.19). This indicates the need for researchers to recognise, explore and construct interpretations and meanings from people’s motives, actions and intentions within particular contexts. Therefore, as stated by Walsham (1995), interpretivism research is considered to be a valid approach to research in the information management and information system disciplines, which seek and interpret the relation and interaction between the information needs, the experience of information system use and exploitation, and the corresponding human’s connection, communication and commitment.

According to the research questions and objectives established for this research project, the researcher needs to identify and categorise tacit knowledge acquired by
individuals in the SW industry, by acquiring subjective insights from individuals’ behaviours and working processes, as well as interpreting meanings of actions, motivations and intentions. Moreover, the research is taken in the context of the IS industry and, therefore, aims at explicitly exploring the experience of individuals when engaged with the processes that categorise software development. Professional, quality and cultural structures that define the sector were identified in the previous chapters and will frame both data collection and analysis. However, since the research focus is on tacit knowledge and this is individually acquired and highly subjective, the final decision was in favour of an interpretivist stance that would enable the development of desired subjective meanings associated with this type of knowledge.

3.3 Research Approaches

After deciding upon the philosophic (both epistemological and ontological) stance, it is essential to establish a suitable and compatible research approach and design. This approach must provide a clear relationship between the research process and the use and establishing of theory. In social science, there are mainly two different approaches to reasoning for acquiring new knowledge, namely deduction (from the general to the specific) and induction (from the specific to the general) (Martin 2010). In order to decide the research approach, it is necessary to first distinguish the basic differences and understandings between these two types of reasoning.

3.3.1 Deduction

Deduction is a process of theory-testing, starting with a developed theory or generalised hypothesis, and then examining if the theory can be applied to specific instances (Hyde 2000). It was originally used in the natural sciences, in which “laws provide the basis of explanation, permit the anticipation of phenomena, predict their occurrence and therefore allow them to be controlled” (Hussey & Hussey 1997, p.52).
However, for social science research, the researchers must express “how data can be collected in relation to the concepts that make up the hypothesis” in order to pursue the objective nature of the testing process and ensure the scientific rigor of the research (Bryman & Bell 2007, p.11; Saunders et al. 2003, p.86). As proposed by Bryman and Bell (2007), there is a series of commonly accepted sequential stages for conducting the deductive reasoning research (Figure 3.2).

As shown in Figure 3.2, the deduction, also known as a “top-down” approach, moves from framing a theory that responds to the research questions established, and narrows down into a specific hypotheses that include testable and applicable variables (Trochim 2006). After expressing the hypothesis in operational terms by determining variables to be tested, how these variables are to be measured and analyzed, and how they are related, the data gathered from empirical evaluation and observation will be used to confirm the theory established. If the confirmation of original theory cannot be made, it may be necessary to revise it in the line with the findings (Saunders et al. 2003). Finally, it is important to note that the establishing of the initial theory and associated hypothesis depends on the existence of a body of knowledge that can support the deduction exercise.
After an exhaustive literature review, it was clearly established in Chapter 2, that there is a lack of theoretical propositions on what constitutes experience in the SW industry and how this is associated with the acquisition of tacit knowledge related to the working processes of software development. Therefore, there is no basis for a sound deductive approach in this case.

3.3.2 Induction

Inductive reasoning starts on the opposite direction from deduction. As expressed by Saunders et al. (2003, p. 87) “theory follows data rather than vice versa”. This means that, with an inductive approach, the study of the phenomenon in particular instances allows the establishing of theories that are grounded on the observation of those instances (Hyde 2000). In social science research, the deductive approach has always been strongly criticised for blindly seeking to establish a “cause-effect link to be made between particular variables without an understanding of the way in which humans interpreted their social world” (Saunders et al. 2003, p. 87). Instead, social and humanities scientists propose that there is a need to use evidence from human activity in specific social contexts as the genesis of the theory to be established (Snape & Spencer 2003). In this sense, inductive reasoning conforms to both interpretivist and critical realism epistemological propositions as inductive research involves the study of human’s activities, judgements and interpretations.

Specifically, inductive reasoning is very suitable when there is not enough theoretical understanding or propositions on specific phenomena or particular contexts. In these cases it may not be possible to establish clear hypotheses in the beginning of the research and therefore not possible to use a deductive approach. Therefore, the development of theory follows the findings of data analysis and theory is established at the end of the research process rather at the beginning. In order to explain the inductive reasoning, Trochim (2006) simply depicts the induction as a “bottom up”
process which contains the sequential steps shown in Figure 3.3.

![Figure 3.3. The Process of Induction (Trochim 2006)](image)

As shown in Figure 3.3, the inductive reasoning starts from an observation process during which data is collected and participants queried, followed by a process of analysis in which patterns or regularities in behaviours, activities, perceptions or opinions are identified. These patterns or regularities are articulated into tentative hypotheses to be explored and ultimately be drawn as generalizable theory (Trochim 2006; Spens & Kovács 2006; Bryman & Bell 2007).

In terms of the research reported here, it was clearly established in the literature review in Chapter 2 that there is an insufficient understanding and awareness of acquisition and use of tacit knowledge in the working processes of software development. Therefore, it was decided to use inductive reasoning, which allows for a less defined theoretical starting point and firms up theoretical propositions after the study of specific empirical cases. Furthermore, an inductive approach is well-suited to apply the interpretivist philosophy selected in Section 3.2.3.

### 3.4 Research Paradigms

After taking a decision on the philosophic stance for the research, i.e. interpretivism, and on an inductive reasoning approach, the next step was establishing the research design, according to the framework in Figure 3.1., to choose a research paradigm.
Such a research paradigm is understood as the “basic belief system or worldview”, in order to sufficiently and flexibly determine an appropriate research process (Tashakkori & Teddlie 1998, p.21). Traditionally, there are two different paradigms, namely quantitative and qualitative paradigms.

3.4.1 Quantitative Paradigm

According to Sale et al. (2002), the quantitative research paradigm is mostly supported by positivists, who assume that behind social events there is an objective reality that is independent of human understanding and awareness. Walliman (2006) proposes that quantitative research usually involves the collecting and counting the numerical data, then analyses data in a statistical method, and therefore aims to test the hypothetical generalisation. Moreover, quantitative research mainly tends to aim at measuring actions, consequences of actions or causes of actions using statistical treatments such as percentages, counts, statistical tests and modelling (Walliman 2006). In order to apply these statistical analyses it is often necessary to convert types of data into numbers (Bernard 2000), e.g. to convert descriptive data, such as words-description or images, into numbers. Therefore, it is important to construct standardised and systematic instruments to ensure the validity of the measurement.

According to the philosophical stance and the approach selected to build theory for this research, this quantitative paradigm does not seem to be very suitable. First, the research does not aim at proving hypotheses nor at measuring actions, consequences or causes. Second, tacit knowledge acquisition, use and exploitation are in themselves not very easily translated into either statistical models or inferences.

3.4.2 Qualitative Paradigm

The qualitative researcher emphasizes “socially constructed nature of reality”, the relationship with facts of natural science, and the information expressed in words, accounts, views, feeling (Denzin & Lincoln 2005, p.10). Unlike quantitative
research, qualitative research is based more on “language and the interpretation of its meaning, so data collection methods tend to involve close human involvement and creative process of theory development rather than testing” (Walliman 2006, p.37). The fundamental features of qualitative research could be listed as follows:

- Unlike quantitative research which relies on positivism, qualitative research provides a naturalistic and interpretative approach to understand the social world (Snape & Spencer 2003; Golafshani 2003). Therefore, interpretivism is commonly considered as “integral” to qualitative tradition (Snape & Spencer 2003, p.7);
- Qualitative research is typically related to generate theory, although it also can be used to test hypotheses (Bryman & Bell 2007);
- Qualitative research can get closer to the social phenomena being studied because it can capture the individual’s point of view using methods such as interviews and observations to collect data such as prose, narratives, first-person accounts, still photographs, histories, biographies and autobiographical materials (Denzin & Lincoln 2005).

To sum up, qualitative research concentrates on securing rich descriptions of data from social words (Denzin & Lincoln 2005). This is highly compatible with the aims of the research reported here. This research is intended to explore the experience in individuals in the working process of software development. Therefore, this research needs to get an in-depth appreciation of the operational processes as well as capture individuals’ opinion and interpret humans’ understandings associated with these processes. Consequently, according to the research questions and objectives stated in Chapter 1, the qualitative paradigm is more appropriate for this research.
3.5 Research Strategies

The research strategy is recognised as a general plan for answering the research questions. Research strategies enable the implementation and fine tuning of original objectives that emerged from the research questions, allow the clear specification of the sources from which it is intended to collect data, provide clear methods for both data collection and analysis, frameworks for the interpretation and generation of theory as well as support reflection on the constraints that pose challenges to the project (Saunders et al. 2003). Therefore, research strategies should be selected carefully from those commonly used strategies in social science: experiment, survey, case study, ethnography, action research, and Grounded Theory.

3.5.1 Experiment

Experiment is a classical form of research in natural science, which clearly derives a number of hypotheses about an independent variable against other dependent variables (Bernard 2011). Therefore, this type of research usually involves the testing the hypothesis of a causal relation between independent and dependent variables (Patzer 1996). In social sciences, this means defining hypotheses, determining actions and expected outcomes and then randomly assign subjects to control and experimental groups (Nunan 1992). Moreover, the data, collected from experiments, is usually quantitative data which is analysed using statistical methods. Saunders et al. (2003) illustrate the typical activities that usually compose an experiment:

- definition of a theoretical hypothesis;
- selection of samples of individuals from known populations;
- allocation of samples to different experimental conditions;
- introduction of planned change on one or more of the variables;
- measurement on a small number of the variables;
This research is intended to develop a theory based on understanding and interpretation of individuals’ experience and opinions. Therefore, experiment is evidently not appropriate for this research.

### 3.5.2 Survey

Survey research is usually rooted in the deductive approach. It investigates a number of group’s attitudes and opinions, and often obtains the data through the form of questionnaire, structured observation and structured interview (Bernard 2011). Frequently, the data collected are standardised, which is easy to examine and compare. Therefore, the research process can be fully controlled by the survey researcher (Saunders et al. 2003). However, low response rates from participants and slow response times tend to be serious problems for this strategy (Krosnick 1999).

It was established that due to the scarcity of literature into this research’s topic it would not be feasible to adopt a deductive approach. Consequently, a survey strategy would not be compatible with the inductive approach selected for this study.

### 3.5.3 Ethnography

Ethnography is typically associated with research that takes an inductive approach. It is particularly used in the field of anthropology and sociology (Del-Rio-Roberts 2010). As defined by Murchison (2010, p.4), ethnography is a scientific research strategy, which “allows researchers to explore and examine the cultures and societies that are a fundamental part of the human experience”. Therefore, ethnographic research usually adopts a cultural lens to develop social patterns by interpreting the human thought and behaviour or specific events in social life (Fetterman 2010). Moreover, this in-depth research strategy usually involves participant observation (Saunders et al. 2003; Sangasubana 2009), which requires the researcher to engage in
the context and interact with the researched as one of their own (Falzon 2009). This type of research is considerably time-consuming and sometimes “spread out over an extended time” (Fetterman 2010, p.39).

This research aims to explore the concept of tacit knowledge associated with experience within the process of software development in Chinese SW organisations. However, despite some professional experience in the sector, the researcher is not a Software/IT professional and it would be impossible to become actively involved in daily working processes. Therefore, an ethnographic research methodology does not seem feasible for this research.

### 3.5.4 Action Research

Instead of describing and explaining the phenomenon, action research explicitly stresses the addressing of practical problems, achieving the solutions, and particularly intervening change from inside (Saunders et al. 2003). It takes a view into the action within the social environments and communities of practice that requires interaction and collaboration between researchers and practitioners (Marshall et al. 2010). However, in action research, while the practitioners are interested in proposing the questions of relevance to their work, and find out the solution (Ospina et al. 2008); it is proposed to contribute a new theory (Whitehead & McNiff 2006). Therefore, it is essential to balance the practical needs (problem-solving in the real social words) and academic research interests (develop new knowledge).

According to the research objectives, this research is intended to identify the professional and personal experience from individuals as result of their professional practice. However, there is no intention that the researcher would initiate any action that would involve changing practitioners’ views or professional practices. Moreover, the researcher is no longer employed by a software organisation in which to conduct the research. Therefore, action research was deemed not suitable for this
research.

### 3.5.5 Case Study

Social sciences have traditionally been closely associated with case study research. This type of approach was used in sociology as early as 1935 (Tellis 1997), which coincided with the movement within sociology to establish it as a credible science. As defined by Merriam (1988, p.9), a case study is “an examination of a specific phenomenon, such as a programme, an event, a process, an institution or a social group”. Robson (2002, p.178) further elaborates on this conceptualisation by stating that a case study is “a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence”. As such, case study research has become a common research strategy which is used to gain in-depth understanding and meaning in the various fields of psychology, sociology, political science, social work, business, and economics (Yin 2003).

Yin (2003, p.13) provides a more technical definition of case study as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident.” According to Yin (2003), the case-study is particularly useful since social phenomenon are not always distinguishable from real life situations and the researchers want to cover contextual conditions that they see as highly pertinent to the study of the phenomenon. That is exactly the case for this research. Tacit knowledge associated with experience in the SW industry sector can only be studied in companies in the sector.

In support of this decision made by the researcher, Benbasat *et al.* (1987), and Dubé and Paré (2003) defend case study research as eminently suitable to study the IT/IS industry. These authors suggest that this type of research is ideal to face the rapid
changes in both technology and business environment that characterise the IT industry, by providing exploratory insights into new emergent topics of research and developing closer and more informed relationships with business and industrial environments (Benbasat et al. 1987). Thus, this type of research approach seems to be ideal for this study from both the conceptual and the application aspects.

However, as recognised by one of the most prominent proponents of case-study approach “the strategies and techniques have not been well defined” to collect and analyse data from case-studies (Yin 2003, p.109). Therefore, the use of case study is often combined with other methodologies such as action research, ethnography or inductive approaches or specific methods of data collection such as surveys, observation or interviews. In the case of this research and since survey, ethnography and action research were already rejected, it was deemed that the best methodological support for a case-study approach would come from an inductive research strategy.

3.5.6 Grounded Theory

Grounded Theory is widely considered as the most frequently used qualitative analysis rooted in the inductive approach (Strauss 1987; Saunders et al. 2003). It was first developed by Glaser and Strauss (1967) (Strauss & Corbin 1998; Birks & Mills 2011), in order “to generate theory through the systematic and simultaneous process of data collection and analysis” (Goulding 2002, p.170). To be more specific, the theory is generated from qualitative data which is collected within particular social contexts and directly from the participants in the phenomenon being studied, without bias of preconceived theoretical frameworks. The data can “lead to the generation of predictions that are then tested in further observations which may confirm, or otherwise, the predictions” (Saunders et al. 2003, p.93). Therefore, it is better to understand Grounded Theory as inductive research that encompasses in its application an evolving combination of induction and deduction, which develops theory with “conceptual density and meaningful variation” (Goulding 2002, p.45).
Importantly and essentially, the focus of Grounded Theory is to generate new theory, not to test the existing one.

Grounded Theory is designed for generating theory where little is known about the particular areas, or which can “provide a fresh slant on existing knowledge” (Goulding 2002, p.42). Moreover, it has been proved and highly recommended as an effective method in IS/IT research, which enables the investigation, analysis and explanation of “the socio-technical issues in software development” (Lings & Lundell 2005, p.197). Therefore, it is appropriate for research that addresses emergent and new issues that have limited cover in the literature review or aspects of more established theories that have been ignored or not addressed in-depth. This is exactly the case of this research study and therefore Grounded Theory was deemed to be a very suitable approach. Additionally, Grounded Theory provides a clear structured process, specific analytic methods and flexible guidelines that provide good support to systematically and intensively collect and analyse data (Charmaz 2006). Therefore, it was deemed to be ideal to complement the use of case-study by providing the necessary methodological support for data collection and analysis.

3.6 Combination of Case Study and Grounded Theory

3.6.1 Characteristics of Case Study Research

Saunders et al. (2003, p.93) claim that case study is particularly suited for generating answers to questions about “why”, “how”, and “what”. Moreover, Eisenhardt (1989) describes different purposes of using qualitative case-study, which include providing description, theory testing, and theory generation. These generic perceptions of case-study have led to several views on how to categorise case study research.

Stake (1995) lists three types of case study: intrinsic, instrumental and collective. The intrinsic case study attempts to evaluate a particular set of actions and activities
Instrumental case study aims to make generalisations. Collective case study extends the aim of generalisation and tries to reach a representation (Cousin 2005). This is a highly controversial classification, since there is general agreement in the social sciences that case-study research findings maybe transferable but not easily generalisable.

On the other hand, Laws and McLeod (2004) provide a much more established and accepted classification of case study research into exploratory, descriptive, and explanatory as well as single and multiple case research design (Table 3.1).

### Table 3.1. Six types of Case Study (Adapted from Laws & McLeod 2004)

<table>
<thead>
<tr>
<th></th>
<th>Single Case Study</th>
<th>Multiple Case Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exploratory</strong></td>
<td>Type 1</td>
<td>Type 2</td>
</tr>
<tr>
<td><strong>Descriptive</strong></td>
<td>Type 3</td>
<td>Type 4</td>
</tr>
<tr>
<td><strong>Explanatory</strong></td>
<td>Type 5</td>
<td>Type 6</td>
</tr>
</tbody>
</table>

Yin (2003, pp.5-11) bases this subdivision on a basic categorisation scheme for the types of questions faced by researchers, namely “who”, “what”, “where”, “how” and “why”. According to Yin (2003, p.5), exploratory case studies are associated with “what” types of questions. The goal for exploratory research is to develop and establish theoretical propositions or hypotheses for further inquiry. In this sense it is particularly appropriate for studies in new areas or where there is little theoretical discussion. On the other hand, an explanatory case study attempts to respond to questions such as “how” and “why”, that is to examine the reasons why and how events happen in real-life practical contexts (Yin 2003, p.5). This type of case study research uses a more traditional science paradigm trying to using cause and effect reasoning (Laws & McLeod 2004). Finally, descriptive case study research, as discussed by Gerring (2004), is associated with descriptive inference rather the causal analysis and aims at illuminating a phenomenon within a real context (Laws &
McLeod 2004). Descriptive case-studies also focus on questions related to “what”, “how” or “why”. However descriptive case-study research asserts a classificatory relationship among aspects of a certain typological relationship that characterizes the phenomenon under investigation, without making any assertions about causal relationships (Gerring 2004).

Since this research focuses on the area of tacit knowledge identification and classification, where there is little research, there are no previous typologies or theoretical propositions to base either causal analysis or descriptive inference. Therefore, this research aims to use case-study as Yin (1994, p. xv) proposes, that is, to use lessons learned from interacting with the socio-technical environment of the selected case to “contribute to the building of new knowledge”. Thus, in order to generate a new theory, and provide an answer to the research questions listed above, the exploratory approach emerged as the more appropriate for this study.

As shown in Table 3.1, case study research has two different types of designs: single and multiple case studies. Single case study designs attempt to use one case to conduct in-depth research. According to Yin (2003, p.45), single case study research is a common design that is eminently justifiable when the case represents:

- a critical test of existing theory;
- a rare or unique circumstance;
- a representative or typical case; or
- when the case serves a revelatory;
- when the case serves a longitudinal purpose.

According to Benbasat et al. (1987), single case study projects are most useful at the outset of theory generation and late in theory testing. Furthermore, these authors suggest that a single case used for exploration may be followed by a multiple-case study. On a first inspection, this research is exactly in that position, that is, at the
outset of new theory and a single in-depth case-study was initially deemed to be very appropriate. However, on closer inspection, it became clear that it would be difficult to obtain the desired “conceptual density and meaningful variation” (Goulding 2002, p.45) from a single case-study. Therefore, a decision for a multi-case study approach was taken.

Multiple cases include two or more related cases in the same research design. This type of design is suitable when the intention of the research is description, cross-case analysis, the extension of theory and generalisation of research results (Benbasat et al. 1987). These types of designs are becoming more prevalent, but they are more expensive and time-consuming to conduct (Yin 2003). Any use of multiple-case designs should follow a replication, not a sampling logic. That is, due to the nature of case-study research, no carefully selected set of case-studies could become a significant or representative sample. Generalisations from such a subset would therefore not be more meaningful than those made from a single case study analysis. Replication as proposed by Yin (2003, p.49) aims at gaining better understandings and explanations while considering each individual case as a “whole study”. These cases treated individually should “serve in a manner similar to multiple experiments, with similar results (a literal replication) or contrasting results (a theoretical replication) predicted explicitly at the outset of the investigation” (Yin 2003, p.53).

To sum up, for the purpose of this research it was decided to adopt a multi-case approach, as proposed by Benbasat et al. (1987), where a first case serves as a pilot study to determine appropriate units of analysis and “familiarize the researcher with the phenomenon in its context”, and subsequent cases provide further insights or contrasts.
3.6.2 Characteristics of Grounded Theory

3.6.2.1 Evolution of Grounded Theory

Grounded Theory was originally presented by the book *The Discovery of Grounded Theory* published by Glaser and Strauss (1967). Strauss had a considerable tradition in qualitative research, whereas Glaser was strongly influenced by quantitative methods (Strauss & Corbin 1998). Based on these different philosophical and sociological traditions, Grounded Theory was derived from the Glaser-Strauss collaboration study of examining the experience of dying in hospitals (Charmaz 2006; Birks & Mills 2011). They proposed a process for conducting inductive and qualitative research framed by clear analytic and systematic guidelines.

Since these early propositions of classic of Grounded Theory presented in 1967, there has been a continuous succession of improvements, additions and re-interpretations of the methodology. However, over the years, Grounded Theory has gradually divided into two main perspectives: a traditional Glaserian and an evolved Straussian (Charmaz 2006; Birks & Mills 2011). The Glaserian approach is Glaser’s original explanation from Grounded Theory, which gives less importance to the rigour of processes to structure of data and advocates the use of creativity and flexibility by the researcher to conceptualise theory (Niekerk & Roode 2009). On the other hand, the Straussian approach is a later perspective in which Strauss, co-working with Corbin, moved towards full description of data constructs and structured prescription of data analysis methods (Strauss & Corbin 1998; Lehmann 2001; Charmaz 2006). According to Fernández (2004), the Glaserian approach focuses on analysing the meaning of unit at sentence level, while the Straussian approach extends to full description which analyses word by word. Moreover, the Glaserian Grounded Theory provides conceptualisation such as theoretical sampling, theoretical coding and theoretical memos, while the Straussian Grounded Theory develops the analytic techniques, strategies and guidelines for using method in practice (Heath & Cowley 2004).
A third thread of Grounded Theory has been presented by sociologist Charmaz, a student of Glaser and Strauss, who claims the researchers “construct our grounded theories through our past and present involvements and interactions with people, perspectives and the research practices” (Charmaz 2006, p.10). This more recent perspective, so-called Charmazian constructivist grounded theory, assumes the live experience of researchers could influence the data collection and analysis in the research process (Charmaz 1995). It proposes to reshape the interaction between researchers and participants, and positions researchers as an author or co-producer of the narratives for which theories are then drawn (Charmaz 1995). However, Glaser (2002) continues to disagree with Charmaz’s by arguing that “joint build of an interactive, interpreted, produced data”, would lead to research bias. Table 3.2 aims to illustrate the main differences among these three perspectives of Grounded Theory.

Table 3.2. Comparison of Glaserian, Straussian and Charmazian Constructivist Grounded Theory
(Developed from Onions 2006, pp.8-9; Skeat & Perry 2008, p.99)

<table>
<thead>
<tr>
<th>Component</th>
<th>Glaserian Grounded Theory</th>
<th>Straussian Grounded Theory</th>
<th>Charmazian Constructivist Grounded Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Paradigm</td>
<td>Postpositivism</td>
<td>Interpretivism</td>
<td>Constructivism</td>
</tr>
<tr>
<td>Grounded Theory Product</td>
<td>Set of well-integrated conceptual hypotheses, organized around a core category, that fits the situation studied and can be used for further research</td>
<td>Verified theory of a phenomenon that allows an understanding and management of the problem</td>
<td>Interpretive theory of understanding of the social and psychological meanings respondents hold of their social worlds</td>
</tr>
<tr>
<td>Research Problems and Questions</td>
<td>General problem area is identified before the study; the actual problem and questions emergent from data</td>
<td>Area of focus and broad research questions are identified before the study suggested by personal experience, literature and/or colleagues. These are refined during data analysis.</td>
<td>The research question was specifically about processes adopted by the participants; this was not a descriptive account of activities.</td>
</tr>
<tr>
<td>Literature Review</td>
<td>Once the core category has emerged, the literature is used as data and incorporated into the theory using constant comparison</td>
<td>Literature is used before the study to suggest sensitizing concepts, and during data analysis to support theory development</td>
<td>Conducting the literature review after developing an independent analysis</td>
</tr>
<tr>
<td>Sampling and Data Collection</td>
<td>Theoretical sampling techniques are used, guided by emergent research questions suggested by concepts and properties discovered in the data. Sampling is of incidents to compare with</td>
<td>Theoretical sampling is used, guided by the emerging theory and analytic questions/hypotheses of researcher. Specific sampling methods (open, relational/variational and discriminate) match coding/analysis phases. Sampling is of incidents,</td>
<td>Theoretical sampling helps the researcher to refine the provisional categories, to develop them as theoretical constructs and to find gaps in the data. This sampling operates as part of an iterative process thereby</td>
</tr>
<tr>
<td>Component</td>
<td>Glaserian Grounded Theory</td>
<td>Straussian Grounded Theory</td>
<td>Charmazian Constructivist Grounded Theory</td>
</tr>
<tr>
<td>-----------</td>
<td>---------------------------</td>
<td>-----------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td></td>
<td>other incidents in emerging theory to develop and saturate categories</td>
<td>events and happenings to develop and saturate categories</td>
<td>the researcher goes back and forth between generating and analysing data. Simultaneous collection and analysis of data.</td>
</tr>
<tr>
<td><strong>Data Analysis</strong></td>
<td>Coding is less rigorous. Two coding phases: simple (fracture the data then conceptually group it) and substantive (open or selective, to produce categories and properties)</td>
<td>Coding is more rigorous and defined by technique. Three coding phases: open (identifying, naming, categorising and describing phenomena), axial (the process of relating codes to each other) and selective (choosing a core category and relating other categories to that).</td>
<td>Coding is flexible. Two coding phases: initial (dealing with fragments of data-words, lines, segments and incidents) and focused coding (selecting the most useful initial codes and testing them against extensive data) (Charmaz 2006, p.42).</td>
</tr>
<tr>
<td><strong>Means of Evaluation</strong></td>
<td>Specific criteria are used to evaluate the theory: fit, work, relevance and modifiability.</td>
<td>Generic qualitative criteria are used (e.g. reproducibility, generalisability), plus seven criteria relating to the research process (e.g. justification for the original sample), and eight criteria relating to the empirical grounding of a study (e.g. conceptual density of categories)</td>
<td>Criteria of evaluation are replaced into reflexivity, credibility, transferability, dependability and conformability (Denzin 2003, p.35).</td>
</tr>
</tbody>
</table>

In terms of this study a Straussian approach was selected. This choice was partly driven by the pragmatic aspect that the PhD candidate was a relatively inexperienced qualitative researcher and would benefit from the more practical guidelines and clearer techniques provided by the research framework proposed by Strauss and Corbin (1994). However, this was not the only aspect in the decision for a Straussian approach; in fact this perspective of Grounded Theory emphasises the interaction of people with their social and socio-technical environments focusing on “perspectives and voice of the people who we study” (Strauss & Corbin 1994, p.274). This is emphasised by Lehmann (2001, p.9) who proposes that the Straussian approach is “people-centric” and particularly useful “for application to case stories, where organisational and political […] phenomena interact with technology issues”. Therefore, this clearly indicates that a Straussian approach is ideally suited for this research both in terms of its research scaffolding framework and its inherent nature.
To sum up, Straussian Grounded Theory was used in this study because:

- Grounded Theory is widely considered as the most frequently used qualitative analysis rooted in the inductive approach (Strauss 1987; Saunders et al. 2003);
- Grounded Theory advocates the theory is generated from qualitative data which is collected within particular social contexts and directly from the participants in the phenomenon being studied, without bias of preconceived theoretical frameworks;
- Grounded Theory has been proved and highly recommended in IS/IT research, which enables the investigation, analysis and explanation of “the socio-technical issues in software development” (Lings & Lundell 2005, p.197);
- Straussian Grounded Theory provides a more structured process, clear and practical guidelines, specific analysis tools (open, axial and selective coding) and specific analytic methods (constant comparison, memoing, theoretical sampling and theoretical saturation) that provide a sound scaffolding for novice inductive researcher and can support the systematic and intensive processes of data collection and analysis.

3.6.2.2 Basic Adaptation of Grounded Theory for this Project

guidelines from Strauss and Corbin’s book (1998) and combine with other practitioners’ understandings and experience of using Grounded Theory (Pace 2004; Rodon & Pastor 2007; Creswell 2013). The next sections define the different concepts used in the research and propose a consistent terminology that is used to operationalise Grounded Theory in the research design and implementation.

Mills et al. (2006, p.28) identified the common characteristics from the different propositions for Grounded Theory which include “theoretical sensitivity, treatment of the literature, coding, diagramming, and identifying the core category”. Pace (2004, p.337) provides his own understand by claiming “data collection and data analysis occurred simultaneously”, and developing Grounded Theory in four stages: “generating categories and their properties; integrating categories and their properties; delimiting the theory; and writing the theory”. Alternatively, Rodon and Pastor (2007) propose their personal experience and practical understanding of applying Grounded Theory in a Straussian approach, which presents the whole research process as follows: entering the field and conducting a literature review; sampling; data collection; data analysis; diagramming; and theoretical matching and generation. However, these different views of Grounded Theory and the different terminologies used “all refer to the same procedure but with different words” (Mansourian 2006, p.390). Therefore, and for the purpose of this research, it was decided to develop a framework which, although initially taken from Strauss and Corbin’s (1998) more theoretical propositions, was also informed by Rodon and Pastor’s (2007) pragmatic research design. This design in practice was found to be particularly relevant since these authors also used a Straussian approach for conducting Grounded Theory in a study in the SW area. The research framework developed encompassed the following generic areas:
• Theoretical Sensitivity and Treatment of Literature;
• Data Collection;
  ➢ Data Collection Methods;
  ➢ Sources of Data from Interview;
• Data Analysis;
  ➢ Coding the Data;
  ➢ Constant Comparison;
  ➢ Memos and Diagrams;
  ➢ Theoretical Sampling;
  ➢ Theoretical Saturation;
• Theory Generation.

The remaining sub-sections under this section will define and discuss these areas and establish a Grounded Theory terminology that is used in the whole of the research.

3.6.2.2.1 Theoretical Sensitivity and Treatment of Literature

Generally, a literature review is undertaken at the beginning of research projects and aims to enhance the awareness and understanding of relevant previous research as well as provide theoretical support in the production and use of theory (Saunders et al. 2003). In Grounded Theory, the purpose of using literature is seen differently, even among the proponents of three main branches, namely the Glaserians, Straussians and Charmazians. The traditional Glaserian theorists claim that “there is a need not to review any of the literature in the substantive area under study [before categories start to emerge]. [...] it is vital to be reading and studying from the outset of the research, but in unrelated fields” (Glaser 1992, pp.31-32). The Charmazian constructivist theorists consider the literature as data that can contribute to the theory creation and generation, and propose a more pragmatic approach by undertaking literature review at various stages during the research (Charmaz 2006). In contrast, Strauss and Corbin (1998, p.45) claim that literature can “stimulate our thinking about properties
or dimensions that we can then use to examine the data in front of us”. However, even though the familiarity of “relevant literature can enhance [theoretical] sensitivity to subtle nuances in data”, it also can “block creativity” of research and make the researcher “steeped”, “constrained”, or even “stifled” (Strauss & Corbin 1998, p.49). Therefore, Straussian theorists advocate no need for reviewing the literature at the start of research, but just for gaining few pre-existing awareness of the research field, research question and main themes. In this sense, the literature review is performed to acquire an initial theoretical sensitivity and not to deduce theories or hypothesis.

3.6.2.2 Data Collection

In Grounded Theory, the researcher is actively involved in the generation of theory through collection and analysis of data in context. Researchers should interact directly with participants by using data collection methods such as interviews or focus groups, and produce the data by looking through notes from fieldwork or memos (Birks & Mills 2011). Therefore, there are different methods of collecting data usually used in Grounded Theory, such as interviews, focus group, observation and document surveys. These may use very different sources of data generation such as interview recording, focus group videos, field notes, and memos.

(1) Data Collection Methods

Methods of data collection represent the process and techniques to gather relevant information that is concerned to the research question and social context where it is studied. In Grounded Theory, the data can be obtained by several different ways, such as observation, document surveys, focus group and interviews.

Observation

Observation requires researchers to collect, interpret and theorise the phenomena being studied through participants’ statements, actions or behaviours (Johnson & Turner 2003). This method involves several activities which include “systematic observation, recording, description, analysis and interpretation of people’s behaviour”
within a natural or structured environment (Saunders et al. 2003, p.221). There are two different types of observation: participant observation and structured observation. Participant observation attempts to discover the meaning of people’s actions, while structured observation is more focused on types and frequency of the actions (Saunders et al. 2003). More specifically, participant observation requires the researcher to actively engage in the social and organisational activities being studied and to directly question informants on their actions, motivations and perceptions. This method provides a chance for the researcher to get “inside” and gain access to some information and evidence (Yin 2003, p.94). In contrast, structured observation is quantitative in nature and aims to represent what type of activities are performed and “how often [these] things happen rather than why they happen” (Saunders et al. 2003, p.231).

This research aims to identify the professional and personal experience from individuals as result of their professional practice. It attempts to explore in-depth appreciation of the operational processes and capture individual’s opinions and perceptions. It is, therefore, qualitative research in nature. Moreover, there is no intention that the researcher would actively be involved in Chinese software professionals’ daily practices or observe the informants in the exercise of their organisational duties and activities. This would be impracticable as the study was mainly undertaken in England in an English University and because the researcher is not a programmer or systems analyst. In fact, despite having worked professionally in the sector as information and marketing consultant, the researcher has a good understanding of the SW design and development process but no expertise in the core and more technical aspects of the industry. This was the same reason that led to discarding the action research and ethnographic approaches. Therefore, observation is not applicable for this research.

**Document Surveys**

Documents contain a variety of forms of explicit data, such as letters, administrative
documents, meeting minutes and newsletters in various media formats. This type of information is used as reference to enhance the evidence of events (Yin 2003). Moreover, such comprehensive surveys are carried out on very large collections of documents, which require access to the organisational repositories, archives and libraries. However, the documents are usually written for different and very specific purposes and reasons and, therefore, are always biased by personal, organisational and even industrial sector agendas. More importantly, this research is intended to identify tacit knowledge from individual professional practices. Therefore, the explicit information represented in documents would not only severely bias the research but yield explicit rather than tacit knowledge. Thus, a document survey was deemed not suitable for this research.

**Focus Groups**

As illustrated by Birks and Mills (2011, p.76), focus groups are the “extension of the standard interview”, which requires more than one participant involved into the discussion. The discussion requires interaction between the participants, with the discussing topic provided by the researchers who take the responsibility as moderators, and the data gathered is the transcription of group discussion and conversion (Morgan 1988). Apparently, the group interaction will explore the research interests and topics based on the discussion and conversion. Therefore, focus groups are more suitable in “exploratory and developmental phases” in a research “where little is known about a somewhat subjective phenomenon” (Rao & Perry 2003, p.239). In Grounded Theory, focus groups are used to collect the different perspectives and broad overviews for concepts generation (Birks & Mills 2011).

Nevertheless, the group interaction requires participants to divulge their personal emotions and thoughts in front of other colleagues, which usually is not very easy in hierarchical organisational environments or strongly collectivist cultures. In any case, if the topic is related to the working experience or business innovation, the participants are usually unwilling to share with others who might be the competitors
Therefore, since this research is aimed at the Chinese SW Industry and within Chinese organisational settings it was deemed that focus groups would not be the best method to identify the tacit knowledge and experience from the individuals. Other researchers have recognised that the strong commitment of individuals to the collective within Chinese society discourages them from speaking their true inner thoughts and feelings (Fiske et al. 1998). This is due to the Confucian, Taoist, Buddhist and Marxist influences within the Chinese culture which affect individual behaviour and individuals’ respectful attitude towards hierarchy and norms of the collective (Bond & Hwang 1986; Eckhardt 2004). Therefore, and since it is tacit knowledge that this research aims at eliciting from participants, it was deemed that focus groups would not be appropriate as a data generation strategy.

Moreover, focus groups advocate that the researchers should act as moderators, who attempt to “structure the participants’ conversational expectations” (Martins & Nunes 2011, p.343), and shape “participants’ preferences, experiences, and disclosed perceptions” (Martins & Nunes 2011, p.342). Therefore, the researcher could be seen to bias and channel the conversation which would be against the pure inductive nature of Grounded Theory.

Interviews

Interviews are sources for interpretive qualitative research (Birks & Mills 2011), which enable the capture of individual interpretations and understandings through direct interaction. As proposed by Patton (2002, p.341), the principle of an interview assumes that “the perspectives of others is meaningful, knowable, and able to be made explicit” and therefore contributes to the understanding of the phenomena in which the informants are directly involved. Therefore, interviewing allows the participants to provide more personal opinions and thoughts. It is also considered as a better approach to collect rich and useful information from participants, when researchers cannot observe the company directly, which is the case with this research.
In terms of this research, interviews seem extremely appropriate as the source that attempts to find out “what is in and on someone else’s mind” (Patton 2002, p.341), that is, tacit knowledge and experience. Furthermore, it enables the capture and gathering of “stories” (Patton 2002, p.341) that help in the understanding and qualifying of interpretations, activities and facts. This study attempts to define and classify individuals’ experience in the process of software development. Thus, the rich information that is usually collected by using interviews seems to be ideal to provide the required evidence to produce rich ontologies that characterise this type of tacit knowledge.

Finally, and reflecting on the cultural problems raised above, related to the strongly hierarchical organisational environments and strongly collectivist culture in the Chinese context, authors such as Zhou and Nunes (2010) propose that the reluctance to express opinions and personal perspectives in public might be minimised in private, confidential, one-to-one interview sessions.

Therefore, it was decided to adopt interviews as the data collection method for this research project.

(2) Sources of Data from Interviews

In the process of data collection for interviews, it is necessary to identify the sources that will be used for the data analysis procedure, and choose the most appropriate combination that best enables a response to the research questions driving the research (Eisenhardt 1989). In Grounded Theory, the data could be gathered from interview recordings and transcripts, field notes, memos and diagrams.

As suggested by Saunders et al. (2003, p.263), there is a need to record an interview “after its occurrence [to] control bias and to produce reliable data for analysis”. This avoids the researchers having to reconstruct the interview from memory, and use their own means to make notes (Lee 2004). The more usual option is to use tape or digital
recording of the interview, which enables accurate and reliable data collection and help the researchers to concentrate on questioning and listening (Saunders et al. 2003). The recorded information needs then to be transcribed to into textual data in order to be analysed, which may require great deal of time (Myers & Newman 2007). These transcripts of the interview can then be easily examined and identified for the emerging themes, and be rigorously coded in the analytic process of data analysis (Goh & Watt 2003).

Moreover, McLellan et al. (2003) highlight that when producing and using interview transcripts, the researcher should consider the content-related information as well as contextual information, such as “elisions, mispronunciations, slang, grammatical errors, nonverbal sounds (e.g., laughs, sighs), and background noises” (McLellan et al. 2003, p.66).

For this specific research it was decided to digitally record the interviews with the participants’ permission and produce the interviews transcripts in a word processor format. It was also considered that for the purpose of Grounded Theory, these transcripts would be the main source of data. No field notes were to be taken as no observation was to take place. The use of memos and diagrams will be discussed as part of the analysis process as in Grounded Theory these are part of analysis techniques such as constant comparison, memoing, theoretical sampling and selective coding.

3.6.2.2.3 Data Analysis

(1) Coding the Data
In Straussian Grounded Theory, data analysis is structured by development of categories. The categories represent “concepts, derived from data that stand for phenomena” (Strauss & Corbin 1998, p.114). Developing categories starts from an open and broad context, selects a core category “that encapsulates and explains the grounded theory as a whole” (Birks & Mills 2011, p.12), then adds the related
categories to “form a theoretical model” (Creswell 2013, p.85), and finally formalises the interaction of categories (Creswell 2013). This generation of categories follows a pattern of coding, which consists of open coding, axial coding, and selective coding.

Open coding represents the “analytic process through which concepts are identified and their properties and dimensions are discovered in data” (Strauss & Corbin 1998, p.101). In the practical application, it is used to break data into fragments, “compare incident with incident, name apparent phenomena or beginning patterns and begin the process of comparison between the codes” identified (Birks & Mills 2011, p.95). Therefore, in this step, early conceptualisations can be identified and categories and sub-categories discovered.

Axial coding follows after open coding and is considered as the “process of relating categories to their subcategories” (Strauss & Corbin 1998, p.123). It attempts to develop and delineate the linkages between categories and subcategories around the axis of a category (Mansourian 2006).

Selective coding is the process of “integrating and refining the theory” (Strauss & Corbin 1998, p.143). In practical application, “the major categories are finally integrated to form a larger theoretical scheme in which the research findings take the form of theory” (Strauss & Corbin, 1998, p.143). Therefore, it is the ultimate step which grounds the basis of the theory.

Daengbuppha et al. (2006) summarise the main features of the three coding process in Figure 3.4. Despite the temptation of seeing this process of open coding, axial coding and selective coding as sequential, Strauss and Corbin (1998) propose a more flexible and free-flowing process, where the coding process is interactive and driven by constant review and evaluation (Daengbuppha et al., 2006).
“Process in data is represented by happenings and events that may or may not occur in continuous forms or sequences. It always can be located in a context. How one conceptualizes or describes process is variable. Although process often is described by analysts as stages or phases, it also can be examined in terms of sequences or shifts in the nature of action/interaction. The choice of form depends on the data and the research question.” (Strauss & Corbin 1998, pp.166-167).

<table>
<thead>
<tr>
<th>Open Coding</th>
<th>Axial Coding</th>
<th>Selective Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aims of the Method</strong></td>
<td><strong>Aims of the Method</strong></td>
<td><strong>Aims of the Method</strong></td>
</tr>
<tr>
<td>To identify discrete concepts, which are the basic unit of grounded theory analysis.</td>
<td>To generate tentative statements of relationships between phenomena.</td>
<td>To integrate and develop the grounded theory.</td>
</tr>
<tr>
<td><strong>Features of Analysis</strong></td>
<td><strong>Features of Analysis</strong></td>
<td><strong>Features of Analysis</strong></td>
</tr>
<tr>
<td>(1) an interview transcript; a sentence, a paragraph, an interview; (2) a field note; an observation</td>
<td>The condition that gives rise to the ‘phenomenon’ and the ‘context’ in which the concept is embedded</td>
<td>Various categories integrated to form ‘grounded theory’.</td>
</tr>
<tr>
<td><strong>Coding Process</strong></td>
<td><strong>Coding Process</strong></td>
<td><strong>Coding Process</strong></td>
</tr>
<tr>
<td>Labelling → Categorising → Dimensionalisation</td>
<td>Relating categories with sub-categories (links at ‘dimensional level’ between concepts in the research situation).</td>
<td>Identify ‘core category’ (central phenomenon) that represents the main theme of the research.</td>
</tr>
<tr>
<td><strong>Analytic Tools</strong></td>
<td><strong>Analytic Tools</strong></td>
<td><strong>Analytic Tools</strong></td>
</tr>
<tr>
<td>‘Fracturing’ (microanalysis) taking data apart and examining the discrete parts for differences and similarities ‘Constant Comparative Method’: method of analysis where incidents are compared in terms of properties and dimensions.</td>
<td>‘Paradigm’: a phenomenon is analysed in terms of its context, conditions and consequences. ‘Condition Relationship Guide’: asking and answering relational questions about the categories to relate structure to process. Contradictions’ between reality and hypotheses to refine the description of categories.</td>
<td>‘Paradigm Model’, ‘Reflective Coding Matrix’: a relational hierarchy for contextualising the core category, which includes ‘properties’, ‘processes’, ‘contexts’, and ‘nodes for understanding the consequences’. The matrix is the contingent relationships established by the Conditional Relationship Guide.</td>
</tr>
</tbody>
</table>

Figure 3.4. The Coding Products in Data Analysis (Daengbuppha et al. 2006, p.376)

(2) **Constant Comparison**

Furthermore, the process of constant comparison is an essential feature of Grounded Theory procedure to identify and develop categories during the process of data analysis (Strauss & Corbin 1998). Corbin and Strauss (1990, p.9) propose that “[Once] an incident is noted, it should be compared against other incidents for similarities and differences. The resulting concepts are labelled as such, and over time,
they are compared and grouped as previously described.” Thus, constant comparison of data is an on-going process (Goulding 2002), which attempts to explore and classify the properties of categories, and therefore to identify the concepts.

According to the propositions from Bowen (2008), constant comparison is used to support four different types of analysis activities:

(1) “comparing incidents applicable to each theme that emerges from the data;
(2) integrating themes and their properties;
(3) delimiting the theory; and
(4) writing the theory” (Bowen 2008, p.139).

Therefore, constant comparison is an important contributor in the generation of theory.

(3) Memos and Diagrams
Memos are generally considered as records of “thoughts, feeling, insights, and ideas” (Birks & Mills 2011, p.40). However, in Grounded Theory memos represent more than “ideas” and instead, they record the process of thought (or doubt) that the researcher engaged in during the formulation of theory resulting from the research process (Corbin & Strauss 1990). Thus, the writing of memos is an essential process of research that helps the researcher remember the conceptualisation of data and may influence the final theory. According on the proposition from Birks and Mills (2011), the process of memoing starts from the planning of research, which involves into the all the phases in the Grounded Theory. However, Corbin and Strauss (1998) argue and claim that memos only contain a specialised records referring to analysis. The language of these memos should be “analytical and conceptual rather than descriptive” (Corbin & Strauss 1998, p.217).
Diagrams on the other hand, are more visual than memos and illustrate the relationships and linkages among the concepts (Corbin & Strauss 1998). The visualisation of a diagram enables the theorists to conceptualise the data in an abstract form (Lempert 2007). Frequently, diagrams and memos are conjoined and used simultaneously. Therefore, writing memos and diagrams were adopted in this research, which helped the researcher to gain analytical distance for the conceptualisation of data.

(4) Theoretical Sampling

The original definition offered by Glaser and Strauss (1967) considers theoretical sampling as:

“the process of data collection for generating theory whereby the analyst jointly collects, codes, and analyzes his data and decides what data to collect next and where to find them, in order to develop his theory as it emerges.” (Glaser & Strauss 1967, p.45)

Based on this definition, sampling is an ongoing process. This represents an important difference between Grounded Theory and more traditional approaches to inductive research and interviewing. Grounded Theory proposes that data collection and analysis are not separate and dissociated processes. That is, it is not expected that the researcher will collect all the data in one process and subsequently analyse all the collected data. Data is collected and analysed and the results of this analysis may direct the data collection process into different directions, e.g. different people or different questions. Furthermore, this means that, contrary to other approaches, the interview script and respective questions may also evolve according to theoretical sampling, that is, it is not a data collection tool created at the start of the project and then used uniformly throughout the collection process. Moreover, the sample can guide the collection of data. The sample is also selected and “redefined by the emerging theory” in the certain level of saturation, and therefore it is “impossible to predict the size of the sample prior to starting the study” (Rodon & Pastor 2007, p.73).
Strauss and Corbin (1998) provide a more practical illustration of theoretical sampling as a:

“Data gathering driven by concepts derived from the evolving theory and based on the concept of “making comparisons”, whose purpose is to go to places, people, or events that will maximize opportunities to discover variation among concepts and to densify categories in terms of their properties and dimensions.” (Strauss & Corbin 1998, p. 201)

The principle of theoretical sampling is therefore purposive, evolutionary and informed by the data analysis. It is expected that it can produce richer, better explained and better understood theories, as well as speed up the analysis and theoretical saturation.

(5) Theoretical Saturation

Theoretical saturation is a consequence of theoretical sampling and data collection (Bowen 2008). As illustrated by Goulding (2002), theoretical saturation “is achieved through staying in the field until no new evidence emerges which can inform or underpin the development of a theoretical point” (Goulding 2002, p.70). Therefore, it is a clear sign to stop theoretical sampling, data collection and data analysis. It also indicates the time for selective coding, conceptualisation of categories and theory building (Strauss & Corbin 1998).

In practical terms, the key points for identifying theoretical saturation are “no new insights are obtained, no new [...] codes] are identified, and no issues arise regarding a category of data” (Bowen 2008, p.140). More specially, Strauss and Corbin (1998) point out the clear indicators when the categories are saturated, such as “(a) no new or relevant data seem to emerge regarding a category, (b) the category is well developed in terms of its properties and dimensions demonstrating variation, and (c) the relationships among categories are well established and validated” (Strauss & Corbin 1998, p.212). Therefore, since the data collection and theoretical sampling are
bound up with theoretical saturation, this research will follow this criterion to guide the processes of sampling, data collection and data analysis.

3.6.2.2.4 Theory Generation

As defined by Strauss and Corbin (1998), theory is “a set of well-developed concepts related through statements of relationship, which together constitute an integrated framework that can be used to explain or predict phenomena” (Strauss & Corbin 1998, p.15). Wacker (1998) lists four essential components of theory: have a definition, have a domain, state the relationships, and make predictions to answer the consequence about “who, what, when, where, how, why, should, could and would” (Wacker 1998, p.364). Therefore, as presented in Section 1.2, in this research the theory building aims at responding to the following questions:

- **Definition:** How can tacit knowledge related to experience within the working practices of the SW industry be identified?
- **Domain:** What constitutes professional and personal experience in the context of the process of SW development? Which components of this experience can be clearly identified so that they can be captured, shared and appropriately managed?
- **Relationships:** What are the relationships between these components of experience?
- **Answers:** How can this experience be explicitly represented in order to support its capture, storage and use in SW companies in China and elsewhere?

Moreover, the process of developing theory is not only to conceive concepts, but also to formulate concepts into “a logical, systematic, and explanatory scheme” (Strauss & Corbin 1998, p.21). Therefore, expression and interpretation of theory building should be carefully designed and presented as follows: ontologies, concept maps and
a theoretical narrative.

(1) Ontologies and Lists of Categories and Concepts
Ontologies are mainly used for abstracting knowledge for a domain of the theory, and explicitly representing the entities and relationships among them (Dolan & Blake 2006, p.21). Moreover, this representation method is used like taxonomy, and widely accepted both by humans and computers (Smith et al. 2006). In this research, an ontology is used to integrate the diverse information resulting from data analysis and represent the various categories and sub-categories.

Furthermore, the lists of categories and concepts are organised to show the specific sub-categories which are indented beneath the core categories (Heflin & Hendler 2000). The lists used in this research are drop-down displays which employ a text-based interface to describe the summary representations and the simple relation between sub-categories and core categories.

(2) Concept and Cognitive Maps
Concept maps are graphic representations that contain several “nodes representing concepts and labelled lines denoting the relation between a pair of nodes” (Ruiz-Primo & Shavelson 1996, p.569). In a concept map, the nodes should bear descriptive text, such as a word or a short sentence, and the relation are using lines to express (Figure 3.5).

![Figure 3.5. Example of a Concept Map (Novak & Canas 2006)](image-url)
Therefore, concept maps can visually and explicitly demonstrate the concepts and relationships between categories and sub-categories.

Another very similar mapping technique is called cognitive maps and it is also graphical representation of several main or central concepts. This technique is used for the “understanding of the images and the words used for the mental representation of a reasoning process and are thus useful in the process of analysing and modelling complex problems characterised by subjective ideas about the reality” (Wilk & Fensterseifer 2003, p.1000). Therefore, the cognitive mapping attempts to look for a cause and explain the causal relation (Hines 2000). An example of using the cognitive map is shown in Figure 3.6.

![Figure 3.6. Example of a Cognitive Map (Wilk & Fensterseifer 2003, p. 1006)]
Consequently, both concept maps and cognitive maps can show the connections between categories, sub-categories and codes identified from the data as result of open and axial coding. In practical terms, these representations are particularly useful to represent the output of axial coding. This research attempts to identify the tacit knowledge related to professional and personal experience from individuals, and express this tacit knowledge into explicit format. However, there was from the start no intention that the researcher would look for the causal and consequence links. Therefore, cognitive maps are not suitable for this research, and concept maps are adapted to demonstrate visually and explicitly the relationships between categories, sub-categories and concepts. Specifically, the concept map portrayed in Figure 3.7 is used in the research.

![Concept Map](image)

**Figure 3.7. Example of Concept Map used in this Research**

(3) Narratives

Narrative researchers aim to “collect stories from individuals […] about individuals’ lived and told experience” (Creswell et al. 2013, p.71). Narrative as a research
approach focuses on “studying one or two individuals, gathering data through the collection of their stories, reporting individual experiences, and chronologically ordering the meaning of those experiences” (Creswell et al. 2013, p.71). Narrative as an analysis method, emphasizes on scrutinizing the construction of different people’s self-accounts (Burck 2005).

When the term “narrative” is used in the context of Grounded Theory research, it usually means a “descriptive narrative about the central phenomenon” of study, and the storyline is the “conceptualisation of this story” (Adams et al. 2008, p.142). Narrative in Grounded Theory is fundamental in explaining the different categories, expressing the rationale behind their definition, explicitly describing their specific properties and characteristics and finally to offer evidence of the grounded nature of the emerging theory. In practical terms, these narratives should explain the categories in plain written form and use explicit quotations from the interview transcripts to qualify and enrich the narrative. Therefore, this research will use this type of descriptive narrative to conceptualise, describe and explain the core categories and respective sub-categories.

3.6.3 Rationale for the Proposed Combination Methods

The previous section explained the choice for an exploratory case-study approach and shared the argument for the selection of a Straussian Grounded Theory approach, as well as describing the main aspects associated with this type of Grounded Theory approach. This section explains how these two types of approaches can be used in combination and provides a basis for a strong research design aiming at a valid and reliable research outcome. The discussion is guided by an analysis of strengths and weaknesses of case study and grounded theory (Table 3.3) and provides an argument for compatibility and complementarity of these two research approaches.
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Case Study Research</th>
<th>Straussian Grounded Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main Objective</strong></td>
<td>Mainly theory building/confirming</td>
<td>Theory building</td>
</tr>
<tr>
<td><strong>Level of Prior Theory Requirement</strong></td>
<td>Medium to high</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Process</strong></td>
<td>Structured and standard procedures;</td>
<td>Rigorous and systematic procedures;</td>
</tr>
<tr>
<td></td>
<td>Practical guideline</td>
<td>Practical guideline</td>
</tr>
<tr>
<td><strong>Content</strong></td>
<td>Somewhat structured</td>
<td>Structured</td>
</tr>
<tr>
<td><strong>Strengths</strong></td>
<td>Replication;</td>
<td>No need for reading pertinent literature;</td>
</tr>
<tr>
<td></td>
<td>Measurable (Eisenhardt 1989);</td>
<td>Encourage to seek variation among concepts and condense categories (Goldkuhl &amp; Cronholm 2003, p.178);</td>
</tr>
<tr>
<td></td>
<td>Empirically valid (Eisenhardt 1989);</td>
<td>Support for yielding rich data, discovering new ideas and relations among categories and properties (Goldkuhl &amp; Cronholm 2003, p.178);</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analytic techniques, strategies and guidelines for using method in practice (Heath &amp; Cowley 2004);</td>
</tr>
<tr>
<td><strong>Weaknesses</strong></td>
<td>Requirement of sufficient prior theory;</td>
<td>A risk for inventing the existing theory;</td>
</tr>
<tr>
<td></td>
<td>Not well-defined strategies and techniques (Yin 2003, p.109)</td>
<td>No focus and too open minded in the phase of data collection (Charmaz 1990, p.1164; Goldkuhl &amp; Cronholm 2003, p.178);</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No explicit support for dealing with the disorder of data (Goldkuhl &amp; Cronholm 2003, p.178);</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Very time-consuming (Cameron &amp; Price 2009, p.423)</td>
</tr>
<tr>
<td><strong>Study in SW/IS Industry</strong></td>
<td>Case study provides the study of IS in a natural setting, learn about the state of the art, and generate theories from practice;</td>
<td>Grounded Theory provides “a focus on contextual and processual elements as well as the action of key players associated with organizational change- elements that are often omitted in IS studies” (Orlikowski 1993, p.310).</td>
</tr>
<tr>
<td></td>
<td>Researcher can understand the nature and complexity of the process taking place;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Valuable insights can be gained into new topics emerging in the rapidly changing IS field (Benbasat et al. 1987, p.370)</td>
<td></td>
</tr>
</tbody>
</table>

In the combination of these two methods and from the analysis in Table 3.3, Straussian Grounded Theory provides analytic techniques, strategies and guidelines for doing research, which can reduce some of the weaknesses of case study in terms of a lack of specific and precise analysis methods. This is an important aspect of complementarity between the two methods, with one offering a suitable and clear organisational context and the other clear and identifiable methods of data collection and analysis.
Furthermore, Yin (1994, p.28) states “theory development prior to the collection of any case study data is an essential step in doing case studies”. However, it was clearly established in the previous literature review in Chapter 2 that there is a lack of research and an insufficient awareness of existing theories about acquisition and use of tacit knowledge related to experience in the software development sector. Therefore, Grounded Theory provides support to do case-study research without an extensive and established prior theoretical proposition. Moreover, in this case there is no risk of re-inventing existing theory that is associated with inductive research.

The organisational borders that delimit any case-study will help minimise some of the weaknesses attributed to Grounded Theory in terms of loss of focus, disorder in data collection and sampling, as well as “too open minded” and inclusive sampling. These borders associated with the organisation structures will also enable the researcher control theoretical sampling and interviewing.

Nonetheless, Glaser (1998) identifies the conflict in the combination of case study and Grounded Theory. Other Grounded Theory researchers recognise the problem and propose that the “utmost care must be exercised to ensure that the canons of case study research do not distort true emergence of theory generation” (Fernández 2004, p.47). Therefore, this research takes the propositions from Fernández (2004, p.47) to heart, which are using Grounded Theory as the main drive, studying the data from multiple-cases, and driving “data acquisition activities within and outside the case study”.

It is also important to note that this combination has been extensively used within the IS research community (e.g. Eisenhardt 1989; Orlikowski 1993; Lehmann 2001; Halaweh et al. 2008). In fact, generating theory grounded from the case study data is generally considered as an appropriate strategy for information technology/information system study. Particularly, Lehmann (2001) highlights that:
“Applying Grounded Theory to Case Study was very successful. It produced a prolific amount and yielded a great richness of information. […] The case settings, furthermore, contained more varied data than could be expected from individual, purely homocentric studies. Efficiency and abundance combined to make this method an exceedingly fruitful one.” (Lehmann 2001, p.87)

Consequently, in this research, an exploratory multiple case study design is utilized driven by Straussian Grounded Theory data analysis methods.

3.7 Summary

This chapter presented and justified the adoption of an inductive and qualitative approach as the overarching strategy for this study. Furthermore the chapter justified the use of Grounded Theory and selected the Straussian approach as the more adequate of the different Grounded Theory schools of thought. The chapter also gives a detailed overview and description of the structure, mechanisms and tools that compose Straussian Grounded Theory and are available to the Grounded Theory researcher. Finally, this chapter offers a justification for the combination of Grounded Theory with an exploratory multiple case study research strategy. The next chapter, describes and discusses how these theoretical constructs were applied in practice through a thorough research design.
Chapter 4. Research Process and Design

Research design aims to provide a framework and structure before data collection and data analysis (De Vaus 2001). A reasonable research design reflects the priority of the research process, and directs researchers to conduct the research for answering the research questions (Bryman & Bell 2007). Based on the discussion and decisions presented in the research methodology chapter (Section 3.2 to 3.6), this section presents the detailed design for this research. This research design section consists of four sub-sections: general research process design, case study design, data collection design, and data analysis design.

4.1 General Research Design

The research design presented and discussed in this chapter is based on an exploratory multiple case studies approach informed by Straussian Grounded Theory data analysis methods methodology as discussed above (Section 3.6.3). Figure 4.1 illustrates this research design developed for this study which consists of: literature review, pilot study, main study, theory proposition and theory reporting.

4.1.1 Literature Review

The first component of this research design is the theoretical sensitisation process through the literature review. This process aimed at obtaining a good sense of theoretical sensitivity so as to be able to design the semi-structured interview scripts and avoid reinventing the wheel, as explained in 3.6.2.2.1, and it focused on reviewing the main theories of knowledge, knowledge management, knowledge sharing and the nature of software. This literature review process attempted to gain a general understanding on the core theoretical concepts of knowledge management and knowledge sharing as well as to obtain an understanding of the structure and main stages related to the software development process.
The literature review process was also extremely useful in showing that there is a clear lack of research in professional and personal experience of individuals in this industry sector. This led to the choice of inductive reasoning and Grounded Theory
as the overarching research methodology. In this sense, the reviews of literature were performed to acquire general awareness and understanding of the existing theories and in doing so to enhance the theoretical sensitivity on the research context. The result and findings of this stage were presented in the previous literature review in Chapter 2.

### 4.1.2 Pilot Study

Traditional pilot studies are usually seen by authors such as van Teijlingen and Hundley (2001) as “mini versions of full-scale study” that aim at “developing and testing adequacy of research instruments; assessing the feasibility of a full-scale study; designing a research protocol; […] collecting preliminary data; assessing the proposed data analysis techniques to uncover potential problems”. This is appropriate for traditional positivist studies when the process of data collection is characterised by uniformity and the data collection tool once established does not change (e.g. questionnaires or traditional interviewing). In Grounded Theory, pilot studies are largely under-reported (Sampson 2004). This is easily explained as in Grounded Theory data collection tools, sample and even scope of analysis may change during the process of research. Therefore, traditional pilot studies might not make much sense in a Grounded Theory project. Nonetheless, pilot studies are used in Grounded Theory to acquire contextual sensitivity as defined by Nunes et al (2010, p.76), that is “to enhance the capacity of ascribing significance to activities, facts, artefacts and decisions as interpreted by the researcher”. As proposed by Nunes et al (2010), this is important when the researcher is inexperienced in the use of Grounded Theory or/and in the context of the research.

Therefore in this research the pilot study aimed at enhancing contextual sensitivity and preparing the researcher in both the use of Grounded Theory and understanding of the Chinese software sector. The pilot study was not only used for testing interview scripts, interviewing techniques and the adequacy of research instruments
but also to obtain a better understanding of the professional environment and types of experiential tacit knowledge in the Chinese software industry.

Finally, there is a major difference in the way data from the pilot study in this case was integrated in the study when compared to traditional positivist pilot studies. In the latter, data acquired from pilot study is discarded and not used in theory testing or generation. Here, data obtained in the pilot represents the actual start of theory emergence and generation. It was not discarded and in fact represented the start for the main study’s theory generation.

4.1.3 Main Study

The main study used the results of the pilot study to further identify the professional and personal experience of software developing teams using two additional software companies in China (presented in Section 4.2.2). The study started from the outcomes of data analysis of the pilot study and subsequent theoretical sampling and further explores, explains and qualifies emergent concepts and categories. According to the decision in Section 3.6.1, a multiple case studies approach was adopted to obtain in-depth information with “conceptual density and meaningful variation” (Goulding 2002, p.45). This approach works in a “manner similar to multiple experiments” (Yin 2003, p.53). The difference is that in this study the researcher decided to combine it with Grounded Theory and that the number of case-studies used was linked and determined by theoretical sampling and saturation (see 3.6.2.2.3). That is the main study was only completed once theoretical saturation was achieved, i.e. once no new codes or relevant diversity of perspectives was being achieved by the process of interviewing and analysis. The number of case-studies and interviews at each company depended on the point in time of the research when theoretical saturation was achieved in that company. As discussed below, in this research, one pilot case study and two main cases were considered necessary to achieve theoretical saturation.
4.1.4 Theory Proposition and Reporting

At the end of the main study a full ontology of tacit knowledge associated with experience in the SW industry in China was produced, a set of concept maps was developed illustrating the relationships between these different tacit knowledge concepts and respective integrating categories and a full narrative was produced describing and explaining the ontology and concept maps. This final narrative includes evidence from the data and is fully illustrated and qualified by rich quotations from the data. Quotations have a dual function of grounding the narrative to the context of Chinese SW development and to provide clear evidence to support the theoretical propositions being made. Therefore ultimately it is the narrative that represents the final Theory Proposition emerging from this thesis.

Finally, Theory Reporting is an integral component of any research project. For a PhD project this usually includes the writing of a thesis as well as the presentation of the findings and theoretical propositions at a national and international conference and in academic refereed journals. Conference contributions occurred at the end of the literature review (ICDIM Conference 2012\(^1\)) and when results started emerging and categories became saturated (ECKM Conference 2014\(^2\)). A journal contribution was only possible as theoretical propositions become firmer at the end of the research process and are in progress at the date of writing this thesis.

4.2 Case Studies

As Hartley (2004) points out, the selection of case(s) should fit the criteria for the research. Therefore, the fieldwork was conducted in the SW sector in China using

---


three types of companies that are representative of the fabric of the sector (See Table 4.1), namely a small and medium-sized enterprise (SME), a large private company and a state-owned enterprise (SOE). The SME was used in the pilot study, the remaining two in the main study.

Table 4.1. The Summary of Three Case Studies

<table>
<thead>
<tr>
<th>Ownership</th>
<th>Baiduchuan Co., Ltd.</th>
<th>Yirong Info Co., Ltd.</th>
<th>Bosi Software Co., Ltd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMEs</td>
<td>State-owned and state-controlled company</td>
<td>Exclusively specialised on electronic archives systems</td>
<td></td>
</tr>
<tr>
<td>Business Products</td>
<td>Multimedia software</td>
<td>Information system only for electric power industry</td>
<td></td>
</tr>
<tr>
<td>Customers</td>
<td>Mainly hardware vendors</td>
<td>Chinese National State Grid Group</td>
<td></td>
</tr>
<tr>
<td>Customer Location</td>
<td>Xiamen, Mainland China</td>
<td>26 provinces of Mainland China</td>
<td>Mainland China</td>
</tr>
<tr>
<td>Interviewing Group</td>
<td>Whole company (6 out of 12)</td>
<td>The electronic records and archives management SW team (13 out of 400)</td>
<td>Whole company (25 out of 120)</td>
</tr>
<tr>
<td>Participants Location</td>
<td>Mainly in-house (Xiamen)</td>
<td>Mainly in-house (headquarter in Beijing); Selected customers’ workplace (Beijing and Shanghai).</td>
<td></td>
</tr>
</tbody>
</table>

4.2.1 Pilot Study Company

Baiduchuan Information Technology Co., Ltd. was the SME selected as the pilot study that aimed to enable the researcher to acquire both experience of Grounded Theory and context sensitivity in the SW business context. Baiduchuan is a multimedia software research and development company, founded in September 2010 in Xiamen City (Fujian Province, South of China). The business scope includes multimedia software for PC/TV, Android system application software, Android application operations, and navigation applications for smart handheld devices. These products can be implemented in Tablet PCs, computers, TV computers and car computers, and are mainly used for home entertainment, business use, hotels, and karaoke clubs. Baiduchuan has also a special relationship as the multimedia software supplier for the Malata Group, which is the largest hardware manufacturing company in Xiamen and has nearly 20 thousands employees. Baiduchuan has 12 employees, but by the time of the interviewing (August 2012), the company had a
number of empty positions waiting to be filled by the Summer break. More information on this company can be accessed from the company’s website (Baiduchuan 2012).

There were two reasons for choosing this Xiamenese Company as a pilot study. Firstly, the company is a privately owned and that meant the researcher could get easier access guaranteed than in state owned companies which have a heavier hierarchical structure and pose more barriers. Secondly, the company is a rather small SME which was ideal for the researcher to find a diversity of roles that concentrated on a fewer number of interviewees in a simpler business environment.

4.2.2 Main Study Companies

After the pilot study, the subsequent cases were selected to have a similar context, but also to provide further insights or contrasts as determined by a good theoretical sampling practice. Therefore, the fieldwork was still conducted in the SW sector in China, but with two other slightly different SW companies, namely a state owned and a large private company. This was expected to yield a rich variety of possible contexts in the SW sector.

4.2.2.1 Yirong Info Co., Ltd.

Yirong Info Co., Ltd. was founded in 2002 and is an innovative enterprise fully owned and controlled by Great Power Science and Technology Co., Ltd (GPST) (SGCC 2002), which in turn is part of the State Grid Electric Power Research Institute (GPRI) (See Figure 4.2), which belongs to the State Grid Corporation of China, a 1.5 million employee corporation (SGCC 2002). The mission of Yirong Info is to provide IT support services and build the national grid information for State Grid of China.
Yirong Info has two main headquarters, one in Fuzhou Software Park and a second in Beijing. The company is divided into the three main business areas of: unstructured business (diverse SW applications for general purpose), power monitoring and control operations, and business intelligence. In particular, the unstructured business section contains different departments such as content management systems, electronic document management systems, electronic document security transmission systems and knowledge management systems. As a state-controlled company, the products and service of Yirong Info are exclusively provided to the companies within State Grid Group, which are located in 26 Provincial Power Companies and the hundreds units and sub-division under these provincial companies. Further details and more information on Yirong can be obtained from their web pages provided under the GPRI corporate pages (GPRI 2005).

Yirong Info has more than 400 employees, who are either located in-house in the two cities mentioned above or in any of the customers sites where work is being undertaken. To answer the research questions, this research chose one SW project department as the main interview setting. The department selected has 20 people,
who mainly develop and implement electronic records and archive management software for the whole group of State Grid. Therefore, this department contains all the activities involved in SW development and is ideal for purpose of this research.

4.2.2.2 Bosi Software Co., Ltd.

Bosi was established in 2006 in Beijing (the capital of China), specialising in the design and development of archival SW and operated exclusively as an outsourcing company for projects managed by UNIS Software Systems Co., Ltd. (UNIS 2015). In fact, all of the Bosi’s top and middle management used to work for UNIS. This very large company, whose annual business is value 30 billion yuan, operates in several areas of SW, such as MES (Manufacturing Execution Systems), EPOD (Enterprise Platform On Demand)-Application Middleware On-demand Configuration, 2D GIS (Geographic Information Systems), 3D Visualization of GIS software, E-Government systems, comprehensive video systems, contingency control systems, information identification systems, e-learning information platforms, and E-Archives management systems. Bosi’s business is scoped in this last area of SW and mainly consists of developing and constructing electronic archives systems as well as providing the professional consulting for digitalisation of archives management. Customers can be found in a wide range of sectors, such as electricity, communications, energy, finance, insurance and other large group of enterprises and institutions all over the mainland China (around 10 provinces). It is worth mentioning that two of the company’s projects on behalf of UNIS (Digital Archives Management for the Jiangsu Electric Power Enterprise and the Information Management Platform of State Grid Corporation) have been rewarded as best operational systems by the National Archives Department of China.

Bosi has 120 employees, of whom 90% have a first degree in computer science, and 25% have a second degree in an IT/IS discipline from the best universities of China (computer science in Tsinghua University or IS in Beijing University of Aeronautics
and Astronautics). In January 2014, Bosi merged into UNIS, to become one part of their “Electronic Records and Archives Department” (Electronic Records and Archives Department 2015), after the researcher finished the research interviews.

Bosi undertakes the whole of the SW development process and was therefore considered to be ideal for this research. It was decided to take Bosi as the last case-study since it was guaranteed by its CEO that the researcher would be allowed to interact with any relevant departments and their size is such that it would provide a very large pool of informants and potentially allow for theoretical saturation to happen. In this sense, Bosi provided a good insurance that theoretical saturation could be achieved and the study could be completed within the time limitations of a PhD programme.

4.2.3 Negotiating Access and Fieldwork Setting

Obtaining access to the case-study sites is one of the crucial issues that can determine the final success of research projects (Denscombe 2007). The authority of access can directly impact the suitability of sources, and availability of data (Saunders et al. 2003). Furthermore, Bryman and Bell (2007, p.469) claim it normally is “a lengthy process” to negotiate the entry into a social setting and maintain this access in the setting of a case. Therefore, Hartley (2004, p.327) and Bryman and Bell (2007, p.469) suggest that using professional contacts in “friendship circles can be helpful”. All of the cases presented above resulted from professional contacts of the researcher, acquired over a number of years of work in Beijing in this sector.

Establishing trust and gaining access to companies for research purposes can be particularly difficult in the Chinese context (Zhou & Nunes 2010). In fact, in Chinese society, the social networks or instrumental ties are based on guanxi (Bian 2001). Guanxi provides security, trust and a prescribed role for the individuals in networks or broader social structures in China (Hammond & Glenn 2004) and is a
critical factor in order to gain access into Chinese firms (Ramasamy et al. 2006). As developed by Bian (2001, p. 278), *guanxi* are “no longer limited to family and pseudofamilies, but also include a broad range of social and work-related connections”. This was the case for this research as securing access from extended familial relationships was deemed unrealistic (the parents and close family of the researcher have not only all retired, but they all worked on the oil sector in China and have no connection with the SW industry). All contact and negotiations with the companies above emerged from the researcher’s own social, university and work-related connections.

### 4.3 Procedures of Data Collection

As discussed and decided in Section 3.6.2.2.2, semi-structured interviews are the preferred data collection method. This section focuses on what Creswell (2013) proposes as the data collection process, which mainly includes the following activities:

- Decide on the research questions;
- Identify interviewees;
- Determine what type of interview;
- Use adequate recording procedures;
- Design and use an interview protocol, or interview guide;
- Refine the interview questions and the procedures further through pilot studying;
- Determine the place for conducting the interviews;
- After arriving at the interview site, obtain consent from the interviewee to participate in the study;
- During the interview, use good interview procedures.

Some of these steps have already been discussed and described (e.g. the research
questions have been presented in Chapter 1) and some steps were executed as part of the development of the research process itself and as result of Grounded Theory principles such as theoretical sampling (i.e. refining interview questions and purposeful sampling of interviewees results from the progress in understanding and explanation of categories and is therefore occurs along with the analysis process). Therefore, this section discusses the data collection procedures on different sequence which includes interview type, interviews design, and pre-testing interviews.

**4.3.1 Interview Process**

This research aims at exploring the tacit knowledge associated with experience in the process of SW development. Therefore, suitable interviewees were identified as people who are related to development of SW in the three different case-study sites. Moreover, the principle of theoretical sampling in Grounded Theory attempts to guide researchers “where to go to obtain the data necessary to further the development of the evolving theory” (Strauss and Corbin, 1998, p. 201). Therefore, interview participants were identified that were Senior Managers, Project Managers, Programmers, Analysts, Designers, Testers and SW Installation Experts. These titles tend to be loosely attributed to people depending on the size, nature and culture of different companies. Therefore, it was decided to have only one version of the interview script which does not differentiate between different working groups.

The interview was conducted in the context of Chinese companies, and all the participants are native Chinese language speakers, who can understand or speak very little English (except some specific universal IT terms). However, the research is presented in English, especially the theoretical sensitivity which is based on a literature review of mainly English language international sources. Moreover, the research results are being presented in English. As suggested by Kvale (2007), the design of interview script should be developed using two lists of questions: “one with the project’s main research questions in academic language, and another with the
research questions translated into the vernacular as questions to be posed during the interview” (Kvale 2007, p.65). Therefore, all questions on the script presented in Appendix 5, were originally developed in English and then translated into Chinese. The English questions were to remind the researcher of the initial purpose for each question. The Chinese translations were used to interact with informants during the interview. The “information sheet” and “consent form” were also written initially in English and then translated into Chinese. Since the researcher is both proficient in English and a native Chinese language speaker, the translations were done by the researcher herself.

4.3.2 Interview Type

Generally, interviews are categorised into three different types: structured, unstructured, and semi-structured interviews (Saunders et al. 2003).

- Structured interviews are highly formalised using “questionnaires based on a predetermined and standardised or identical set of questions” (Saunders et al. 2003, p.246). The participants are asked to respond to the same questions in exactly the same order (Bryman & Bell 2007). This technique is typically used in survey research and, therefore, is deemed not suitable for this research.
- Unstructured interviews are undertaken only with “a list of topics or issues” (Bryman & Bell 2007, p.213), and with “no predetermined list of questions” (Saunders et al. 2003, p.247). The phrases and sequences of questioning are informal, and sometimes will vary based on the interviewee’s perceptions (Bryman & Bell 2007). In this sense, this technique requires the interviewer have a clear understanding about the research aspects and orientation of exploration aspects. In this research, the selected method of Grounded Theory is designed for generating theory where little is known about the particular areas. Therefore, unstructured interviews were not suitable for this research.
• Semi-structured interviews are guided by “a list of themes and questions”, which can vary depending on the flow of conversation (Saunders et al. 2003, p.246). Moreover, additional questions may also emerge that help to explore the research objectives during the interviewing. Therefore, in semi-structured interviews, “the interviewer is prepared to be flexible […] allowing interviewees to speak their minds of discovering things about complex issues” (Denscombe 1998, p.113). This type of interview is based on open-ended questions, which enable the researcher to focus on the significant questions and to elicit substantial perspectives, opinions and ideas from the interviewees. This is exactly the objective of this research and thus semi-structured interviews were selected.

With the emergence of information and communication technology (ICT), there is an increasing trend to conduct interviews via telephone, video links and the Internet. It is useful when researchers “do not have direct access” to the research case site (Creswell 2013, p.164). In addition to the long-distance access, the advantages are also related to the lower cost of the process and higher speed of access (Sturges & Hanrahan 2004; Saunders et al. 2003; Bryman & Bell 2007). However, the traditional face-to-face interview is still the most widely used. The face-to-face interviewer is able to establish a better personal contact and trust with participants, which is important and helpful to explore the responses in the qualitative research (Saunders et al. 2003). Therefore, this research employed exclusively face-to-face interviews with a semi-structured format.

4.3.3 Interview Design

Millar, Crute and Hargie (1992) present three phases of the process for interviewing, which was summarised from a number of theories proposed in the literature. These three phases are: the opening phase, the body of interview, and the closing phase. Therefore an interview script needs to be designed to support these phases.
The opening phase is considered as “relationship-establishing phase” (Millar et al. 1992, p.106), which comprises the introductory information about the research and research objectives. Additionally, the other factors, such as the indication of time needs and results from interview used in the research, also need clearly explained before doing the interview (Kvale 2007). Importantly, ethics issues like confidentiality, anonymity, and the recording of interview, should be outlined in this phase (Millar et al. 1992). Moreover, in order to guarantee the permission of participants, Creswell (2013) claims it is better to have the interviewee complete a consent form at the beginning.

For the purpose of this research, a “research information sheet” was designed that contained 12 items explaining the purpose of the research, the reasons for the interviews, the way and place of conducting the interview, and ethics consideration in the research. This “research information sheet” is attached in Appendix 3. It was translated to Chinese and used at the start of every interview in both the pilot study and main study. Five minutes were given to the participants to read and understand the research and confirm their decision to continue with the interview. This process proved successful and was well received by participants. Furthermore, a “consent form”, which is attached in Appendix 4, was used for participants to sign a record their agreement with the research process.

The opening stage for this research consisted of ten minutes of reading the information sheet and signing the consent form and an early engagement with the informant through three initial ice-breaker questions (Part A of the interview script as shown in Appendix 5).

Furthermore, as discussed in Section 3.6.2.2.2, this research used digital voice recording of the interview conversation, which enabled accurate and reliable data collection and at the same time freed the researcher to concentrate on questioning,
listening and redirecting during the interviewing process. However, it may “inhibit some interviewee responses and reduce reliability” (Saunders et al. 2003, p.264). Therefore, during the opening stage, permission was always asked in advance to record the interview. The need for the recording device was explained in the research information sheet but was reiterated by the researcher by stating that:

“Your interview will be digitally recorded with your permission. After the interview, the recording will be transcribed into Word documents and fully anonymised, as any reference to participants’ identity will be eliminated. Additionally, all information disclosed in the interview process will remain strictly confidential. Would you like to proceed?”

Moreover, in order to help the participants ease the discomfort caused by the digital recorder and encourage them to talk, during the entire interview, the researcher tried to be “be respectful and courteous” as proposed by Creswell (2013, p.166) and tried to be “a good listener rather than a frequent speaker” as proposed by the same author and advocated by good practice of Grounded Theory.

The body of the interview represents the core stage for gathering information to the research (Millar et al. 1992). In this stage, the interview question script is considered as a useful guideline for the researcher to lead and control the interaction with the informant and guarantee the collection of relevant and meaningful information to develop the theory (Kvale 2007). For the purpose of this research a number of related open-ended questions were designed to form the core of the semi-structured interview script. For each question that was main formulation as well as a number of follow-up and triggering questions which attempted to guarantee rich and in-depth responses from participants as illustrated in Figure 4.3. Moreover, for each main question, a blank space was designed to allow the interviewer to take notes of any non-resolved answers or new emerging, themes, ideas, opinions, expanding thoughts and potential issues, etc (Figure 4.3). This space was not
designed to record informants’ answers, as all interviews were digitally voice recorded and any manual recording would just be redundant. Therefore, this space was created to help manage and direct the interview during the process. The interview script, including all the questions used for the pilot study, is in Appendix 5.

2. How long have you been a practitioner in this field?

Main Question

Follow-up Questions

Blank Space for Annotations by the Interviewer.

Figure 4.3. An Example of Interview Script Design

Questions four to seven were derived from the literature review and aimed at exploring general understanding of experience and tacit knowledge. Question 8 was the core and comprised eight subsections which represent the SW development processes and resulted from the literature review undertaken in Chapter 1 (See Figure 4.4). These questions were designed to acquire responses about experience concerning the specific stages of SW development identified in Section 2.4.2, starting from the Planning and Managing Phase, Capturing Requirements Phase, Designing Phase, Programming Phase, Testing Phase, Installing and Delivering Phase, Maintenance Phase, and to the last phase Evaluating and Improving Products, Processes and Resources.
The final two questions (Question 9 and 10) tried to lead the informants to summarize their general opinion on the importance of experience in the SW industry and highlight the importance of studying these issues. Finally, the closing phase of the interview is very critical for the researcher to make a lasting impression (Millar et al. 1992). Millar and Tracey (2009, p.94) highlight that “to achieve an effective closure, the ending should be viewed as a stage rather than an event”. Therefore, this stage was built into the interview guide, and concluded with a phrase such as: “Your input has been very helpful, and thank you again for your participation.”

4.3.4 Pre-Testing Interview

Kvale (2007) claims a good interview question should be assessed “with respect to both a thematic and a dynamic dimension” (Kvale 2007, p.57). The thematic criteria mean the contribution of producing knowledge, while the dynamic dimension relates to the interpersonal relationship with participants in the interview (Kvale 2007). However, these criteria are rather vague, so the researcher tried to find more precise ways to test the initial interview script and found it in the propositions of Wilkie et al. (2005), who presents three instruments to pre-test semi-structured interview questions, namely face validity, responder burden and content validity. Face validity evaluates participants’ comprehension and interpretation of questions as well as participants’ opinion of the relevance and acceptability of the questions (Wilkie et al. 2005). Responder burden is examined by the time and difficulties to answer the questions (Haberman & Bush 2012). Content validity considers the extent the questions cover...
the entirety of the research questions and objectives (Hatcher & Colton 2007). All of these testing instruments are considered and used in social science research, for instance face validity was applied in behaviour analysis research (Kazdin 1977); responder burden was considered in socioeconomic status research (Somi et al. 2007); and content validity was used to test data collection in SMEs research (Sireci 1998).

Therefore, after the first draft of the interview script was produced and prior to starting the actual interviewing process, the researcher undertook two different tests one with the English version and a much more thorough second one with the Chinese version, since this is the one that would be used in conducting the actual interviews. The initial set of interview questions were designed by the researcher, who lacked at the time the experience in producing this type of data collection tool and at the same time had only limited experience of working in the field of SW (circa 2 years after obtaining her MSc in a private company in Beijing).

Thus, the original English questions were designed to be validated by the supervisors and then colleague PhD researchers and one IS academic. This resulted in the realisation that the number of questions proposed was far too large and there was the need to merge them. The sequence was not ideal and there was a need for some ice-breaker questions to support the opening stage of the interview to enhance face validity and ensure acceptance and involvement of the participants. Additionally, there was a need to redefine the terminology that sounded far too theoretical and academic to be well accepted by a practitioner in the field, in order to reduce responder burden. Otherwise, the set of questions proposed seem to present good content validity and cover all the required aspects of the SW development process.
Table 4.2. An Example of Pre-testing Interview Questions Treatment

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face Validity</td>
<td>The understanding and acceptability of questions</td>
<td>What kind of skills and experience make you think that you are suitable for your job? (use of information and experience, constructed patterns of programming techniques and strategy, etc.)</td>
</tr>
<tr>
<td></td>
<td>What kind of skills and experience make you think that you are suitable for your job? (use of information and experience, constructed patterns of programming techniques and strategy, etc.)</td>
<td>What kind of skills and experience make you think that you are suitable for your job? (use of information and experience, constructed patterns of programming techniques and strategy, etc.)</td>
</tr>
<tr>
<td>Responder Burden</td>
<td>The difficulties with answering the questions</td>
<td>Question not easily understood without a comparison in relation to others that do the same job. Cultural conflict.</td>
</tr>
<tr>
<td></td>
<td>What kind of skills and experience make you think that you are suitable for your job? (use of information and experience, constructed patterns of programming techniques and strategy, etc.)</td>
<td>What kind of skills and experience make you think that you are suitable for your job? (use of information and experience, constructed patterns of programming techniques and strategy, etc.)</td>
</tr>
<tr>
<td></td>
<td>Question not easily understood without a comparison in relation to others that do the same job. Cultural conflict.</td>
<td>Comparison to others added.</td>
</tr>
<tr>
<td>Content Validity</td>
<td>Programming stage</td>
<td>Adequate</td>
</tr>
</tbody>
</table>

The improved version was then translated to Chinese. This translation of interview questions into Chinese was deemed to bring potential risks, such as ambiguity of terminology or gap between terminology used and individual understanding of it. Therefore, the translated Chinese questions were pre-tested by Chinese IT/IS practitioners, in Beijing from the Bosi SW Co., Ltd. presented in Section 4.2.2.2. The test was done question by question (see Table 4.2 for an example) and holistically. More than half of the questions required adjustments similar to those shown in Table 4.2. However, it was found that the translated interview script was adequate in terms of content validity and face validity.
4.4 Procedures of Data Analysis

Once rich and reliable data is gathered from selected cases, the data analysis presents a critical role for the development of theory in qualitative research. This research employed an exploratory multiple case study design informed by Straussian Grounded Theory data analysis methods. Therefore, the whole stages of data analysis were developed in Figure 4.5.

![Diagram showing the process of conducting Grounded Theory in the study]

Figure 4.5. The Process of Conducting Grounded Theory in this Study

Generally, the typical analysis procedure comprises “preparing and organizing the data for analysis, […] reducing the data into themes through a process of coding and condensing the codes, and finally representing the data” (Creswell 2013, p.180). The central stages of analysis are “coding the data, […] combining the codes into broader categories or themes, and displaying the making comparisons” (Creswell 2013, p.180). In this research, the design and application of Grounded Theory data analysis was presented and discussed following a pattern of coding, which comprised open coding, axial coding, and selective coding.
The coding process is central for the Grounded Theory data analysis which requires a researcher to “read and reread the data to draw from the text the key areas of concern” (Cameron & Price 2009, p.417). Moreover, in a Grounded Theory approach, the coding process “involves constant comparison between the text being coded and previously considered text and codes to see how the coder’s current view of the text is informed by what they did previously” (Cameron & Price 2009, pp.417-419). Therefore, it is helpful to keep memos on rationales and insights related to the codes. As discussed in Section 3.6.2.2.3, there are three types of coding processes used by Grounded Theory, which are open coding, axial coding and selective coding. However, there is a significant difference between theoretical understanding on how to code and the practice of effectively and efficiently coding a transcript (Bazeley 2007). Therefore, this section discusses the application of the Grounded Theory coding processes from a practical application perspective.

4.4.1 Open Coding

Open coding is the initial step in the data analysis which draws out from the text and labels “the key issues within the data” (Cameron & Price 2009, p.417). It is more than just labelling, it is also formulating a theoretical language which describes the meanings from participants (Gibbs 2002; Cameron & Price 2009). Since a research question for this study is to identify the tacit knowledge related to experience within the working practice in the Chinese SW industry, the codes identify activities described by participants, where they perceive experience as an important factor in their performance. These codes were drawn out from the interview transcripts and qualified through examples, justifications and story-telling by the participants. A recording tool illustrated in Table 4.3, was used to support coding, content comparison and memoing. Table 4.3 illustrates with two examples how codes were identified, labelled, and recorded. Appendix 6 shows the entire findings for the pilot. This table continued to be expanded until theoretical saturation was achieved in the main
Moreover, each quotation was assigned a unique identifier:

“I + Interview Number. Page Number. Line Number. Participant’s Role in the Company”.

This unique identifier allowed the researcher to anonymise the participants, but be able to refer back to the participant’s interview transcription. For instance, the first quotation shown in Table 4.3 was identified as “I1.2.35.PM”, which shows that the quotation was adopted from line 35, page 2 in the primary document of first interviewee’s transcription. And “PM” means the interviewee is the project manager in the company. In any future reporting or publication of the findings, these will remain the identifiers of any quotations used. This will enable full anonymization, making it impossible for the researcher to track any quotation published to the individual that stated it in the interviews.

### 4.4.2 Axial Coding

Axial coding is the following step of the open coding, which aims to “look for
relationships between the codes, for areas that are connected, for concerns that seem to be linked.” (Cameron & Price 2009, p.419). It is a process that tries to associate and relate concepts represented by the codes into group concepts and into identifiable categories.

Table 4.4. The Presentation of Emerging Categories and Sub-categories

<table>
<thead>
<tr>
<th>Codes (Activities where experience determines use or acquisition of knowledge)</th>
<th>Sub-Categories (Level 3)</th>
<th>Sub-Categories (Level 2)</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimation of Time for Others</td>
<td>Task Estimation and Scheduling</td>
<td>Management of Projects</td>
<td>Working in Projects</td>
</tr>
<tr>
<td>Task Scheduling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding of Suitable Project Management SW</td>
<td>Ability of Dividing Labour</td>
<td>Task Assignment</td>
<td></td>
</tr>
<tr>
<td>Task Assignment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fostering a Sense of Growing Together</td>
<td>Management of Teams</td>
<td>Management of Project Teams</td>
<td></td>
</tr>
<tr>
<td>Management of Teams</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value-added of Developing Sharing Habits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value-added of Sharing Different Working Practices</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awareness of Benefits of Knowledge Sharing</td>
<td>Knowledge Sharing</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In this research, the axial coding process consisted of grouping related ability, skills or experiences associated working practices in the SW Industry. Table 4.4 illustrates how this process was performed after the interview. Codes were associated into categories, and related categories were then grouped into overarching categories. This process was recorded formally by expanding the initial tool presented in the previous section and Table 4.3. Table 4.5 illustrates how categories, subcategories and links to other categories were recorded. Links were recorded in the Memo column.
Finally, axial coding was also represented diagrammatically by using concept maps in order to enhance holistic understanding of the different categories visually. As illustrated in Figure 4.6, the full set of concept maps that represent the axial coding carried out is presented in Appendix 7. This recording tool as well as their corresponding concept maps evolved and were expanded all throughout the study as theory continued to emerge, being characterised and explained.

![Figure 4.6. An Example of a Concept Map](image-url)
4.4.3 Selective Coding

Selective coding is the step to “draw together the categories and the relationships between them to produce” the results from research (Cameron & Price 2009, p.422). It is the process to identify the core category that could tie other categories together, and also integrate the categories that contribute to the theory. This final coding process, discussed in Section 6.2.2, produced Working in Projects as the core category..

4.4.4 Constant Comparison

Constant comparison in the stage of open coding consisted of comparing any emergent concept with existing codes in the attempt to identify if it fits within identified codes and categories. Any concept that did not fit was deemed to be a new code and registered in the tool as shown in Figure 4.3.

<table>
<thead>
<tr>
<th>Codes (Activities where experience determines use or acquisition of knowledge)</th>
<th>Quotation</th>
<th>Translation</th>
<th>Memo</th>
<th>SW Stages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimation of Time for Others</td>
<td>“在分配任务之前，我自己心里已经有了底，包括上限和下限值，毕竟自己已经做了这么多年的开发，东西大概要多久时间，还是可以估摸出来的。” (I1.2.35.PM)</td>
<td>“After assigning the tasks, in my own heart [meaning after careful reflection], I have set the bottom line of time for each task, including the upper and lower limits. Since I have done SW developing so many years, I could figure out how much time is needed for the tasks.” (I1.3.1.PM)</td>
<td>Here “heart” means “careful thinking in mind”.</td>
<td>Planning and managing project</td>
</tr>
<tr>
<td></td>
<td>“基本上，是先分配任务，分配完任务，就是具体时间就是让具体的某个人去评估，然后看一个评估有没有太大出入。” (I1.2.26.PM)</td>
<td>“Basically, the first thing is to assign task. After that each individual give a required time for their own task. Then I will assess if there is some much difference from my expectation.”(I1.2.26.PM)</td>
<td>Planning and managing project</td>
<td></td>
</tr>
<tr>
<td></td>
<td>“就是说，这种项目，你的一个工期大概有多长，时间这个自己心里有个底。” (I5.2.43.M)</td>
<td>“It means you will have an estimation of the time for this project. How long will it take? You could have a bottom line in your heart.” (I5.2.43.M)</td>
<td>Here “heart” means from serious thinking by mind.</td>
<td>Planning and managing project</td>
</tr>
<tr>
<td>Ability of Estimating Individuals</td>
<td>“通常一个项目下来，我们会拆成几个小块，拆成小块之后，我会根据项目的情况，包括个人的一个水平，然后稍微分配一下任务。” (I1.2.32.PM)</td>
<td>“Usually, we will break down a project into several small pieces of tasks. After that, I will assign tasks to the person, according to the situation of the project, including the different abilities of individuals.” (I1.2.32.PM)</td>
<td>Planning and managing project</td>
<td></td>
</tr>
</tbody>
</table>
For instance, the quotations shown in Table 4.6 of 1.2.35.PM, I1.2.26.PM and I5.2.43.M, were deemed to all be represented by “Estimation of Other’s Code” and therefore were registered as representative quotations that code. On the other hand, the quotation from I1.2.32.PM was deemed to represent a different concept and therefore represented by a new code labelled as “Estimation of Individual Abilities”. This process was repeated for every emerging quotation that could indicate a new code. This is one of the reasons why Grounded Theory analysis is so time consuming and to a certain extent very repetitive. However, this is also one of the reasons why Grounded Theory produces such good emerging theories as an inductive approach.

Constant comparison in the stage of axial coding consisted in verifying if each code may fit in an already identified category or sub-category. This aimed to identify the new structures for non-related codes and organize them into new categories.

Both types of comparison were used in this research as described above until theoretical saturation was achieved. In fact, constant comparison was the key to determine this saturation point, which was achieved when, after a number of successive interviews and all alternatives for theoretical sampling were exhausted, no more new codes were generated.

4.4.5 Memoing

Memoing in this research was used to record the researcher’s observations during the course of the analysis. This was recorded in the tool under the column “Memo” as illustrated in Table 4.7. For instance in the same illustration, this column is used to explain the term “rice” in Chinese culture, which emerged in the quotation I4.10.27.M. “Rice” here and as used by the participant means the individual’s ability and skill that allow him to be successful. Another use of the Memo column emerged from the quotation from I1.7.17.PM that was coded as “Holistic Understanding of Project”,

124
however this quotation could also fit under another code (“Leadership/Management of Teams/Understanding of Project Nature”). This was therefore recorded as it shows the connection and interaction between these two codes and the categories under which they were grouped, that is they were deemed to be candidates for the creation of a new category or for axial coding relating these two categories. Decisions concerning any of these alternatives could only be taken once the categories slowly became better formed and explained.

### Table 4.7. An Example for the Use of Memo

<table>
<thead>
<tr>
<th>Codes</th>
<th>Quotation</th>
<th>Translation</th>
<th>Memo</th>
<th>SW Stages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self Estimation of Ability and Interests</td>
<td>“(...) 就自己，自己能吃几碗饭，很清楚。恩，人要有自知之明。” (I4.10.27.M)</td>
<td>“[...] For myself, I am so clear about how many rice I can eat. So people should have clear assessment of themselves.” (I4.10.27.M)</td>
<td>“Rice” is also the Chinese culture use for ability.</td>
<td>Programming</td>
</tr>
<tr>
<td>Holistic Understanding of Project</td>
<td>“(...) 有必要对项目有清晰全面的了解。全面很关键, 因为你要是对项目进行管控, 关键点会影响比较大。” (I1.7.17.PM)</td>
<td>“[...] It is necessary to have a clear and comprehensive understanding of the project. Comprehensive understanding is critical, because if you have to control the project, the key points will have large impact.”(I1.7.17.PM)</td>
<td>Also Management of Project Team/Management of Teams/Understanding of Project Nature</td>
<td>Planning and managing project</td>
</tr>
</tbody>
</table>

### 4.5 Ethical Considerations

Ethics is defined as “individual’s personal beliefs regarding what is right and wrong or good and bad” (Davidson & Griffin 2000, p. 114). Therefore, social research, which involves “collecting data from people, and about people”, should be examined by rigorous ethical considerations (Punch 2005, p.276). Generally, there are four ethical precautions involving social research which are suggested by Diener and Crandall (1978), and especially well illustrated by Bryman (2012). The four ethical precautions are classified as harm to participant, lack of informed consent, invasion of privacy, and deception (Bryman 2012). Moreover, Cameron and Price (2009) particularly highlight the importance of ethical issues when using the interview for the data collection, which concerns “honesty, confidentiality and non-abuse of power” (Cameron & Price 2009, p.388).
This research followed the policies and guidelines established by the Ethical Approvals (Human Participants) Sub-Committee (Loughborough University 2015). The researcher was particularly careful in following guidelines proposed by the “Code of Practice on Investigations Involving Human Participants” issued by that committee (Loughborough University 2015). Specifically, this research adhered the following procedures to make sure of ethical approval:

- **Ethical Clearance Checklist**: Using this checklist as a guide, the researcher sought and obtained approval from the University Ethical Advisory Committee (ERC). This was done during the first year study, and has been attached to the first year report.

- **Research Information Sheet**: In order to ensure the participants are fully informed as discussed in Section 4.3, the purpose and process of research needs to be explained before starting the interview, and as well as “the ways in which data will be recorded and […] how it will be used” (Cameron & Price 2009, p.388). Other necessary aspects also need to be provided in the information sheet, such like the possible risks and inconveniences that may arise during the interview, the potential benefits for the researcher and participants themselves, confidentiality of individual information, use of digital recorder, etc.

- **Participant Consent**: This was also discussed in Section 4.3. The informed, voluntary and signed consent of the participants was sought from participants before the interview.

- **Data Protection Act and Confidentiality**: There is an obligation to protect the participants from the harm and invasion of privacy. After the interviewing, the digital recording was transcribed into text. The digital recording and interview transcript were both kept strictly confidential and in a secure place. Any use of quotations was and will be protected by the mechanisms discussed in Section 4.4.1.
In addition, the interviews were conducted off campus in China. Based on the guidelines from “Guidance Notes for Investigators Conducting Interviews Off-Campus and Working Alone” (Loughborough University 2015), the researcher undertook careful preparation in order to reduce any risks to herself or the participants and assure the safety of the process. Moreover, and as part of this preparation and safety assurance, while in China, the researcher maintained weekly contact with supervisors.

4.6 Summary

This chapter described, in detail, the research design developed for this study using a combination of exploratory multi-case study approach with Grounded Theory. Furthermore, the this chapter described in detail how all the procedures and tools of a Straussian Grounded Theory approach were used in this study and presented all the supporting tools used by the researcher to ensure that coding, constant comparison and memoing were recorded as well as rigorously and systematically done.
Chapter 5. Research Findings

5.1 Introduction

Figure 5.1. Concept Map for Core Category and Main Categories
The purpose of this chapter is to present the analysis of the qualitative data collected according to the research design presented in Chapter 4. This data was collected using face-to-face semi-structured interviews undertaken during the periods of August 2012 (pilot study) and April to June 2013 (main study). Since the method used is Grounded Theory, the research findings are presented and discussed in terms of the main categories that compose the emergent core category of “Professional Areas that Require Experience” as shown in Figure 5.1 (The concept map with full codes is presented in Appendix 7).

Each of these categories is presented in separate sections and includes specific activities where experience results from the use or acquisition of knowledge in the process of SW development. Six main categories were identified, which are directly related to distinguishable types of activities and make use of specific tacit knowledge associated with experience, namely: Understanding the Nature of Experience, Communication, Individual Development, Knowledge Sharing, Working in Projects and Professional Attitudes. Before the in-depth discussion of categories, the chapter describes and summarises the results which emerged from two research stages: the pilot study and the main study.

5.2 The Evolution of Research Findings

Before the presentation of the six main categories identified, it is important to show the progress of the theory generation and present a summary of the emerging results from each of research stages defined in the research design in Chapter 4, namely the pilot study and the main study.
5.2.1 Preliminary Findings from Pilot Study

5.2.1.1 Introduction of the Pilot Study

As explained in Chapter 4, the pilot study in this research had the main aim of enhancing the researcher’s contextual sensitivity and understanding of the Chinese SW sector. It was also used to prepare the researcher in both interviewing and the use of Grounded Theory. The case-study used in this first stage was described in detail in Section 4.2.1. The data collection employed the semi-structured interview script shown in Appendix 5, following the strategy shown in Section 4.3. The structure of the interview script was designed following the generic SW development activities identified in the literature review and discussed in Section 4.3.3. Overall, six interviewees out of 12 possible candidates were purposively sampled and selected to be interviewed from the SME that was selected to be the pilot study company. These participants were two Senior Managers, two Developers, one Project Manager, and one Content Manager (See Figure 5.2).

![Figure 5.2. Interview Strategy of Pilot Study (Baiduchuan)](image-url)
Interviews were conducted in Mandarin Chinese and generally ranged from 100 to 120 minutes in length. All interviews were recorded using a digital recorder with the permission of the participants. Digital recordings were transcribed into Word files after the completion of each interview. The interview transcripts were manually analysed (see illustration in Figure 5.3) according to the procedure described and discussed in Section 4.4. The decision not to use specialised SW to support the analysis (such as NVivo, ATLAS.ti) was based on the principle that, at this early stage, it was better to gain familiarity with the data analysis process before running the risk of being influenced or even driven by the features of the software.

5.2.1.2 Summary of Preliminary Findings

5.2.1.2.1 Numbers of Emerging Codes and Categories

After completing the open coding of the six interview transcripts, the researcher obtained 121 codes and 215 quotations from the interview data. These codes were grouped and organized into a category hierarchy that included 6 main structured categories and 35 sub-categories that resulted from the axial coding. The emergence of these new open codes and new sub-categories is illustrated in Figure 5.4.
As shown in Figure 5.4, each of the interview’s data analysis resulted in the identification of new codes and new categories. This meant that the concepts that form the theory kept emerging as the theory itself was being continuously developed. However, the graph in Figure 5.4 reveals that in interview 6, no new sub-categories emerged, but there were still a good number of new codes identified. This meant that, as expected, no theoretical saturation had been achieved but that the categories that define the theory were now becoming well established, and the explanation of these by the identification of new codes was still growing. Since no theoretical saturation had been achieved, it was still necessary to carry out a more thorough and focused research in the main study. Moreover, theoretical sampling was planned so that a greater diversity of perceptions was added to the study. In order to do so the researcher tried to identify additional potential types of participants, such as human resource experts, shareholders or even sales managers.
5.2.1.2.2 Description of Preliminary Emerging Codes and Categories

After open and axial coding for the pilot study, a list of emerging main categories, sub-categories and codes was established and is presented in Appendix 6. These categories formed the base and point of departure for the main study. However, as expected with deeper understanding of the emergent theory and deeper insights emerging from main study, many of the sub-categories and codes have changed significantly in the final theory. Many codes and sub-categories were labelled differently, were changed from one subcategory to another or were merged with other codes. However, the main categories remain stable. Appendix 6 shows that, as the result of the data analysis of the pilot, the 6 main categories that still form the core of the theory presented in this thesis had been already identified as shown in the concept map in Figure 5.5.

![Figure 5.5. Concept Map for Main Categories](image-url)
5.2.2 Findings from Main Study

5.2.2.1 Introduction of the Main Study

In order to continue exploration of individuals’ experiences following the findings which emerged from the pilot study, the main study was conducted in similar contexts, but since the categories seemed to be already stabilising, it was deemed by the researcher that other types of SW companies were required in order to allow more diversity of informants and contexts. For this purpose two different types of SW companies in China were sought, namely a stated-owned enterprise (SOE) and a large private company. These main study case-studies were described in Section 4.2.2. This combination of private SME, private large company and SOE covers the full scope of companies that characterise the Chinese business fabric and are expected to allow richness and as much variability as possible in the responses this study’s research questions. Additionally, as required by a Straussian approach to Grounded Theory, a theoretical sampling strategy was also adopted to inform the researcher “where to go to obtain the data necessary to further the development of the evolving theory” (Strauss & Corbin 1998, p. 201). This meant, as indicated in the reflection of the pilot studies above the inclusion of a more diversified type of informant, as shown in Figure 5.6 and Figure 5.7, namely Managers, Project Managers, Programmers, Installation Experts, Human Resource Managers, and so on.

![Figure 5.6. Interview Strategy of SOE (Yirong)](image-url)
This theoretical sampling strategy led to inclusion of 13 interview participants in the SOE and 25 interview participants in the large private company. The overall demographic profile, including the participants from both pilot and main study, is illustrated in Table 5.1. It is important to refer that due to the size of the two companies in the main study and their National penetration, the researcher had to travel to different cities in China as shown in Table 5.1.

Table 5.1. Demographic Profile of Participants

<table>
<thead>
<tr>
<th>Interview Location</th>
<th>SME (Baidu chuan)</th>
<th>SOE (Yirong)</th>
<th>Large Private Company (Bosi)</th>
<th>Total per Professional Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Xiamen</td>
<td>Beijing</td>
<td>Shanghai</td>
<td>Beijing</td>
</tr>
<tr>
<td>Share Holder</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manager/Vice Manager</td>
<td>2</td>
<td>1</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Project Managers</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Developer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Programmers</td>
<td>2</td>
<td>6</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Testers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installation Experts</td>
<td></td>
<td></td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content Manager</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sales</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human Resource</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Per Company</td>
<td>6</td>
<td>13</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As required by Grounded Theory, data analysis was conducted in parallel with the data collection, aiming at developing understanding of the theory as it emerged and an effective process of theoretical sampling. After each interview, the data was briefly analysed by using open coding and axial coding. The results from initial analysis enabled a better use of the interview script. Some questions were used less, some others were given greater emphasis and some were not used anymore, such as the last two in the interview script presented in Appendix 5. This approach also enabled the researcher to make better informed choices of who should be approached for the next interview according to the direction of the emergent theory development. The data collection was stopped when the theoretical saturation was perceived to have been achieved, i.e. when no new open codes emerged from the interviews (see explanation in Section 5.2.2.3.1). However, the data analysis conducted in the research field was not rigorous enough, so another round of detailed and in-depth data analysis was undertaken after completion of data collection and the researchers’ return from China.

5.2.2.2 Data Analysis Process and Software Used in the Main Study

Computer-assisted qualitative data analysis software is a type of SW well established in facilitating the analysis of qualitative data (Lewins & Silver 2007). As similar types of SW for quantitative statistical treatment of data, computer-assisted qualitative data analysis software offers a quick and easier way to handle and analyse rich qualitative data, and present reliable and general pictures (Lewins & Silver 2007). Therefore, due to the volume of data produced during the main study, the researcher took the decision to adopt computer-assisted qualitative data analysis software to enable data management, analysis and representation for this research. NVivo was chosen over other software packages, primarily because it is compatible with Grounded Theory and provides specialist tools designed to support the processes of coding, grouping codes into categories and representation of these in terms of concept maps (Ozkan 2004). NVivo is an updated version and improved application from the earlier NUD*IST and has been used widely by qualitative researchers for a
number of years (Welsh 2002). The usefulness and effectiveness of NVivo has been asserted widely in terms of increasing the “speed and flexibility in coding, retrieving, and linking the data” (Ozkan 2004, p.591).

Table 5.2. Number of Transcriptions

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Job Title</th>
<th>Identifier</th>
<th>Duration (h:m:s)</th>
<th>Number of Transcribed Words</th>
<th>Number of New Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>SME (Baiduchua n)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interview 1</td>
<td>Project Manager</td>
<td>PM</td>
<td>2:01:01</td>
<td>15,930</td>
<td>37</td>
</tr>
<tr>
<td>Interview 2</td>
<td>Product Manager and Designer</td>
<td>D</td>
<td>1:20:03</td>
<td>12,154</td>
<td>18</td>
</tr>
<tr>
<td>Interview 3</td>
<td>Web Editor /Content Manager</td>
<td>D</td>
<td>1:29:20</td>
<td>15,098</td>
<td>8</td>
</tr>
<tr>
<td>Interview 4</td>
<td>Vice Manager</td>
<td>M</td>
<td>1:11:43</td>
<td>16,008</td>
<td>10</td>
</tr>
<tr>
<td>Interview 5</td>
<td>Vice Manager</td>
<td>M</td>
<td>1:16:00</td>
<td>14,628</td>
<td>11</td>
</tr>
<tr>
<td>Interview 6</td>
<td>Developer</td>
<td>D</td>
<td>1:14:46</td>
<td>13,568</td>
<td>7</td>
</tr>
<tr>
<td>SOE (YiRong )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interview 7</td>
<td>Installation Expert</td>
<td>D</td>
<td>1:03:19</td>
<td>13,112</td>
<td>10</td>
</tr>
<tr>
<td>Interview 8</td>
<td>Installation Expert</td>
<td>D</td>
<td>0:37:22</td>
<td>7,530</td>
<td>9</td>
</tr>
<tr>
<td>Interview 9</td>
<td>Installation Expert</td>
<td>D</td>
<td>0:46:45</td>
<td>8,902</td>
<td>7</td>
</tr>
<tr>
<td>Interview 10</td>
<td>Installation Expert-Team Leader</td>
<td>PM</td>
<td>1:07:45</td>
<td>12,716</td>
<td>9</td>
</tr>
<tr>
<td>Interview 11</td>
<td>Project Manager</td>
<td>PM</td>
<td>1:23:28</td>
<td>13,470</td>
<td>13</td>
</tr>
<tr>
<td>Interview 12</td>
<td>Senior R&amp;D Engineer</td>
<td>D</td>
<td>0:47:49</td>
<td>10,257</td>
<td>6</td>
</tr>
<tr>
<td>Interview 13</td>
<td>Technical Supporter</td>
<td>D</td>
<td>1:03:07</td>
<td>10,330</td>
<td>10</td>
</tr>
<tr>
<td>Interview 14</td>
<td>Senior R&amp;D Engineer</td>
<td>D</td>
<td>0:25:09</td>
<td>5,411</td>
<td>1</td>
</tr>
<tr>
<td>Interview 15</td>
<td>R&amp;D Engineer</td>
<td>D</td>
<td>0:22:19</td>
<td>4,858</td>
<td>1</td>
</tr>
<tr>
<td>Interview 16</td>
<td>SW Engineer</td>
<td>D</td>
<td>0:18:57</td>
<td>3,280</td>
<td>3</td>
</tr>
<tr>
<td>Interview 17</td>
<td>Java Developer (F)</td>
<td>D</td>
<td>0:30:31</td>
<td>6,097</td>
<td>3</td>
</tr>
<tr>
<td>Interview 18</td>
<td>R &amp; D Manager</td>
<td>PM</td>
<td>0:27:51</td>
<td>4,594</td>
<td>1</td>
</tr>
<tr>
<td>Interview 19</td>
<td>Department Manager</td>
<td>M</td>
<td>1:05:56</td>
<td>14,429</td>
<td>6</td>
</tr>
<tr>
<td>Large Private (Bosi)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interview 20</td>
<td>Installation Expert (F)</td>
<td>D</td>
<td>1:05:50</td>
<td>16,702</td>
<td>7</td>
</tr>
<tr>
<td>Interview 21</td>
<td>Installation Expert</td>
<td>D</td>
<td>1:04:53</td>
<td>8,878</td>
<td>2</td>
</tr>
<tr>
<td>Interview 22</td>
<td>Installation Expert</td>
<td>D</td>
<td>0:23:23</td>
<td>3,249</td>
<td>0</td>
</tr>
<tr>
<td>Interview 23</td>
<td>Installation Expert-Team Manager</td>
<td>PM</td>
<td>1:51:37</td>
<td>18,459</td>
<td>9</td>
</tr>
<tr>
<td>Interview 24</td>
<td>Installation Expert</td>
<td>D</td>
<td>1:19:53</td>
<td>17,793</td>
<td>4</td>
</tr>
<tr>
<td>Interview 25</td>
<td>SG Project Department Manager</td>
<td>M</td>
<td>2:09:15</td>
<td>30,989</td>
<td>13</td>
</tr>
<tr>
<td>Interview 26</td>
<td>Development Manager</td>
<td>PM</td>
<td>1:34:42</td>
<td>18,231</td>
<td>6</td>
</tr>
<tr>
<td>Interview 27</td>
<td>Installation Manager</td>
<td>PM</td>
<td>1:52:52</td>
<td>23,029</td>
<td>1</td>
</tr>
<tr>
<td>Interview 28</td>
<td>Installation Manager</td>
<td>PM</td>
<td>1:14:29</td>
<td>16,410</td>
<td>7</td>
</tr>
<tr>
<td>Interview 29</td>
<td>R&amp;D Developer</td>
<td>D</td>
<td>0:31:17</td>
<td>6,061</td>
<td>0</td>
</tr>
<tr>
<td>Interview 30</td>
<td>R&amp;D Team Leader (F)</td>
<td>D</td>
<td>1:05:25</td>
<td>10,986</td>
<td>0</td>
</tr>
<tr>
<td>Interview 31</td>
<td>SW Programmer</td>
<td>D</td>
<td>0:43:54</td>
<td>7,917</td>
<td>1</td>
</tr>
<tr>
<td>Interview 32</td>
<td>Development Manager-Team Leader</td>
<td>PM</td>
<td>1:06:18</td>
<td>14,276</td>
<td>1</td>
</tr>
<tr>
<td>Interview 33</td>
<td>Installation Experts</td>
<td>D</td>
<td>1:04:32</td>
<td>10,184</td>
<td>0</td>
</tr>
<tr>
<td>Interview 34</td>
<td>Development Manager</td>
<td>PM</td>
<td>1:24:36</td>
<td>13,722</td>
<td>0</td>
</tr>
<tr>
<td>Interview 35</td>
<td>Programmer</td>
<td>D</td>
<td>1:09:29</td>
<td>12,102</td>
<td>0</td>
</tr>
<tr>
<td>Interview 36</td>
<td>Developer</td>
<td>D</td>
<td>0:37:14</td>
<td>6,420</td>
<td>0</td>
</tr>
<tr>
<td>Interview 37</td>
<td>Java Development Engineer</td>
<td>D</td>
<td>0:31:36</td>
<td>5,327</td>
<td>1</td>
</tr>
<tr>
<td>Interview 38</td>
<td>Tester (F)</td>
<td>T</td>
<td>1:04:46</td>
<td>10,753</td>
<td>1</td>
</tr>
<tr>
<td>Interview 39</td>
<td>Product Department Manager</td>
<td>M</td>
<td>1:15:26</td>
<td>14,245</td>
<td>0</td>
</tr>
<tr>
<td>Interview 40</td>
<td>Installation Expert</td>
<td>D</td>
<td>1:15:59</td>
<td>11,256</td>
<td>0</td>
</tr>
<tr>
<td>Interview 41</td>
<td>Development Manager-Team Leader</td>
<td>PM</td>
<td>1:28:49</td>
<td>12,378</td>
<td>0</td>
</tr>
<tr>
<td>Interview 42</td>
<td>Owner/Share Holder</td>
<td>SH</td>
<td>1:16:55</td>
<td>12,867</td>
<td>0</td>
</tr>
<tr>
<td>Interview 43</td>
<td>Sales Manager</td>
<td>S</td>
<td>0:35:30</td>
<td>7,093</td>
<td>0</td>
</tr>
<tr>
<td>Interview 44</td>
<td>Human Resources (F)</td>
<td>HR</td>
<td>0:04:10</td>
<td>890</td>
<td>0</td>
</tr>
</tbody>
</table>

Theory Generation 218
Since the “design of NVivo was strongly influenced by grounded theory” (Gibbs 2002, p.165), the NVivo software became a natural platform for the researcher to examine the emerging open codes, categories, and sub-categories. Before the in-depth data analysis, the digital recordings were transcribed word by word into Word files. Table 5.2 shows the number words transcribed for each interview. These files were then imported to NVivo for analysis. In fact, NVivo was extremely useful in enabling the researcher to read, retrieve, analysis and manage the data from the interview transcripts (see illustration in Figure 5.8). NVivo was also used to conduct the open coding and group the codes into a hierarchical category structure that formed the ontology to be proposed (see Figure 5.9).

Figure 5.8. A Screenshot of NVivo Platform
Additionally, an Excel tool was used to support constant comparison and memoing, namely the list of Codes and Representative Quotations as illustrated in Table 5.3. The full table is not included in this thesis as it comprised of more than 180 pages.

Since Mandarin is both the language of the interviews and the mother tongue of the researcher, transcripts were analysed in Mandarin but labelled in English, as illustrated in Table 5.3. All relevant quotations were also translated to English so that they could be used in the production of the theoretical narrative.

**Table 5.3. Example of Presentation of Emerging Codes and Representative Quotations**

<table>
<thead>
<tr>
<th>Project Management</th>
<th>Task Assignment</th>
<th>Extraction of Individuals’ Attitudes</th>
<th>Observation</th>
<th>SW Developing Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Planning and managing project</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Planning and managing project</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Planning and managing project</td>
</tr>
</tbody>
</table>

Figure 5.9. A Screenshot of NVivo Hierarchical Codes Structure
5.2.2.3 Summary of Emerging Results

5.2.2.3.1 Numbers of Emerging Codes and Categories

As stated above, the data analysis process was stopped once theoretical saturation was achieved, that is when no new open codes emerged from the data analysis, all categories were well developed, and relationships among the categories were validated. The data analysis obtained a total of 218 different codes and 797 representative quotations. These codes were grouped and organized into a category hierarchy that includes 6 main categories and 31 sub-categories. The emergence of new open codes and the achievement of theoretical saturation are illustrated in Figure 5.10.

![Emerging Codes and Sub-Categories](image)

**Figure 5.10.** Emerging Codes, Sub-categories and Theoretical Saturation

As shown in Figure 5.10, despite an early stabilisation of the categories (around interview 28), new codes kept emerging until much later in the data collection process (interview 38). After interview 38 no new codes emerged but the researcher continued with the interviewing process in order to make sure that theoretical saturation had been achieved. This was done to avoid phenomena such as the one encountered after the 32nd interview. In fact, although no new open codes emerged
between the 34rd to 36th interviews, new codes were identified in the 37th and 38th interviews due to the use of theoretical sampling and selective coding. These new codes indicated new perspectives that had not been explored (namely by the first professional tester interviewed and specialist programmer) and revealed that theoretical saturation had not yet been achieved. Theoretical saturation was considered to be achieved at the 38st interview, but the process was continued until the 44th interview in order to obtain a better degree of certainty. Importantly, the theoretical sampling was used to identify additional different perceptions that could add to the emergent theory, such as a Share Holder (I.42), a Sales Manager (I43) and a Human Resource Manager (I44). However, despite these efforts to diversify the scope of informants, no new codes emerged that were relevant to the research questions guiding this study.

5.2.2.3.2 Description of Emerging Codes and Categories

A list of the identified main categories, sub-categories and codes is presented Appendix 8. Although not significant in terms of the final theory, Appendix 8 also indicates which new codes and sub-categories have emerged during the main study. These new codes and new sub-categories are marked with “◎”.

Appendix 8 clearly shows that the main study brought significant findings to the development of theoretical proposition of this thesis. This enabled the development of Appendix 8 which also forms the basis for the ontology of activities that require tacit knowledge associated with experience in the SW industry in China. Theory and ontology are illustrated by the concept map presented on Figure 5.1. The remainder of this chapter now presents each of the categories separately based on the deconstruction of the concept map in Figure 5.1 into detailed category concept maps that qualify each category in terms of the different tacit knowledge codes.
5.3 Understanding the Nature of Experience

As shown in Figure 5.11, before illustrating and discussing the professional areas identified in this research that requires experience, it is essential to define the understanding of experience associated with tacit knowledge from the perspective of SW practitioners and professionals. The experience “gained from working practice and routine work” (I11.14.3.PM) was seen by interviewees as “very important” (I11.14.6.PM), because “once you have experience, you can quickly find out the solutions when you deal with very difficult issues” (I11.14.6.PM). For instance, one of the developers illustrated the influence of experience:
“Yes, the experience is possibly intangible, but sometimes it can affect you. For example, humans are like dough, if the environment gives a punch, it will be deformed. I think humans are the same. This experience and knowledge affects you. The knowledge you learn from others can also affect you. It is very invisible. [...] especially when new problems arise, then it affects the quality of your work … and also your own experience will be enlarged.” (I20.17.22.D)

Other interviewees claimed that the experience gained from practice is very different from the knowledge that is written explicitly in textbooks, as one of the project managers stressed:

“In fact, the textbooks also contain a lot information of empirical knowledge. I think, although there is such knowledge introduced by books, it is not necessarily appropriate to be immediately used in our work practice. Because of the actual situation and its continuous changing nature, it is very unlikely that it will be the same as what the books contain.” (I26.19.10.PM)

“The circumstance in reality is different from books, in particular, the working style and people in the state-owned enterprises (SOE). Even though the circumstance is the same as the books describe, there is still a big gap between book information and real life situations… [thinks for a while] Yes … Therefore, the better way is to combine personal experience and theoretical knowledge to find the best solutions for our problems in real life.” (I26.19.13.PM)

Most interviewees considered the experience to be an individual’s asset. The accumulation of experience from working practice was seen to be the only way to achieve “personal development and career planning” (I25.27.37.M), as explained by one of the developers:
“In my opinion, experience from these years’ of work would help me to achieve success in my personal career. My own knowledge will accumulate in my own mind. For example, the knowledge I gained from Shanghai [Shanghai Electric Power], I also can make use of in Zhejiang, even in the company headquarters. Therefore, once the knowledge becomes mine, it will slowly transform my capabilities. After several years, this knowledge will become spontaneous, and would not been forgotten.” (I8.3.15.D)

Some other developers gave very clear and specific examples of the potential use and value of experience:

“Experience is certainly important. My job is to accumulate [work] experience, and I expect it will help me to move to a better company.” (I7.13.31.D)

“I think my experience is very important. At least this knowledge is necessary for me to switch to other companies. Moreover, others certainly do not know my knowledge. In terms of my personal career development, this experience made me and allowed me to sustain my competitive edge in the company.” (I31.9.16.D)

Since experience was “formed in people’s minds” (I11.14.6.PM), several informants, noticeably the managers, expressed that it was important to transfer this tacit knowledge in people’s minds into explicit formats. Otherwise “when this member of staff moves into another company, the asset would be lost” (I8.9.12.D). One of the installation experts, who had been involved in development of a knowledge management system before, gave a strong statement:

“[For a company], the tacit knowledge [from individuals] will be useless if it is not transferred into explicit format. It would not become explicit knowledge if we just verbally talk about it. The company’s tacit knowledge is all hiding inside individuals’
minds. If it can be converted into explicit [knowledge], it will become an intangible asset of a company and not so easily lost.” (I8.9.8.D)

Once the tacit knowledge is converted into explicit knowledge, one of the managers suggested classifying the knowledge based on its domain. This should be done for the purpose of better utilization and dissemination in the organisation, directly justifying the motivation and importance of this study. He stressed that

“The knowledge and experience are unlimited and tremendous like the sea. In order to deal with the infinite experience, there is a need to identify and classify it. Following this identification and classification, you can easily create and use this knowledge, like using the drawers for our clothing. If you have no drawers, you will just heap everything inside, the more you put in, the more chaos it is going to be. Therefore, there is always a need to identify, define and classify your own experience and that of your employees.” (I25.28.17.M)

Having established that the informants have a clear understanding of the value, importance of experience as well as its tacit nature, it was rather gratifying for the researcher to identify that interviewees also had a clear understanding of the need to make this tacit knowledge into explicit knowledge as well as the need to divide it into categories. The next sections will present, describe and discuss the experience categories identified by this study.
5.4 Communication

Figure 5.12. Concept Map for Communication
Communication has always been considered as the crucial activity in successful human activity systems (Di Salvo & Larsen 1987). The findings of this research suggest that this is particularly true in the context of Chinese SW as reinforced by one of the interviewed project managers, who believed that: “To a certain point, any jobs done in any society depend on the communication between the people involved, no matter whether it’s academic study or work. Therefore the communication is always particularly important.” (I23.5.14.PM) Communication in this study was identified as the activity to convey information through the exchange of thoughts, reflections or explicit messages during the process of SW development. This category emerged very strongly in the assessment and perceptions of the informants and its composition is illustrated in terms of its sub-categories and codes in Figure 5.12. Following the structure presented in that concept map this section discusses the details of each sub-category: Understanding the Importance of Communication, Communication with Different Agents in the Development Process and Ability to Use Different Communication Modes.

5.4.1 Understanding the Importance of Communication

Since communication plays a significant role in daily working practice, the ability to communicate and negotiate is perceived by the informants to be crucial for every individual, no matter if they are a technical developer or a project manager, as noted by a manager:

“Ahhhh … I think the most important is the communication skills, which means to understand what others are saying and to let others understand what you’re saying within an effective period of time.” (I25.2.16.M)

Moreover, when the work is more about contact with people instead of independent
research, the ability to communicate is more significant than technical ability. Another two project managers reinforce this idea by stating the following:

“Well, after I have visited the various provincial companies of our customers, I think communication with customers and language [oral] presentation skills are absolutely necessary [when I talk to customers]. In the past, I thought the technical capacity was very important. But now I think at this stage (in which I need contact with customers) the ability of communication is more important.” (I11.3.24.PM)

“In fact, during the process of SW implementation, almost 30% of the work needs technical ability, and 70% needs communication skills. Communication skills are particularly important.” (I23.5.15.PM)

5.4.2 Communication with Different Agents in the Development Process

![Concept Map for Communication with Different Agents in the Development Process](image)

*Figure 5.13. Concept Map for Communication with Different Agents in the Development Process*
The findings showed that different stakeholders in the development process need to be addressed in different ways. Professionals need to adapt ways and methods of communication according to the different types of people they are trying to interact with, as demonstrated in the following example:

“In my opinion, there are three [different] aspects of communication, which are communication within the project team, communication with SW users (customers), and the communication with the company boss.” (I10.2.3.PM)

Nevertheless, other respondents expanded the communication skills required to interact, cooperate and network with, ranging from business competitors to policymakers. Additionally, the results of data analysis showed that the effective ways to communicate with customers, colleagues and leaders are difficult skills and require solid experience. Therefore, this section focuses on discussing communication with different types of agents in SW development, including colleagues, leaders, business partners, and customers (see Figure 5.13).

5.4.2.1 Communication with Colleagues

As shown in Figure 5.14, communication with colleagues is an unavoidable activity at work, especially when people need work in teams and need each other’s assistance, as is the case for SW development and was clearly expressed by two of the developers:

“The communication between colleagues occurs mainly in teamwork, particularly for cooperative activities.” (I18.2.8.PM)

“Sometimes, if your task is relatively heavy, you could negotiate to your colleagues, and ask their help to share a little bit. It requires the communication with colleagues, and coordination of the work.” (I7.3.5.D)
“The communication with my colleagues, for example, we have a task and I need their assistance, then I need to ask them, or sometimes they have problems and need my help. This communication helps in the cooperation with and assistance of each other and for a good working relationship.” (I13.2.25.D)

Figure 5.14. Concept Map for Communication with Colleagues

Communication is also fundamental in seeking colleagues’ advice. As explained by one of the project managers, he would ask other members’ opinions before submitting the project design proposal.
“Yeah, if we adopt this framework, we need the collaboration from other colleagues, so I definitely need to communicate with them. If most people have a strong opposition, in order to avoid drawbacks, we would also adopt another framework.” (I1.7.39.PM)

Other project managers also shared similar ideas that good communication with colleagues is a way to satisfactorily be able to negotiate and coordinative work:

“Ah, communication with colleagues in the daily work is important. For example, when there are different opinions or ideas about the resolution of problems, how could you persuade your colleagues and try to satisfy both sides?” (I11.4.8.PM)

The success of this type of peer communication is seen to be linked to a more frank, casual and unrestricted interaction, as noted by one of the programmers: “[in order to succeed] the communication with colleagues needs to be more casual, and should not be so restrained.” (I13.2.37.D)

This need to adopt different styles of communication, depending on the interlocutor, was clearly identified by one of the department managers who explicitly expressed that the language used during the conversation should be accessible to the conversation partner and that this is an essential skill for a leader (this is further discussed in Working in Projects\Management of Project Teams\Leadership\Scheduling and Monitoring\ Adapting Language to Team’s Level in Section 5.7.2.1.1.)

“[In order to definite customers’ needs in terms of a system’s interface,] you should have an understanding of the working methods and ideas of technicians. Therefore, a technical conversation needs to use technical language and comply with technicians’ expectations
and thinking habits. Sometimes, just one correct word makes an entire sentence make sense. One the other hand, one vague word could make them not understand what the whole sentence means.” (I25.16.39.M)

Good communication skills seem to also be a fundamental tool for professionals and managers to build cooperative relationships with other departments in the organisation or even external partners:

“When we mention communication between the same level people, such as department manager to department manager, this is coordination relationship. Because there are a lot of things I can’t finish in my own department, I may need to ask for resources from other departments. For example, I need to go to the marketing department to make business contract with our customers, or sometimes some customers even require them (staff in marketing department) to communicate. It is the same for the finance department or human resources department. I need to claim for a raise of salary for my colleagues if they are not get enough. Or sometimes I need to talk to the human resources department about new recruitment. Right? … If my staff is not enough, and the projects time is really limited, then I need to go there and ask their cooperation [to hire a person whom I need].” (I19.2.33.M)

“Ah, basically, the communication between the same level departments is a negotiation process. Because the work of technology R&D department, business department, and administrative department overlaps with each other, and requires coordination, the communication is mainly about negotiation to find a reasonable balance.” (I25.4.19.M)

Moreover, managers also recognise that they need sound communication skills in order to provide feedback, monitor the individuals’ working progress or provide assistance when this is needed. For example one department manager commented the following:
“Communication would be different depending on your viewpoint. If you are talking to your team members, your role is then one of a coach [who needs to support them and also to monitor them]. In this case, the relationship between you and your subordinates will be like a teacher and students, sometimes like friends, who you need to guide and monitor, as well as push.” (I19.2.29.M)

On the other hand, middle managers see communication as a way to build a bridge between employees and senior bosses, as explained by one department manager:

“Because of my position, firstly I need to report to the boss, sometimes I also need to communicate to the same level of people, and other times I need to talk to my own subordinates. That is, I am in the middle of those people. In fact, my role is equivalent to a bridge, to form a connecting link between the top boss and bottom employees. So I should have a certain communication ability [to balance each side].” (I19.5.2.M)

Another installation project manager mentioned

“Ah, as a project manager, I must understand what the company wants and what my installation staff needs. I mainly play a coordinating role to balance demands from both sides.” (I28.2.30.PM)

5.4.2.2 Communication with Leaders

As shown in Figure 5.15, understanding the characteristics of communication with leaders was seen as a fundamental skill for the practitioners and a key factor in being successful in their working environment. This is probably one of the subcategories in the entire theoretical proposition that is more greatly influenced by the Chinese culture that, in turn, is characterised by a very hierarchical society and extremely high
Power distance is immediately apparent in a comment by a project manager when referring to the need to understand the nature of communicating with a leader:

“When you talk to the company leader, the communication would be like a form of reporting. In another words, we treat this as ‘being summoned’ by the leader.”

(I10.2.17.PM)

In comparison to communication with colleagues, the interviewees claimed that communication with leaders should be more careful and avoid negative or confrontational opinions about the company or any other colleagues, as one of the
developers stressed:

“Ah, I think the difference [between talking to leader and talking to colleagues] is that I would be more cautious [when I talk to the leader].” (I13.2.36.D)

Additionally, informants have noted that a respectful attitude should be adopted when communicating to leaders, as illustrated in the following quotation:

“When I talk to the leaders, I think at least I should show a certain respect to them. I would seriously consider about what I can speak and … of course no complaints.” (I31.6.29.D)

It is unlikely that these aspects of addressing leaders would emerge from interviews with Western SW professionals, but being straightforward was a more universal facet that emerged in many of the concerns about communication with leaders. Some participants expressed the perception that having a clear and straightforward discourse is important to present and discuss their own ideas, proposals and problems. One R&D project manager explained this as follows:

“The communication with our leader, actually, should be straightforward. As R&D staff, I like to go directly to the leader and discuss the problem. Then both of us could have a thorough understanding of the problem [and can take decisions].” (I26.10.13.PM)

Another project manager gave more examples about this skill:

“If I need to communicate with my leader, I will put my thoughts out in a straightforward manner. For example, if I have alternative case A and case B, I will present clearly the strengths and weakness for each selection.” (I1.5.26.PM)
“More often, I would illustrate strengths and weaknesses of each [SW design] solution to the leader. The leader also may also have ideas about which one is suitable for this project. Specifically, the leader can be more informed to decide which one (solution) we use.”

(I1.7.26.PM)

This perception was also supported by a departmental manager, who claimed that straight forward communication saves a lot of time and resources, as the following example demonstrates:

“[In our company], communication with superiors is basically to solve problems, so it is very direct and straightforward. Moreover, for a software company, in order to solve problems in a short time and keep high efficiency, it is more appropriate to keep to such a direct way of communicating. Therefore, the communication with superiors basically deals only with the current situation, and should not spread to other issues or less-related themes. Otherwise, work would be delayed and efficiency would be reduced.”

(I25.4.11.M)

Therefore, this department manager strongly recommends that for the purpose of solving problems, communication should also be concentrated on the current situation. Besides solving problems and decision making, communication with leaders was also seen to be a fundamental skill in reporting individual and group working progress, without which managers would find it very difficult to maintain overall control of each ongoing project. One department manager gave the following example:

“My relationship with the leader is possibly more like representing [the project]. The communication is to report the details of the project and mainly about the issues he should be more concerned about, such as the current situation of each project, some difficulties in the process of the project, and what he can do to help me coordinate with others [such like other departments].”

(I19.2.40.M)
This reporting function and required communication skill was also identified as crucial by developers who apply it as part of their daily working practices, as commented by different developers:

“In my opinion, I think [that presenting my own progress to the project manager frequently] is very important. Because sometimes the project manager might think he did not know what happened in the process of project implementation. So, I personally will talk to him after I finish every small task, or sometimes ask for help with the problems.” (I9.2.26.D)

“It is different when you talk to the leader and your colleagues. Well, this is part of your social behaviour. Right? … After the leaders allocate a task to you, your role is to finish it and report back the progress of your allocated task.” (I13.2.22.D)

“When you communicate with the team leader, it is better to let the leader know what you have done, and what progress you are making. Otherwise you may get into trouble [laughs]. ” (I16.2.8.D)

Last but not the least, taking the initiative to talk to and inform the leader was also seen to enable effective communication and help project team building. This issue is also discussed as part of Working in Projects\Working in Project Teams\Being a Responsible Team Member\Identification and Reporting of Technical Difficulties in Section 5.7.3.2. One very experienced developer was very insistent about the importance of being pro-active in communicating with the project manager:

“Of course, it is important to take the initiative and actively communicate with your leaders. Do not wait until the leader comes and asks you what the problem is. [If you do not communicate with leader regularly,] It affects the relations [with the leaders] and sometimes even wastes time and affects the project schedule.” (I37.3.26.D)
5.4.2.3 Communication with Business Partners and Competitors

In the SW industry it is very common for development teams to contain external partners that are sometimes cooperating with their company and at other times competing. These business partners include functional experts, context, subject and sector experts and technical experts. As shown in Figure 5.16, in addition to their company colleagues, developers and project managers that sometimes work on
projects with business partners require specific communication skills. This type of communication demands a good understanding of what is required in order not to compromise important business partnerships. This was clearly explained by one of the project managers:

“Sometimes, my communication with an external person and an internal person are different. It depends on the situation. To be more specific, there are certain topics that I would not raise when I talk to the external person (our business partners). Yes … [seems to be reflecting] definitely. I believe there are some lines you should not cross at inter-enterprise level. Even though they are project partners, we still have a certain concern.” (I11.10.16.PM)

Even though the project manager described those project partners as “external people”, this is not always easy to deal with by the actual developers who work closely and on a daily basis with them as team members. Therefore, one developer provided a different perception of this type of communication as follows:

“The communication with business partner is relatively little, only saying ‘hello’ [when we meet]. The communication is mainly about work. Basically, the situation is [when there is problem, we would have a talk].” (I7.4.25.D)

“Psychologically, it is certainly different [the communication with colleagues from the same company or from a business partner]. With the colleagues from my own company, we can discuss everything, such as dinner and life. But with colleagues from our business partners [or sometimes business competitors], we can only talk when a professional problem emerges. The purpose of communication is only for work and how to solve the problem.” (I7.4.19.D)

This developer was working as an Office Automation Maintenance expert for Shanghai Electric Power Company. Apparently, the Shanghai Company gave the
maintenance of their Office Automation project to two IT companies, one that is the stated-owned enterprise being used in this study and another one that is a subsidiary of Shanghai Electric Power Company itself. Therefore, these two companies were working together as business partners. However they also competed for the following contract, and for other projects.

This type of situation was also found in the large private company that was part of this study. In this case a complex situation was expressed by the project manager:

“Actually, we are not just simple business partners. They are our boss and we are their IT outsourcing subcontractors, which is not a simple business partnership. Even though we cooperate together to develop the system, they have the contract from the customers not us. They divided half of the functions that compose the SW development with us. So they are, at the same time, our customers and our partners. Therefore, we should pay attention to the tone when we communicate.” (I26.6.24.PM)

This same project manager further explained that, in addition to professional attitude, their communication needed also to be considerate and avoid arrogance or sense of superiority that could compromise the relationship.

“When we communicate [with project partners], we should not hurt them through our better technological knowhow.” (I26.6.31.PM)

“When you communicate with partners, do not hurt them. OK, we are all partners. Even though they have poor technological skills, you should not be rude. So you should pay attention to the ways and means of communication.” (I26.6.22.PM)
5.4.2.4 Communication with Customers

Communication with customers is certainly a crucial aspect in the success of any SW development process. However, this sub-category is also equally closely associated with the Negotiating with Customers in Section 5.7.4.2. For the purpose of consistent and meaningful presentation of the findings and a natural fit under Negotiating with Customers, this sub-category is instead discussed in Section 5.7.4.2.

5.4.3 Ability to Use Different Communication Modes

Modes of communication as defined by this sub-category are the media used to share information between stakeholders of the SW development. These modes were clearly identified by the informants as face-to-face, formal documentation, instant messaging, telephone and email.

![Concept Map for Communication Mode](image)

*Figure 5.17. Concept Map for Communication Mode*

One of the project managers clearly explained and differentiated the use of each media. He recommended that:
“Email is certainly more suitable for formal occasions. Sometimes, in the different departments, it was used as a collaborative tool [in the previous company].” (I1.15.37.PM)

“For example, customer requirements are better presented in a written format. […] then there is evidence if problems emerge during the project process.” (I1.13.43.PM)

However, another manager claimed that email or formal documents did not always work effectively as mode of communication. He gave the following explanation:

“If the formal document of requirement is so useful, why does the company need to send a salesman to visit potential and existing customers to engage in face-to-face communication? Basically, we only use formal documents as evidence or reference. But … It is not the way to collect requirements from customers.” (I4.10.17.M)

Therefore, depending on the situation, different modes of communication need to be used. Face-to-face communication was considered as the main tool for capturing and negotiating customers’ requirements: “face-to-face communication is the most effective [way]” (I1.14.35.PM). This same mode of communication is also used when he negotiated with customers about the unclear requirements expressed in formal documentation. He explained this as follows:

“The specific role of [face-to-face] communication is so that we can timely collect feedback from each other, and make some rapid adjustments.” (I1.14.6.PM)

Moreover, another developer shared the similar perception about face-to-face communication with colleagues inside the company.

“For overlapping functions, two of us would sit together and communicate directly to solve the problem.” (I31.4.33.D)
The same developer also illustrated that the company even provided open area working space to enable their convenient communication.

“Yes, the [using of] a long table is because our manager has prioritised face-to-face communication. If we use one table for one person, the communication [between R&D staff] would not be so convenient.” (I31.5.16.D)

As shown in Figure 5.18, the R&D departments of Bosi uses long benches that can seat multiple designers and developers side by side so that communication and sharing is done easily and effectively between employees working on the same project. The advantages are obvious when comparing with individual seating areas as illustrated in Figure 5.19 and Figure 5.20. The long bench working environment seems to provide a relaxing atmosphere for communication as well as provide the benefit of fast feedback and the benefit of being able to take advantage of visual clues from the colleagues instantly.

Figure 5.18. Example of Long Bench Seating Area at Bosi
Figure 5.19. Example of Individual Working Areas (or Pidgeon Boxes if Directly Translated from Mandarin) at the Shanghai Electric Power Company Facilities Where Some of the Bosi’s Employees are Placed.

Figure 5.20. Example of Individual Working Areas Where Another Department of Bosi’s Employees are Placed

Compared to face-to-face communication, instant messaging facilities seemed to be used less and mostly for quick collection of opinion or ideas from others working in different geographical locations.

“For example, chat software, certainly, is timely, most timely, and provides relatively high feedback. It is also relatively less formal. Moreover, it can sometimes enable deeper
talking, but less systematic. If there is a large amount of information I need from others that are away, then MSN communication may help my work.” (I1.14.16.PM)

Furthermore, one of the managers proposed the use of instant messaging facilities, namely QQ and MSN to build and maintain the social networks which can help not only in the interchange of information, but also in exploring the potential markets.

“[…] These forums help me establish a larger circle of professional contacts. […] I have been active in these forums since 2007 … Sometimes, I exchange the QQ or MSN messages with them … As time goes by we are getting older, some of my contacts there, that were previously programmers, are now senior managers. […] Recently, I realised that one of my friends there has now a company that produces GPS for vehicles. He estimated his business demands as 200,000 units for cars per year. This allowed me to suggest our iPad app from the [name deleted here] Group for which we produce apps, and so sell our apps indirectly. This is a big opportunity for us. Maybe a fortune! [smiles].” (I5.5.32.M)

One of the project managers considered the telephone as “a secondary tool when MSN or QQ cannot express clearly what we need. In this situation, the customer would further communicate by telephone.” (I1.15.29.PM) But, he also pointed out some of the disadvantages of using a telephone:

“If we use the telephone to communicate, it will have more effect on current work, and actually create more damage, because you have to stop the current work, listen carefully on the phone, and try hard to understand other’s thoughts and intentions.” (I1.15.32.PM)

However, another project manager disagreed with him, by claiming that telephone communication requires relatively less skill because:
“Using a telephone [to solve the customers’ problems] is more flexible [does not require eye contact and body language etc.]. However, when you need face-to-face communication with customers, it requires slightly stronger abilities … because once the customers need to come to see you face-to-face directly, it means the problems are much more serious and difficult.” (I28.16.8.PM)

Regardless of advantages and disadvantages of the various modes, the use of them totally depends on personal choice, team and group habits as well as the ability to actual use the technology that supports the communication. SW developers are technical people, but customers are often not, so some of the communication modes may not always be possible.

“Many [of these communication tools] have been used. It is just that different people have different preferences, and different companies have different habits and special circumstance.” (I1.16.2.PM)

5.5 **Individual Development**

Individual development was identified as a crucial aspect in a very fast changing and evolving field, where technological, methodological and sometimes philosophical trends seem to come and go periodically. For the purpose of this research, individual development is closely linked with experience and acquired awareness and motivation to engage with continuous professional development. This link was reinforced by the majority of informants that identified the motivation and capacity for individual development as a crucial factor in their professional success. Moreover, informants linked this capacity for continuous professional development with the awareness and ability to use a great variety of learning modes and learning resources. These learning modes were grouped into three major categories, as shown in Figure 5.21. The motivation for continuous professional development is not the only element that
participants identified as important in terms of individual development, these are also identified to in Figure 5.21.

Figure 5.21. Concept Map for Individual Development
5.5.1 Motivation for Continuous Professional Development

As shown in Figure 5.22, “the IT industry is in a process of constant development. The replacement of old by new knowledge is relatively fast.” (I30.12.3.D) In order to “catch up with the changing speed” (I30.12.3.D), the awareness of challenges posed by a fast changing technical environment was seen as a fundamental skill for SW practitioners and a key factor in their professional success. This point was also clearly explained by one of the developers and one of the managers:

“Because, like software, the software development technologies and methods update very fast … Many new technologies continually appear. If you do not have a strong self-learning ability, then you will not be able to catch up.” (I6.2.35.D)
“It requires some technical skills and needs continuous learning. Because the IT industry is changing so fast … it changes almost every eight months or so. I should keep an attitude that I need to constantly learn and understand the new technologies.” (I4.3.18.M)

Moreover, many technicians highlighted their concerns that technical knowledge and skills should not be the only area to be developed.

“For technical people, if you only know technology, then your career is finished. [...] Well, you certainly want to expand into other areas. If you want to develop, you definitely should have the knowledge of other areas.” (I20.5.23.D)

Data analysis showed that self-motivation for continuous professional development is clearly increased by experience acquired during the SW development processes by engagement with both technical and soft skills. Therefore, the awareness of personal development needs beyond technology was often a reflection from past experience and long-term development throughout individuals’ careers. For instance, one of the interviewed project managers explained:

“That is right. [When the capability of technology has reached to a certain level], you could explore the other abilities [to grow]. There is no way to say that technology skills for an individual have reached their upper limit. But after these (the ability of using technology) have reached a certain level, for the personal development, there would have many aspects and directions to pursue.” (I11.3.30.PM)

During the interview, almost every participant claimed that they have received formal education of software engineering and computer science from university. Though “university has taught them some conceptual knowledge” (I35.9.23.D), but that was “basic knowledge for getting started” (I38.10.41.T), sometimes even “too simple and totally not related with real practical applications” (I35.3.9.D). There were several interviewees that commented on this issue:
“Knowledge needs to be practiced in the actual operation. Because learning from books, you might understand, but when you start to operationalising it, you will find that in fact you can’t. This is the reality of software development.” (I3.14.14.CM)

“Moreover, there is very little work related learning in the university. After graduated, you will find you are not capable of work in the practice, because in the school or university, the knowledge you learn was just basics for a beginner. Certainly, there is more in-depth experience required in work.” (I6.3.8.D)

For some of the practitioners this lack of work related learning was apparent even before coming to the real world of SW development: “sometimes I even did not attend the class” (I36.2.17.D). Therefore, there is a clear awareness for the need of training beyond academic learning. This awareness informed by experience results in a significant motivation for individuals to gain practical knowledge:

“[...] because it was really difficult to find a job with only the knowledge I learned from university, I had to go for a professional training in Beijing for another six months.” (I6.3.35.D)

“Actually, the knowledge I learnt from books in the university really did not help much. I could only participate in a professional project after I took training from the training institution, called DaNei. This training institution gave me a chance to apply my knowledge to the practical operation of projects. Of course, practice and exercise would be more helpful than just reading textbooks at university.” (I33.2.9.D)

In order to contextualise this last statement, the researcher investigated what this DaNei institution is. Beijing DaNei Science and Technology, is IT training school, which aims to train participants software skills on Java, C + +, C, 3G/Android, 3G/IOS, PHP, and software testing etc. This school hired the SW experts from IBM, Huawei, UF, AsiaInfo, Neusoft and other well-known IT enterprises to ensure high
quality of training. The human resource manager of Bosi, later confirmed that most of the newcomers into the company actually took courses in DaNei or in similar training institutions.

“Well, we have been looking for SW people from several training institutions, such as APTECH and DaNei. But the students’ quality from APTECH was not so good, so we decided to hire people from DaNei, and keep our relationship with DaNei for future recruitment.” (I44.2.11.HRM)

This is an unexpected finding. On one side it seems to indicate an antiquated and misadjusted pedagogical model is still being used in Higher Education in China, since all programmers come into these SW companies with either one or even two university degrees. On the other side awareness of this inadequacy of pedagogical models seems to have originated a specific and lucrative training market that is now actively sought after by programmers and companies. This type of formal professional training is also considered in the next section on a specific mode of learning from others in order to acquire practical knowledge and is discussed in Section 5.5.2.2.

5.5.2 Modes of Learning for Continuous Professional Development

Despite the acknowledgement that continuous professional development is increasingly important to be successful in the SW sector, there were very distinct perceptions on how to learn and on modes of learning. These perceptions seem to be dependent on experience and growing awareness of both learning needs and modes. For the purpose of the research, continuous professional development was defined as it emerged from the informants’ perceptions, i.e. as a range of learning activities that SW practitioners and professionals need to engage with in order to maintain and develop their skills and knowledge as well as to ensure that they retain their
competitiveness within in their working environment. These learning activities were discussed in-depth by informants from all the different positions in the companies and they include very different modes of learning that were identified in this research and involve both individual learning and learning from others (Figure 5.23).

**Figure 5.23.** Concept Map for Modes of Learning for Continuous Professional Development
5.5.2.1 Individual Learning

Individual learning focuses on self-driven learning activities that are undertaken by individuals without interacting with others. These reflect a more private, introspective and independent learning process and are strongly dependent on individual’s experience, motivation and ability. Findings for this sub-category qualified individual learning according to different modes of learning: Continuous Learning, Self-Learning, Learning by Doing, Self-Selective Learning based on Current Work, Just-in-time Learning and Learning from External Case-Studies as shown in Figure 5.24:

Figure 5.24. Concept Map for Individual Learning
Continuous Professional Development requires that individuals engage in reflective practice and continuous learning. This is necessary to define and understand development needs and was seen by interviewees as the core activity for individual to “upgrade their knowledge and improve their abilities” (I30.12.4.D). The need for this continuous individual learning was very clearly explained by one of the developers as well as a manager:

“The job I am doing is all related to technology, which does not mean I don’t need to learn more after I acquired good knowledge about one of these technologies. The IT world has been producing new stuff all the time, so working with IT requires that I keep learning … (laughs in self-pity).” (I16.4.26.D)

“If you are able to keep your understanding of the technology up to date, then you will be also able to learn the best practices for using the latest technology.” (I25.19.35.M)

The awareness and ability of continuous learning was also used by one of the managers in relation to improving efficiency and innovative ways of work and, as such, these are a firm requirement for personal development of the employees:

“For example, for one particular SW module you may need to write ten lines of code, but I would be able to finish the same module in a single line of code … and mine would run faster than yours. This means that I have learnt more [in terms of programming and algorithms] and that I have more experience. There is no better way [to catch up with experienced staff] … just keep learning continuously and improving that way.” (I25.19.30.M)

Therefore, “Doing software [development] requires a strong self-learning ability” (I6.2.41.D). This ability for self-learning associated with continuous learning was one of most referred activities identified by interviewees, managers and developers
alike. Self-learning was associated with each stage of SW development, such as planning, designing, programming, and testing etc. Examples were given by managers, project managers and developers as illustrated below.

“In terms of the new technology [proposed in the plan] … I need to study it myself and understand the latest development of technical trends required by our project.” (I4.4.19.M)

“I need to constantly understand new technology that might be useful. For example, for big data, we need study in order to choose between a relational database or NoSQL.” (I26.9.23.PM)

“Electronic records systems have higher requirements in terms of system pressure and system performance. Therefore, technical requirements will be relatively higher for each development staff member. SW development is like construction of buildings which needs everyone to have the capability of working with old and newest technology, not just one special person. So the whole team needs to enhance their technological awareness and understanding.” (I26.5.42.PM)

“This knowledge of using testing tools can only be learned by yourself in your own extra time. If you do not have this knowledge, you can always go online to gather the relevant information.” (I13.7.17.D)

It is important to mention that web search engines and specialist web resources were mentioned as being widely used to obtain specialized information by self-learners. These learning resources are discussed in depth in 5.5.3.

An important aspect in both continuous and self-learning is the capacity to do so by reflecting on your own work and work practices and therefore learning from both successes and failures. Learning by doing is, therefore, one the most crucial modes of individual learning to enable the acquisition of experience and new knowledge
from working practice. This was noted by several of the developers by proposing that “repetitive use of programming techniques and technology will slowly allow us to accumulate more and more experience through practice” (I6.2.15.D). This acquired experience may itself help in the learning process by enabling practitioners to reflect on specific aspects of their practice:

”However, now I can selectively absorb knowledge from real working practice. Moreover, if one component of knowledge is frequently used, my understanding and my retention of it would be more in-depth.” (I17.2.43.D)

This view was also highlighted by a project manager who gave similar opinions:

“Well, I think experience can certainly enhance the individual’s work efficiency. But experience means you have written lots [of programs and routines] before. … Yes … if you are asked to program modules that you were never in touch with, then you definitely cannot be fast. If you write the same type of code every day then you certainly will be faster. Moreover, you are usually able to explore ways to maximise the efficiency and fast running of your code.” (I11.12.24.PM)

This learning-by-doing aspect of the professional practice in SW development may even imply developing skills and experience in areas that the developers had not had previous knowledge in, such as developing a sense of aesthetics which is especially useful at the stage of designing the SW, as explained by a product designer:

“I think designing SW has a relation with personal experience … that is if you have developed a number of systems before, you would have a sense of what works. Maybe these senses are not always explicit or tangible. Sometimes it is just a kind of feeling of beauty, on how to make an interface more beautiful or on how to make the operation of the SW more convenient. This sense is usually connected with the experience of the
Learning-by-doing was perceived to be also useful in the acquisition of leadership knowledge, as stated by one of the department managers from Bosi that expressed the view that the best way to learn how to be a leader was by reflecting on his daily practice:

“I really think that the experience of leading can only be gained from prior experience of actually leading. I think this field of SW engineering, there always new knowledge or new ideas emerging that we need to use in our work. These new things may require different ways of managing, scheduling, monitoring and even leading … you know … I always need to analyse these latest things using my previous experience, extracting ways of dealing with it and applying them into my work. This ability is very important. In this way, while doing my job, my skills will continually grow and my knowledge is refined and accumulated.” (I25.4.42.M)

Another important aspect raised by informants was the ability to engage with just-in-time learning, i.e. to learn if and when the developer’s tasks require the learning of new techniques, algorithms, technologies or even new organisational environments and business sectors. This was stressed as highly desirable by a manager, especially when preparing for meetings with new customers:

“You should be ready to learn at any time. Sometimes, we need to write a report [to customers] on the second day. But I know nothing [about some of the technologies required or business environment of the customer]. So I need to search information overnight, and try to understand it, until I become a little bit more knowledgeable than the customers.” (I4.4.20.M)

The need for just-in-time learning seems to be also associated with adapting to
different performance requirements from different customers

“As we all know, electronic records projects require high technology in order to deal with large amounts of data, probably more than 10 million G in the case I am working with, as there are higher performance requirements from the database technology. Moreover, if various business systems export data into the electronic records system, the pressure on the system will be very high. So, there is a need for higher technology, that I need to learn about.” (I26.5.37.PM)

Therefore, just-in-time learning was not surprisingly mentioned by many of developers, but significantly it seems to be part of all activities related with development as expressed by content manager:

“For example, if I want to remove an element of a specific picture, or add some flash for the title or add a company watermark … I need to learn by myself how to do it.” (I3.8.1.CM)

One mode of individual learning that virtually all developers mentioned as being crucially important refers to learning from external examples, failures and successes in external case-studies. This are widely spread in the Internet and heavily used by the SW community worldwide, as discussed in section 5.5.3. The use of these external case-studies is highly dependent on experience and individual awareness of where to search for useful information. One developer gave an example of individual learning about big data as follows:

“We are now doing a number of studies on the architecture and technical architecture for a big data system. How do we face such a large amount of data, and how do we deal with such high concurrency? Meanwhile, we also combine [our current situation with] some experience from the Internet, such as Taobao or others who have experienced on dealing with big data.” (I12.2.23.D)
Taobao, is the Chinese equivalent to eBay and the biggest consumer-to-consumer e-commerce platform in China. It contains nearly 16 million independent vendors, listing their products and shipping directly to buyers. It has applied big data analytics as the basis for their meteoric success and a common case-study for others to learn from.

Another developer gave an example of information security as follows:

“For example, we would like to know how some of the large domestic and well-known enterprises, such as banks, have designed their security and what the technological principles behind their solutions are. That is the type of information we need to learn about and apply in our own systems. This is important because we just started to use some of these new technologies and the best way is to learn from other’s success cases.”

(I13.5.39.D)

This discussion has focused on individual learning triggered by self-motivation and work needs. However, continuous professional development is often more deliberately and strategically planned, so that active involvement of others helps the practitioners develop faster and become more focused. The next section addresses this learning from others aspect through mentoring, tutoring or even formal training.

5.5.2.2 Learning from Others

Learning from Others refers the learning in more formal settings and with active involvement of peers, mentors or external experts. This may still involve one-to-one processes or more traditional training processes in groups or even classes. Interviewees referred to this mode of learning frequently as part of their preparation to enter the work world and more significantly to this research as part of their professional development. Learning from others was categorised according to very
different aspects, as shown in Figure 5.25: Learning from Online Training Systems, Learning from Company Tutoring Schemes, Learning from Team Members, Learning from Internal Training Initiatives, Learning by Training Others as Instructors, Learning from Invited Experts, Learning from External Case-Studies and Learning from External Professional Training.

![Concept Map for Learning from Others](image)

**Figure 5.25.** Concept Map for Learning from Others

Learning from Online Training Systems was considered as the most convenient mode of learning by developers. It seems to suit their natural working habits as well as
providing flexibility to learn at their own pace, at any time that suits them and from anywhere they can log on from. Companies and management seem to support this mode of learning as well, as they do not have to spend funds on external training and do not have to lose developers work during the periods of training. Therefore some of the companies have made sustained efforts to develop online training materials and systems. Yirong (the large state-owned company) created what they name the “Online University” that is now heavily used:

“Well, the training from the Online University is required and encouraged [by our boss]. He encourages and makes us to study on one or more courses every season (3 months, there are 4 seasons a year), every year. There is also an appraisal system for each year to evaluate how many hours we have spent and studied on the course though the Online University.” (I9.5.24.D)

“There is a record of your account that contains the history of your study. The online training course cannot be skipped to the end [if you started]. You have to watch it from the beginning to the end. Finally, there is a test after you complete the watching.” (I9.5.29.D)

Yirong developers also stated that there is a wide choice of subjects and that not all of these are technical.

“The online training system has an URL for it … you can use your account [the company’s internal account] to log in and search for the subjects you like to learn … even philosophy or management science. Some online courses are particularly designed for problem-solving. This searching is a bit like using Baidu, except the resources are all integrated.” (I9.5.11.D)

The contents and materials for these courses were “bought from professional training institutions” (I9.5.20.D), according to what the company deemed necessary for their
employees’ individual development.

Beyond online training, interviewees also mentioned learning from company tutoring schemes, where junior practitioners are tutored or mentored by senior colleagues, coaches or “shifus [师傅]” (I20.15.38.D) assigned by company. Informants seem to be unanimous in thinking that this is the best and more effective way to gain knowledge:

“[...] Anyway, I feel I should [take the chance to] listen more and learn more during the coaching time. I might have not gone through some situations yet, but by observing [my coach’s activities] and listening [to my coach’s advice], I could learn how to best solve problems and even communicate with colleagues.” (I33.5.9.D)

Informants also mentioned informal learning that occurs while working with peers and other team members. Junior staff seem to value this type of learning the most and mentioned how easy it is to learn and be influenced by other team members’ working style and methods. Therefore, learning from team members was identified as an important way to develop knowledge and accumulate experience from others. For instance, one developer gave a very good example about learning about testing from other team members as follows:

“Another way to gaining knowledge of testing tools is during the project. For example, at the very beginning, I was not familiar with the testing tools. But there was another team member really good at these. So when we worked together, I could follow his steps and learn from his experience.” (I13.7.18.D)

However, experience from other team members may not necessarily be directly applicable or even useful for the different individuals and their specific roles. Interviewees stressed the need for self-reflection and analysis in order to process others’ knowledge and work practices into their own work. One of the developers
gave a detailed explanation:

“No one is so talented that they are perfect at everything. Everyone uses work practices familiar to me as well as some unfamiliar. Sometimes, other team members’ suggestions and methods are fresh ideas to me. … But should I use these? … I need to carefully think about it. Sometimes, to adopt their ideas, I need to go online and search for related information and do much deeper research. In this way, new knowledge or ways can be generated which really improve my efficiency.” (I31.3.5.D)

Interviewees also referred to more traditional internal training initiatives such as seminars and courses provided by senior or experienced staff.

“The company does encourage us to learn. Sometimes there is a training course in the company, which is taught by some of those senior and more experienced staff. This training is very specialised on the aspects of business operation and technology application that we use daily … it is especially useful for the new employees.” (I17.4.13.D)

This type of internal training seems to also provide learning opportunities for the trainers themselves. Interviewees that took roles in training others as instructors noted that the preparation of training sessions “require you have a deep understanding of the system. If you are not very familiar with it, you cannot train new staff.” (I26.8.37.PM).

“If I do not train other people, I may simply look through the training document, and probably only know a certain level of each of chapter that relates to you. But if I have to give training, I should have a deeper understanding and more thorough understanding, because I need to teach everything and also use a more simple way to express all the meanings. [short period of self-reflection] … Right … using a simple way to express and present things during training could make people acquire a better understanding of the
system. On the other hand, I can also practice and enhance my ability of expression during the employees’ training.” (I19.4.32.M)

If there is a training need that cannot be directly resolved using internal knowledge, informants from all three companies referred to the use of “Invited Experts”. This seems to be common practice when adopting new technologies or engaging with previously unknown types of business.

“Yes, the invited experts would explain to us how to operate the new technology. I can give an example which is not about the system performance. It was about Oracle. Our developers were not familiar with DBA within Oracle, so our boss decided to invite a senior engineer from Oracle to give us training. During that training, we were able to communicate with him, and learn much more from this information exchange and idea interaction.” (I13.7.28.D)

Invited experts may also be asked to present, describe and analyse external case-studies. This learning from external case-studies occurs through close links with other companies in order to share and learn from others’ experiences, strategies and approaches to problem solution. This seems to be easier to enact by larger and state-owned companies, such as Yirong, who have an established network of influence as well as the reputation and influence to invite other experienced companies to teach their own employees, as stated by one developer from this company:

“Sometimes they [the experienced external company] will come to our company to communicate with us. Yes, they would exchange experiences [with us], and see how to help us. But in terms of the details, such as solution report, they certainly would not say too much, but our boss could help us to ask for it… Anyway, the exchange of ideas would still be helpful when we have problems.” (I13.6.32.D)
According to statements of managers and perceptions of employees, if everything else fails, individuals and companies will then resort to external traditional training solutions. This external professional training was identified as important to acquire new knowledge and “keep up with knowledge the work requires” (I17.1.34.D). Moreover, the professional training intuitions do not only train, but allow contact with a different learning culture that actually motivates the leaners, as remarked by one developer:

“Yes, the atmosphere in the professional training institution is completely different. […] because the learners who went to the training institutions were spending extra money to learn IT knowledge […] So under the great pressure, they study harder and more carefully. … Right … The atmosphere in the training institutions is the pressure of survival.” (I36.2.4.D)

Conversely, other developers were not necessarily happy with this generic external training and claimed that the knowledge taught by this mode of learning was too broad, too difficult to assimilate in a short period of training and difficult to transfer into their realities of practice. One of those developers illustrated this as follows:

“[In the training school], you were covering too many things in one day, and sometimes you might think you have acquired some knowledge, but actually you cannot apply it or even remember how to apply it after. There is too much knowledge to learn in such an intensive time … In fact, after completing the training, most classmates would select their own directions independently.” (I17.2.38.D)

Finally, participants also stated that they were sometimes able to learn from their leaders, as a way to gain leadership knowledge. Since as a team member, participants would have been supervised by different leaders, they could use these experiences to reflect on strategies that were successful and others there were less so. One project manager gave an example as follows:
“Personally, I think, I probably learnt more from the leader of my previous project in my old company. Yes … in my previous company, there was a team leader in charge of project management and I learnt very much from him in relation to his ways of leading and methods of monitoring the project.” (I1.5.11.PM)

Leaders themselves stated that they sometimes sought advice and learned from other leaders and in doing so gained from their experience and strategies. One of the installation project managers from Bosi gave the following example:

“For example, as I just mentioned, my team member [name deleted here] was difficult to manage, and sometimes he did not even listen to me. I had to ask other colleagues on how to deal with this type of issue. A senior manager [name deleted here] gave me a lot of support and advice. He gave me examples on how he dealt with similar situations and what he would do in my place. I have learnt a lot from him.” (I23.5.22.PM)

“Yes, I adopted his advice. I understood that there is no need to monitor my team members every day, every minute. I just needed to schedule the tasks for them, and ask about progress at regular times. But not as frequently as I was doing before. I understood that they felt stressed and even offended if I was asking and monitoring them so often. This advice was effective, and I am still doing things in this way.” (I23.5.28.PM)

Having discussed motivation and different modes of learning, it is important to discuss learning resources used during the learning processes. This discussion is particularly important to this research since knowledge of the existence, utility and usability of these different learning resources is closely associated with experience.
Taking notes on and memoing professional activities was referred to as a very important activity by managers and SW practitioners in the interviews. It was
considered as an essential element to keep individuals’ experience and acquired knowledge for further use as well as a strong enabler for individual learning and reflection. The analysis of collected data in this aspect of experience led to the creation of the two main following sub-categories: Ability to Use Different Annotation Tools and Annotating Different Types of Knowledge, as shown in Figure 5.26.

### 5.5.2.3.1 Ability to Use Different Annotation Tools

![Figure 5.27. Concept Map for Ability to Use Different Annotation Tools](image)
Recording and annotating of reflections and learning that occurred during professional activities requires specific methods and tools. Participants assigned considerable importance to this aspect of being able to record and document experiences and activities by using relevant tools, such as mobile apps, computer applications, diagrams and abstractions and written notes.

Since “many people do not have the habit and time to keep a diary” (I4.7.5.M), participants stated that they relied on mobile apps to keep their annotations and immediate impressions, that is to “simply write a few words occasionally about some ideas that came to my mind at the time or management understandings that I gained from experience” (I23.7.15.PM).

Specialised annotation computer applications were another tool used by participants in recording and managing text documents and files, as explained by one of the project managers:

“I am using a computer application to manage my annotated files. It is like search tool, which classifies all my files in the computer. For example, the files that are connected to one specific project are placed into the project folder. This software is very small, called ‘Everything’. When I type a keyword for searching, it will list all the related materials I have inside of my computer relevant to that keyword. I really like to use this small application software to manage and search the notes and documents that I have saved.” (I10.12.29.PM)

Moreover, participants indicated that diagrams and abstractions are good tools to record the algorithms, processes or specific types of information flows, as claimed by one of the developers:
“Sometimes, I would use a graph, like a simple concept map. It helps to focus my mind on a problem and the solution.” (I2.7.12.D)

Finally, written notes seem not have become obsolete, not even among technical people. This type of note was still proposed by participants as a good means of recording informal thoughts, ideas or understandings that emerge from practice, as explained by many project managers and developers alike:

“I think that writing down the important things that pop up while doing my work makes it easier to remember them later and use … well implement them when I need them again. […] Finally, the process of writing ideas down also pushes me to reflect and think … Yes … to express your ideas more clearly.” (I1.3.31.PM)

“I may write something down during the process of daily work. How can I explain to you … If I only think about the problem in my mind, later … it would be very vague. But if I write it down, later my thoughts will still be much clearer.”(I2.7.8.D)

“I always record the reasoning for a solution, like tips to myself. Therefore, when I have the similar problem next time, I can always know where to look to start thinking about a solution.” (I8.5.9.D)

Although interesting, this sub-category is in itself not really significant. Much more significant is what these professionals actually take notes on. This is discussed in the next section.

5.5.2.3.2 Annotating Different Types of Knowledge

Informants in this study indicated that they record and take notes on a number of types of knowledge closely related to their professional activities, project activities and SW development, as shown in Figure 5.28: Technical Knowledge, Reusable
Technical knowledge was claimed by many informants to be knowledge that is mainly accumulated by “own technical reflection on experience” (I14.3.28.D), and the purpose for documenting it is “for future use” (I14.3.29.D). This opinion was
confirmed by another developer:

“I record the technical knowledge that I gain from my own experience. In my opinion, the new technologies I am confronted with or solutions I find to problems I’ve never encountered before were the most significant. So I always record this type of information.” (I30.5.26.D)

This type of reusable knowledge was seen as one of most important aspects that should be recorded by all developers. The documentation of this knowledge is expected to “save time and save costs of the project” (I6.9.33.D), as explained by a developer:

“For instance, I have documented how to transfer messages from Linux into my own computer. I recorded this type of knowledge because … well I am interested in it … but also I feel it will be useful in the future.” (I7.6.41.D)

The advantages of annotations are very important for the individual, but sometimes can also help others as can be seen from the statement of another two developers that used notes to describe their code, so that themselves and others can understand it and use it later:

“I always put notes in my written code. This will explain the function of this code. This will also allow others that may want to use the code to understand it … but very importantly for me … it will also help me to understand the code after the project has competed and I need it again.” (I29.6.6.D)

“I have written down all the things about how I developed my systems. This includes configuration processes, code to create, read, update and delete (CRUD) tables and attributes of the database etc. […] Then, next time I need something like that, I can use
my notes to develop new systems directly ... I use this to enhance my work efficiency.”

(I15.3.13.D)

According to interviewees, these technical notes and memos maybe be of two types: innovation or solution of emerging problems. Documenting Innovative Procedures was seen as one of the best ways to improve work efficiency and quality in the future as highly stressed by one of the managers:

“For example, we have developed a SW version for the iPad, and now we are going develop the version for the iPhone. In the first process we can formalize some all of what we have done to develop the interface to access to data [...]. I have probably spent half of the project time into the developing all this for the iPad, but now it will only take us a few days for the phone.” (I5.6.14.M)

Programming and technical problems are inevitable in software development. One of the installation experts explained the reason why documenting technical problems is very important as follows:

“I really do not want the same problem that already occurred in the past to happen again when I install the SW. If this time I still need help from the developers on something that was solved before … then it is not right ... I cannot rely on their help when a similar problem occurs again. Therefore, I always take notes of any problem and respective solution that I meet” (I9.3.27.D)

The same installation expert gave a more detailed description on how to record this type of knowledge, indicating that “pictures and screenshots” (I9.3.34.D) should be taken to illustrate the SW problems as well as the solutions found.
5.5.3 Specific Learning Resources

![Concept Map for Specific Learning Resources](image)

It became apparent from all the interviews that the SW community uses very specific information Internet resources in both acquisition and sharing of knowledge. These resources are, therefore, referred to as well in Section 5.6.2. Access and use of these information resources may be via direct access if the communities of practice and resources are already known or via consultation of search engines as shown in Figure 5.29.

Web search engines were considered as widely used and extremely useful learning resources which are employed to obtain and identify suitable information and knowledge resources, learning materials of all kinds, experts in specific areas as well as communities of practice with whom to interact with.
“[…] if there is a problem, I will go look at Baidu, and ask questions. Slowly I will become a better professional.” (I3.14.13.CM)

Baidu, rather than Google that was banned in mainland China at the time of the research, offers a Chinese language-search engine that indexes websites, blogs, audio files, images and more. Baidu was “the first choice” (I9.8.16.D) for most people. However, if there is a situation in which “we can’t find a solution from Baidu” (I9.8.16.D), then Google is still used, by going over the Chinese “Great Firewall of China” created by the Golden Shield Project. These are very technical and competent professionals that have no apparent difficulties in circumventing the wall. One project manager gave an example:

“Generally, I can find the information and knowledge from Google or other open source websites, which are more helpful than our company’s collaboration system. With the help of Google and open source websites, I can solve a lot of problems with solutions that no one has encountered in the company.” (I23.6.42.PM)

However, “Google in English needs people be able to read in another language” (I9.8.17.D). Therefore, this developer suggested that:

“In this case, I need to use a dictionary to translate the language, because in the chatting community [searched from Google], all the answers are in English. Some sentences I cannot understand and of course, I need to use a dictionary. However, even though I can only understand half of the meaning of these, it is very still useful and helpful.” (I9.8.18.D)

However, in the state-owned company Yirong these escapades over the wall are not always possible or well thought of, especially when working at a customer’s facilities who are themselves a state owned company. In this case, individuals may not even have access to the internet from within the state-owned company. For instance, the
customer company (Shanghai Electric Power) did not allow the developers working in their premises access to the Internet because of information security considerations. This did not seem to stop the use of internet search engines. The installation expert in the Shanghai workplace would “use the mobile 3G Internet, for the search engines” (I9.8.10.D) and it turned out to be “very helpful” (I9.8.10.D).

Experienced developers however, have portfolios of resources they use on a regular basis. Internet Message Boards (IMBs) are such resources used very frequently to capture specialised knowledge very fast or discuss ideas and solutions. One of the developers gave a very good example of Internet Message Boards (IMBs):

“Ah … yes … I do learn new technology from books, but mostly, I use some technical forum, such 51CTO.” (I16.4.30.D)

51CTO (http://bbs.51cto.com/) is one of China’s leading IT technology web forums, which provides a knowledge platform for Chief Technical Officers (CTO), IT Technical Managers, System Engineers, Network Engineers, Information Security Engineers, Database Engineers, Developers, and Project Managers etc. 51CTO is the most popular IT forum in China and has nearly 10 million IT professional users sharing their technical ideas and discussing technical topics through its platform. Therefore, technical knowledge is being increased and updated continuously through all the different contributions and it is seen by interviewees as the best way to learn.

In addition to generic IMB, more experienced developers claim membership of specialised Communities of Practice (CoP) used to share and learn knowledge in more interactive way.
“I do learning from people who share knowledge on the internet, mostly in some communities I participate in often. I always go to communities like ZHIHU. This is the most popular community where people can discuss a variety of issues, not only IT, but also other issues. However, discussion about IT is the predominant topic.” (I2.5.12.D)

ZHIHU (http://www.zhihu.com/) is a Chinese community for questions and answers on different technical issues, which is public and open for everyone. The value of using CoPs as learning resources was strongly agreed by many other developers:

“Yes, these communities [CoPs] allow interactive learning. People on these communities probably use the same technology but have slightly different work patterns. We can exchange and discuss ideas often, and contrast different practices between our companies.” (I6.4.35.D)

From the discussion above it became apparent that professional learning in the world of SW development is an interactive process that involves knowledge sharing between practitioners, in formal ways or by participation in informal web communities. The value and use of this knowledge sharing in work practices is closely linked with experience as well and is discussed in the next section.

5.6 Knowledge Sharing

Knowledge sharing as an emergent category in this study extends the previous category of individual learning by adding a dimension of active contribution for the development of knowledge in the company and in the field at large. As such, and for the purpose of this research, knowledge sharing encompasses all the interactive activities related with transferring or disseminating knowledge between individuals, groups, and even organisations. Moreover, and for the purpose of this research, knowledge sharing was found to be very closely associated with individuals’ awareness of the benefits of these interactive sharing activities. This awareness was
clearly linked with the degrees of professional experience of individuals and this, in turn, seems to determine individuals' willingness and ability to represent and share their experiences, practices and personal tacit knowledge associated with the process of SW development.

Figure 5.30. Concept Map for Knowledge Sharing
This category emerged very strongly from informants’ contributions and its composition is illustrated in terms of its sub-categories and codes in Figure 5.30. Following the structure presented in that concept map this section will discuss the details of each of the following sub-categories: Motivation for Knowledge Sharing, Awareness of Benefits of Knowledge Sharing and Knowledge Sharing with Different Agents.

5.6.1 Motivation for Knowledge Sharing

![Concept Map for Motivation for Knowledge Sharing](image)

The findings showed that the motivation for knowledge sharing, a time consuming and demanding activity, is highly related to the awareness managers and developers have of the benefits associated with this professional practice. Informants expressed...
or shared their experiences and tacit knowledge with others, partly because it was required by their companies and partly because they have a sound awareness of the need to share knowledge both inside and outside their organizations. While compulsory knowledge sharing may be an effective way to encourage people to engage with this type of process, it is not the best method to guarantee good quality and efficient sharing their experience and tacit knowledge, which requires an individual and sustained volunteer effort over long periods of time. Therefore, it was crucial to the research to determine levels of awareness of the benefits of knowledge sharing among SW developers and how these link with motivation to do so. Findings of this study identified two different types of motivations for knowledge sharing: extrinsic and intrinsic as shown in Figure 5.31.

Aware of the value of knowledge and experience as assets that need to be kept in the company in order to face high turnover of staff that characterises the SW industry worldwide, as well as in China, managers in the companies studied devised ways to encourage peers to internally share knowledge with their peers. Two of the companies studied decided to add knowledge sharing to their personal performance evaluation schemes in the form of contributions to internal information repositories. With promotions and progression in careers on the line, this was used as extrinsic motivation to prompt people’s sharing, as suggested by one of the managers:

“In order to encourage them to share their experience, we ask them to post articles of shareable knowledge on our company collaborative system. These contributions are part of their performance evaluation. The evaluation depends on the volume of articles, and most importantly, the utilization of the articles by others. If people who read an article think it is good, they give a feedback, such as a word or an expression picture [emoticon]. We can then assess if this is a useful article. Positive numbers of contributions, give extra scores at the end of the annual job performance evaluation.” (125.8.40.M)

However, if the knowledge sharing strategy set out by the company is not well
explained and accepted by the employees this sharing process was exposed as not being very efficient. Lack of understanding and awareness of the benefits of knowledge sharing, revealed very low levels of intrinsic motivation by the developers. One of the project managers explained the reasons why this knowledge sharing strategy in his company (Yirong) was a failure:

“In my opinion, the knowledge sharing strategy in my company is useless and has does not really support my developers when they need it. The company requires us to contribute five tips of knowledge every season [4*3 months seasons per year]. Some of us always go to the Internet to look for some technical information to fill into the knowledge management system. Actually, there is no requirement for the content, just a request for five contributions. Even if you did not provide these five in this season, you are still allowed to compensate next season. There is no punishment. Moreover, the version of this system has not been upgraded. Some bugs are still not fixed and resolved. For example, if you import the same title with same content into the system, the system would not recognize it and still admit it as a new contribution.” (I10.4.10.PM)

This quotation illustrates the misuse of a sound company strategy due to the lack of intrinsic motivation to do so. Contributions are mechanistically added that may not even be related with work practices due to pressure from the company. The system will then contain no real useful information and worst random contributions downloaded from the web rather than real contributions emerging from reflection on work practices. Therefore, even for these company set structures, it is very important that individuals have intrinsic motivation to actively and voluntarily share their experiences and tacit knowledge. One of the developers believed that sharing could make him “feel pleasure” (I9.11.14.D) as follows:

“I feel very sad if there was no one answering my question [on the CoP]. So if I know the solution, I am willing to help. Moreover, some solutions are not secret or unique, and they are available in open resources on the web. If I do not contribute, the community will not
work and I will have no answers in the future. So, in my opinion, if I know, I will help.”

(I9.11.19.D)

This intrinsic motivation as expressed by this developer shows a good awareness of the benefits belonging to a professional community of practice that enables a strong learning culture. This awareness is discussed in the next section and seems to be the predominant factor in motivating knowledge sharing habits in the SW industry worldwide and in China in particular.

5.6.2 Awareness of Benefits of Knowledge Sharing

It was crucial to the research to determine levels of awareness of the benefits of knowledge sharing among SW developers. Findings of this study associated this awareness with the following codes: Value-added of Knowledge Sharing in General, Value-added of Help to Solve Technical Issues, Value-added of Sharing Different Working Practices, Value-added of Sharing in Internet Message Boards (IMBs), Value-added of Sharing with Communities of Practice (CoP) and Value-added of Developing Sharing Habits, as shown in Figure 5.32.

Knowledge sharing was defined as “a process of exchanging ideas and exchanging opinions, which can produce new knowledge” (I2.15.7.D). Moreover, knowledge sharing with other experts and informed individuals was seen to enlarge the influence and increase the value of knowledge itself. For instance, one of the developers used a metaphor to explain the value added during knowledge sharing:

“Well, sharing knowledge … of course … it is important. For example, when you play chess with a senior player, your skill will get better; if you play chess with a lower junior, your skill will only get worse. And if all the masters of chess players could talk to each other, and share some experience, then they could only gain more knowledge … (smiles) … this is the value-added of knowledge.” (I15.6.19.D)
Knowledge sharing through working practice and day-to-day interaction with peers in the company is expected to help employees to solve similar technical issues that others have experienced before. For instance, one of the Bosi company installation experts working in the Shanghai customer site claimed:
“Right, you cannot always look for your boss to solve the problem for you. Then I would communicate with other installation experts in other provinces through the private telephone or QQ. The colleagues working at other provincial companies actually implemented the same system with same features. Some of my problems they might have encountered before. If they have solved them before … then through communication we could help each other.” (I24.6.7.D)

Inclusive learning culture seems to help people not only to improve themselves but also realize their aspirations, as expressed by one of the project managers: “I am not a particularly strong person. It is possible to learn about some experiences from other successful project managers” (I18.6.25.PM). One of the developers illustrated this concept as follows:

“First of all, the knowledge acquired through experience, it is not easy to get. This type of knowledge is very valuable, yes, because it is not possible to get it from books, especially because not everyone’s working environment is the same, neither are the contexts and specific conditions of project processes. Therefore, the experience gaining from the different projects can be totally different. So the experience a colleague gains from his project could be very distinctive from what I might get from my own project.” (I15.6.7.D)

However, all of the technical developers openly declared that not all knowledge sharing processes were internal to their organisations.

“Sharing outside the company is also definitely good. It is better that we have the opportunity to share the things with other people. The actual experience of the problem still belongs to you, but, if we share, all us [meaning all of us in the development community] can learn and improve our knowledge, and grow faster together.” (I16.5.19.D)

Like SW developers all over the world developers from all three companies studied
actively seek for advice from the wider National and at times International community of practice that forms around Internet Message Boards or Bulletin Board System (BBS) Forums. These forums work based on informal and volunteer response to technical questions posed. Reaching a very wide audience and therefore allowing for very fast response times, these very simple and limited systems have traditionally been used by the SW development community for decades. This type of system would not qualify as a CoP in the modern sense of the world and therefore was considered as an independent code. However, according to the respondents to this research, these Internet Message Boards are always the first port of call whenever technical problems emerge, often before asking in-house.

“I always use the Internet Forum to exchange ideas. That is, I would post a message into the 51Test [in order to seek for help]... Ahh, you may not know this, but the 51Test is a relatively large forum for questions and answers. The reasons I use this forum are: one, because the people are really enthusiastic and, two, because there is a lot of information sharing on this platform, particularly in the testing field. So I gain a lot from it.”

(I38.5.7.T)

51Testing (http://www.51testing.com/html/index.html) is the most popular testing forum for Chinese developers and testers. It stores a wealth of responses on how fix SW bugs, develop test specifications and deal with unstable systems. This forum is specialized on testing, but, as discussed in Section 5.5.3, there is a myriad of other such Internet Message Boards both generic and specialised in a variety of SW development areas, such as programming languages, configuration, project management.

Despite its extremely high level of use and success, Internet Message Boards only provide very limited degrees of interaction and do not usually provide rich interaction. This interaction is perceived to be very important and is usually supported by more sophisticated Internet based CoP, such as Zhihu, as discussed in section 5.5.3.
“This type [sharing in the community] is more interactive, because you can hear different voices. Like a brainstorm … you can see the different points of view.” (I2.6.10.D)

This type of Community of Practice (CoP) is recognised to be a mechanism of obtaining and providing knowledge from experience:

“This [sharing] is a process that we need to understand. When I joined this industry, I learned from my work by myself and did not share with others. But after a period of time, I found that I was wrong. I found that all the techniques I learned the hard way all by myself, I could have found on the web. This web is a big platform where everyone is sharing. For example, I have a new innovation, and you have another. Then each one of us only has one innovation. If we share with each other, both of us will have two innovations and both of us gain from each other. If I am selfish and you are selfish we both lose.” (I14.3.11.D)

Therefore, knowledge sharing needs to be seen as a process and the junior SW developer may not always understand it or be aware of its importance. Moreover, more traditional ways of knowledge acquisition such as their graduate, friends and professional networks (see Section 5.6.3) may not be enough to support their professional practices efficiently. CoP was presented as the ideal platform to share and exchange ideas with others but require the awareness and willingness to develop personal knowledge sharing habits.

“I will always document [in a separate file in a folder he created for this effect] the information on the problem-solution that I found from the Internet. If I do not record this, it might still be a problem for me next time I need it because I may forget it. Moreover, if there is someone asking for help from communities on that problem for which I already know a solution for … because I have it recorded … I can then post it onto the site and answer their questions.” (I9.8.20.D)
"In fact, sharing is a habit. Some people are good at writing, like blogging, they like to write down their technological knowledge in their blog, and share with others. Many are not so good or do not have the habit of doing so, but for sharing to work effectively we all need to make an effort and get used to share regularly." (I5.14.20.M)

This suggests that awareness of benefits of knowledge sharing and having the experience, understanding, habit and skills to maximise these benefits, are different issues and, therefore, it was decided to address these as a different subcategory.

5.6.3 Knowledge Sharing with Different Agents

![Figure 5.33. Concept Map for Knowledge Sharing with Different Agents](image-url)
In this study, Knowledge sharing did not seem to be confined to the boundaries of the company, but also involved friends, web based communities of practice (CoP), professional networks and even competing organisations. Having the experience to maximise the benefits of this sharing led to the creation of the following sub-categories: Knowledge Sharing with Internal Colleagues and Knowledge Sharing with External Parties, as shown in Figure 5.33.

### 5.6.3.1 Knowledge Sharing with Internal Colleagues

Informants in this study indicated colleagues within their own company as the group of individuals from which they could gain more relevant and ready applicable knowledge, as stressed by one of the project managers from Yirong:

> “If the company can provide a good a platform for people to share and obtain knowledge, it is really useful. For example, you can log on to the platform, and gain other people’s knowledge. I think it is really good for individuals and an effective way to use a company’s strategy to share.” (I11.14.12.PM)

This study uncovered a number of such company policies and tools for knowledge sharing with other colleagues, including Knowledge Sharing trough Formal Mechanisms (Sharing through Annual Work Summary, Sharing through Annual Seminars, Sharing through Routine Meetings, Sharing Company Tutoring Schemes and Sharing through Group Training) and Informal Knowledge Sharing (Sharing through Chatting Facilities, Sharing through Company Mobile Phone, Sharing through Company Information System) as shown in Figure 5.34.
Figure 5.34. Concept Map for Knowledge Sharing with Internal Colleagues
5.6.3.1.1 Knowledge Sharing through Formal Mechanisms

![Concept Map for Knowledge Sharing through Formal Mechanisms](image)

Figure 5.35. Concept Map for Knowledge Sharing through Formal Mechanisms
Formal mechanisms for Knowledge sharing were defined in this research as non-optional exercises that are part of organisational policies. These may range from formal meetings to the production of mandatory review documents.

The end of the year personal report was mentioned by employees and managers from both Yirong and Bosi. It is produced annually and requires employees to make a self-summary of their work and self-evaluation of their performance. These documents are then made available internally in these companies through “collaborative systems” (I27.11.15.PM) that, although different technically in the two companies, have the aim of allowing the sharing of experiences and work practices among all employees. One of the project managers illustrated how he used the chance afforded by having to do this document to reflect his experience in a document and share this explicit knowledge with his colleagues:

“I have shared [my experience with colleagues] though the annual report of work in the company. In the report, I write the real story and practical experience I gained though the year … not just something copied from the Internet. The knowledge that I have now written down comes from my insights [of working in customers’ implementation sites], and this was the only opportunity that I had and the only time I was given to recall my memory about the working practice and reflect upon it … and also … that I had the courage to write these down.” (I10.4.4.PM)

A less formal but still mandatory annual means of sharing ideas, emerges from the annual company retreat. This is a highly anticipated reunion away from the workplace and usually in a good rural hotel. This is common practice in Chinese organisations of all sizes and usually occurs just before the Spring Festival holiday. This retreat usually takes two to three days that are divided into reflection meetings in the morning, social or sport activities in the afternoon and entertainment in the evenings. For the purpose of this research these retreats are named as Annual Seminars since they were referred as such by the informants. The reflection sessions
in the morning are seen as particularly useful and one of the few occasions in which employees are given an opportunity to speak freely in extremely hierarchical Chinese organisational settings. Furthermore, these sessions are intentionally interdepartmental and include elements from all areas of the organisation. Therefore, once a year individuals are given an opportunity to voice their ideas, complaints and opinions, as described by one of the developers and project managers:

“Ah … knowledge sharing in our company is ok. Sometimes, when New Year is coming, our job would be relatively less than before. The boss would organize some seminars [and ask us to talk and share our own experience with others].” (I13.3.10.D)

“Right … especially the annual seminar was very useful for sharing knowledge. For example, about the Shanghai project. As a project manager, I may only participate in one part of the whole project, like requirements investigation and requirement specification in the beginning. However, the installation expert, who staying at the Shanghai customers’ site, was with the project from start to finish. He probably was the only one who could reflect on all of the practical experience, working processes, and problems encountered for this project. The annual seminars require staff to fly back to headquarters [Beijing and, in this case, the retreat hotel], and gave us a chance to listen to his story about Shanghai. Therefore, as a manager, I could ask him to share his experience and explain some questions for installation experts in other provinces.” (I27.12.44.PM)

Apart from these annual seminars that were seen as ideal mechanisms for knowledge sharing, there are more frequent “weekly meetings” (I6.5.6.D), routine meetings that were often considered as a way to summarize and discuss the week’s work, present employees’ problems and “exchange or share experience” with others (I6.5.6.D). Not surprisingly these meetings were strongly valued by project managers:

“Some people are not particularly good at communication, and always hide their own ideas in their own stomach [idiomatic expression]. However, they have come to realise that if
they cannot resolve a technical problem, others may, so we started to use these routine
meetings to force everyone to talk. If there was no such meeting, everyone would do their
job on and keep to their own mind. Sometimes, such problems can still be unresolved for
a while. That means during those periods, he achieves nothing. It is really a waste of
time. … [Sighs] … So I strongly impose these meetings to help deal with the problems that
they cannot deal with themselves.” (I18.2.33.PM)

Tutoring Schemes were also seen as an excellent means of sharing knowledge. Even
though the company’s training handbook would show all the information that
newcomers needed to know to start their work, all of the companies studied still
provide a personal tutor for each new member of staff. These tutoring schemes are a
way for senior experts (known and addressed by junior employees as “shifu”, a word
that in other contexts could mean master or teacher) to share their experience with
their junior colleagues, as explained by one of developers:

“Generally speaking, our developers are willing to share ideas. Sometimes, I am even
afraid that I might talk too much … so much that newcomers may absorb it. I would tell
him everything. If I have time, I will definitely teach him ‘hands to hands’ [idiomatic
expression] … It will be very good for our teamwork.” (I14.3.22.D)

Informants of all the companies also added an additional mechanism described as
“internal workshops” (I27.6.17.PM). These occasional workshops are led by
internal experts. These sessions occur several times a year, whenever the need
emerges for a particular area of expertise to be shared.

“Sometimes our developers will organize the internal self-training workshops which imply
one of our own giving a lecture on his specific strengths and sharing with others.”
(I16.2.21.D)

Additionally, it was stressed by several project managers that these workshops are not
necessarily aimed at newcomers, but are very often targeted at other employees who may lack expertise in specialized subjects:

“The internal workshops provide a chance for people to express their strengths, and more importantly, to summarize their own experience. For myself, I started as very unexperienced installation staff member… through a lot of learning, work and trouble I am now a senior expert. Therefore, following my own experience, new employees and employees who never experience either specific project types or technologies, have everything to gain from the internal workshops. It is a fast way to make them more capable.” (I27.6.18.PM)

5.6.3.1.2 Informal Knowledge Sharing

![Concept Map for Informal Knowledge Sharing](image-url)
Informal knowledge sharing as defined in this study refers to those activities there are not initiated by organisation policies and managers. These are, therefore, initiated informally by employees themselves and maintained through informal networks in the organisation.

For instance, when a new project starts the project members “create a discussion group, […] in chatting [QQ chat groups], they discuss all kinds of issues and are open to everyone’s advice” (I3.13.10.CM). These group chatting facilities are heavily used in informal knowledge sharing and eliminate geographical differences. For instance, “the installation experts from different cities” (I9.4.9.D) are able to share experiences, encountered problems and solutions. Developers can help each other when they “encountered similar [technical] problems” (I9.4.11.D). Therefore, these chatting facilities help people with similar special interests to interact effectively and timely. These interests may emerge from being in a project together, working in the same area (e.g. installation experts) or dealing with the same type of technical job (e.g. programmers using the same programming language).

“We share with each other very often. Here, we have a group chatting message board which is the RTX tool that resides in our company’s internet. [interviewer requested explanation] … You can understand it as a QQ chatting group, an instant message tool. It was designed by our own company [Yirong] and is used for internal sharing within teams.” (I9.4.3.D)

In fact, QQ Messenger is the most popular instant messaging facility in China and is used by millions of people on a daily basis. It offers a variety of services, including voice chat, group chat, online social games, music, shopping and microblogging. Unlike the stated-owned enterprise Yirong, the other two companies did not have the resources to develop their own chatting tools, so they chose this social chatting facility as the companies’ communication and knowledge sharing platform. For instance, one of the project managers from Bosi stated that:
“We do have a sharing knowledge facility in the QQ groups. Sometimes I share with friends, sometimes I share with colleagues from our company. That is, if they ask some questions [in QQ group chatting], someone would answer or sometimes I would respond myself to the questions.” (I23.18.23.PM)

In order to encourage the team members to exchange ideas with each other, Bosi even offered a SIM card for each installation expert who stays at customers’ sites and far away from each other. With the “credit inside of the card on each phone number” (I21.4.20.D), team members were “encouraged to communicate with each other, even if they are not in the same city” (I21.4.31.D). One of the installation experts from the Hangzhou customer’s site remarked:

“After we have been allocated the phone number, we definitely use this phone and talk to each other, including others that implementing our SW in other cities. I like it because of personal reasons … (laughs) … I like to save money. To be honest, we would use it mostly to communicate with colleagues in other provinces to solve a problem we find here. After the problem is solved, we would probably chat a little bit. However, the frequency of calling is not very high. Basically, if there is no problem, we would not call each other. Generally speaking, when you are busy, others may or may not be; when you have leisure time, others maybe busy. The situation of implementation in the various provinces is different. So sharing may difficult to maintain frequently.” (I21.4.35.D)

As expressed by this developer, instant messaging facilities and mobile calling require people to be available synchronously in order to exchange ideas. If this availability is not their knowledge sharing may not be possible. This led two of the companies (Yirong and Bosi) to implement their own asynchronous information system for knowledge sharing. This was considered as a better way to “express the working experience or project constructing experience, and share the solutions of some problems that they encountered before” (I25.8.23.M). These knowledge
management systems had different degrees of success. The knowledge management systems in the stated-owned enterprise Yirong seems to have failed (see explanation in section 5.6.1), while in the large private company, the “sharing system” (I30.5.6.D) seems work very well, as stated by one of the managers from Bosi:

“Yes, this [sharing] website is a bit like a blog. Team members can post articles about their experiences or solutions for problems during the project. They write their experience for everyone to read. Therefore, some newcomers may not need to take heavy training from our company, and just read through those articles to understand the typical problems and solutions.” (I25.8.29.M)

All of the knowledge sharing discussed in these sections refers to sharing processes that are internal to the organisation and exclusively with other members of the same organisation. However, as it emerged from the collected data, Chinese IT professionals also share knowledge with their external professional and social circles.

5.6.3.2 Knowledge Sharing with External Parties

In addition to sharing with internal colleagues, whom they perceive as potential career competitors, some interviewees were more comfortable and willing to share with external parties, whom they see as more “enthusiastic” (I38.5.9.T) to share and with whom would feel “particularly close” (I7.5.41.D). Sometimes they even express that they share “emotional feelings about life” (I7.5.42.D) with non-internally linked external parties.

Therefore, this section focuses on discussing knowledge sharing with these different external parties, namely knowledge sharing within individuals’ social circles (friends and university classmates) and knowledge sharing with professional circles (business partners, competitors and SW community), as shown in Figure 5.37.
Figure 5.37. Concept Map for Knowledge Sharing with External Parties
5.6.3.2.1 Knowledge Sharing with Social Circles

Figure 5.38. Concept Map for Knowledge Sharing with Social Circle
Social circles are “formed within the context of the Chinese Guanxi social network, which may play a more important role than mutual trust” (He 2014, p.136).

“Guanxi means connection and is made up of two words: guan and xi. According to the Modern Chinese Dictionary, guan, as a noun, originally refers to a juncture or a pass that is usually of strategic importance. It is then used figuratively to refer to barriers, as in technical barriers (jishu guan). Guan is, in one sense, a barrier, and, in another, a conjunctive point that connects otherwise separate entities. As a verb, however, guan by itself means to close, but together with other words that denote connection it means to relate to (e.g. guan lian). Such is the case with guanxi. Xi can serve as a linking verb like “be” in English, or a conjunctive word meaning in relation to or having a bearing on. When used as a regular verb, it means to tie up. Guanxi together can be used as a verb or a noun. As a verb it means to have bearings on; as a noun it denotes a state in which entities (objects, forces, or human beings) are connected” (Chen & Chen 2004).

Therefore, Guanxi is known in China as a network of social interactions that forms “intimate and reciprocal relations” (Bian 2002) in which favours and information are exchanged over time, involving individuals within networks of reciprocal obligation. As stated by Zhou and Nunes (2013), this phenomenon has become so important in China that “without guanxi, one simply cannot get anything done” (Davies et al. 2003). Usually, there are different types of Guanxi, namely: “teacher-student relationships (Shisheng Guanxi); classmate relations (Tongxue Guanxi); alumni relations (Xiaoyou Guanxi); kinship (Jiating Guanxi); colleague relations (Tongshi Guanxi); and other friendships (Penyou Guanxi)” (He 2014, p.136). From the interaction with informants, three of these emerged as important in terms of knowledge sharing: traditional classmates and friends networks and web based communities of practice.

In this research, friends were mentioned as one of the biggest external parties that individuals would like to share information and feelings with. However, in terms of
work related knowledge informants seem to prefer friends with similar experience and mutual trust. Evidence of this sharing practice was apparent in the statements from one of the project managers and one of the developers:

“Basically, I like to share with previous colleagues I have been working with for several years, and are still working on very similar areas … sometimes intersections between us lead to knowledge sharing. Thus, we often have discussion and exchanges.” (I1.3.27.PM)

“If I share about work related issues, it is with friends that are in the same industry, because only from the same industry, we could find similarities. For it to be beneficial, these talks must only be based on practice and application of work. Beyond that, we will not talk about company internal technological developments or customer information. That is secret.” (I15.3.4.D)

In China, university classmate Guanxi is seen as one of the most important resources for individuals and generates very cohesive social networks that are actively maintained throughout individuals’ professional careers. This was consistently mentioned in all interviews and it emerged that this is the social circle that interviewees are most like to share with. In this case, informants also reveal a preference to share with others engaging with activities within the same industry, as explained by one the project managers:

“[…] another sharing group is former classmates. Some classmates of mine also work in this industry, and since we have the same interest we can talk and communicate.”(I1.3.30.PM)

Moreover, the classmates from continuing high education, such as MBA and EMBA, are considered as an invaluable social circle for more experienced interviewees. In fact it was explicitly mentioned by managers (e.g. I25.6.36.M) that the main purpose of taking further graduate high education are not only to learn knowledge from
university, but also to make friends from various industries, such as the “financial industry, banking, investment fund industry, insurance industry…the manufacturing industry, as well as government departments and public agencies, etc.”. Therefore, in order to tap into these very important social circles many managers (including CEOs) in China are now taking MBA and EMBA courses. This was the case of one of the managers from the large private company (Bosi) who was, at the time, “doing an MBA course in Renmin University” (I25.6.33.M) which is one of the best business schools in China. Conversely to the friend’s circle, sharing knowledge with these classmates who are from “different industries” (I25.6.29.M), seems to help managers gain and develop knowledge beyond the IT or SW industries, as explained by the same manager:

“Well, one of my classmates gave me very good suggestion on human resource management in my company. Well … he said if I took employees age and gender into consideration for construction of my teams, it would be more helpful for the creativity and cohesion of the team. He was right and I had never thought of this before.” (I25.7.15.M)

Since sharing is mutual, interviewees also provided examples of acting as advisors to other classmates, being the more experienced expert. For instance, one of the managers who took an MBA course, is actually one of the entrepreneurs, founders and shareholders of the Bosi company. He claims to have shared this experience with other MBA classmates who were in the process of “creating their own business or starting their own company” (I25.7.27.M):

“Well, one of my classmates gave me very good suggestion on human resource management in my company. Well … he said if I took employees age and gender into consideration for construction of my teams, it would be more helpful for the creativity and cohesion of the team. He was right and I had never thought of this before.” (I25.7.15.M)

“Some of them are now doing very well on their own. I believe it may have been because of all the conversations and discussions we had related to the experiences I shared with them before. Well … sharing experiences generates mutual benefits.” (I25.7.36.M)

However, helping and advising others does not seem exclusive to managers. Developers and other interviewees gave examples of advising and helping others as
illustrated in the following example:

“I have a lot of classmates who are still confused about of their careers and their professional development. If they really want to do software development, I will talk to them about the trends of each of the programming languagees.” (I6.4.21.D)

This sharing, guiding and advising also seems to include supporting other classmates in specific areas of acquired expertise in the SW Industry, as explained by one of the developers:

“Because I have taken a lot of training and acquired a lot of training materials … like teaching videos or training PowerPoint sides … I can give these to my classmates. One of them, after several months of learning, also decided to go for a job in Java development.” (I6.4.26.D)

Finally, sharing is also done through Web-based Communities of Practice (CoP) as discussed in depth in section 5.6.2 above. The discussion above has already addressed the main aspects of this type of knowledge and therefore no repletion is need here. The only additional point of interest that emerged strongly here refers the added importance attributed to this type of CoP by more junior SW practitioners who do not yet have strong social circles and personal networks.

5.6.3.2.2 Knowledge Sharing with Professional Circles

External professional circles were defined in this research as groups which are interconnected by the professional activities embedded in the working practices of the company, that is, knowledge sharing with either business partners or business competitors. Communication with business partners and competitors is discussed in depth in Section 5.4.2.3.
Figure 5.39. Concept Map for Knowledge Sharing with Professional Circles
In this section, it is stated that these sharing practices with competitors usually emerge with competing organisations in the same area, sometimes working in parallel with the same customers, albeit in different systems. This sharing may occur due to good personal relationships (friendships guanxi as explained above in section 5.6.3.2.1) as stated one of the developers from Bosi:

“I would share knowledge with the partners who are sitting next door. They are from Yirong, not only our business partners but also competitors. I would share with them only because our personal relationship is very good.” (I20.6.5.D)

However, more often this professional sharing occurs because of the closeness in professional activities and interests. Competitors and external partners are identified as one type of party who possesses highly relevant and applicable knowledge, as closely related to their professional experiences as their own internal colleagues.

“I would share with other co-workers. Yes, they are from other companies – our business competitors - but both of us are working for the same customers on the same project, the Jiangsu Electricity Power Company and the digital archive system.” (I20.6.2.D)

Sometimes, these external sources are other companies and business partners that cooperate on the same project. This cooperation was seen to be extremely beneficial by interviewees and an excellent opportunity to acquire new technological knowledge, as illustrated by one of the managers

“Some of those companies have the latest technologies or better experience about some software, hardware, or even the internet issues than us. We realise that in the process of developing the project, these technologies or experience we learnt from them would be helpful for us to use in another project in the future” (I25.26.30.M).

The same manager also expressed the importance of interactions and social
negotiation with the external partners in order to acquire a working understanding of
the new knowledge acquired and being able to use it in future projects:

“Yes … the knowledge we acquire from external companies, sometimes is not given to us
in an explicit format. We need to take the initiative to explore their methods and ways
during the work and cooperation with them. We may also communicate with them
directly about some issue we want to learn more about. Well, to survive in this business
we are always paying attention to a variety of ways to gain relevant technology knowledge
from competitors and partners … if we can of course.” (I25.26.35.M)

Besides the technical knowledge that could be learned from external sources,
participants also mentioned that management methodologies could be learned from
cooperation between competitors. Participants stated that they could then “apply this
knowledge to their own working practice” (I25.27.12.M), as illustrated by one of the
managers:

“Yes … there was an example where we have taken the benefits from others’ knowledge.
Our partners have a set of methodologies for implementation SW, which is much more
advanced and systematic than ours. So we took their concepts and principles, and
combined with our actual needs as a company. Eventually, it helped us to improve the
knowledge of our own developers and installation people … yes … the efficiency of their
work was much improved.” (I25.27.26.M)

Therefore, to sum up, it seems that according to the perceptions of the informants, the
capability for knowledge sharing is very important for SW practitioners, no matter if
they are experts or novices.

“I do share a lot. I like to have a chat with people. Because, I know sharing is not only
important for experienced people, but also good for inexperienced people.” (I28.3.2.PM)
5.7 Working in Projects

Working in projects is an inherent characteristic of the SW industry. Projects are created and teams are formed to design, develop and deliver SW products and services. Members of projects assume different roles in different projects depending on size, importance and sensitivity. Therefore, participants constantly referred to project work during the interviews in order to illustrate their statements, perceptions and opinions. This systematic focusing of the interviewees on project led to the emergence of the “Working in Projects” category and explains why this is the most extensive and comprehensive category of the emergent theory discussed in this thesis.

At the early analysis stages of this research, this category was even considered for a core category, but selective codes have shown that there were a number of experience aspects that are generic and not project dependant as shown in the other categories that form this theory. Nonetheless, this is still the largest and more complex of all the categories discussed in this thesis. This complexity reflects the complex set of skills (ranging from soft to very technical ones) that are informed by experience of
working in projects of this nature. This “Working in Projects” category was divided into six sub-categories that are discussed in depth in the remainder of this chapter, namely: Management of Projects, Management of Project Teams, Working in Project Teams, Interacting with Customers, Building and Maintaining Customers’ Trust, and Providing Training to Customers (as shown in Figure 5.40).

5.7.1 Management of Projects

![Diagram of Management of Projects]

**Figure 5.41.** Concept Map for Management of Projects

228
The management of project activities is a permanent feature of the design and development of SW products and services. For a manager, it usually includes activities such as planning, organising, motivating and controlling the process of development, design and implementation, as stated by a senior manager:

“In fact, during the entire project, it is important to monitor the plan. In the other words, it is to important that I control the developing and the progress of project.” (I5.7.34.M)

As a consequence all the interviewees had very strong opinions on managing projects, and the skills and experience that are necessary to make a project succeed.

“Before assigning the tasks, in my own heart, I have set the bottom line for time, including the upper and lower limits. Since I have developed SW so many years, I can figure out how much time is needed for the tasks.” (I1.2.35.PM)

“Usually, we will break down a project into several small pieces of tasks. After that, I will assign tasks to the person, according to the situation of the project, including the different abilities of individuals.” (I1.2.32.PM)

However, technically managing the projects is not the only perceived responsibility of managers. They also have the responsibility to monitor, manage and support each of the project members. That aspect of management is discussed in 5.7.2. Additionally, it is expected that all members, including the project manager, understand the work breakdown structure and activity sequence of the project as expressed by one of the developers as follows:

“[…] Let’s say it’s a problem of sequence … because various projects have different patterns of operation. Very different situations can occur. When we implement one project, we may plan the sequence of tasks in a particular way. But we may find out that
This sequence is not suitable for the next one. In this situation, we need to change, in order to enhance the effectiveness and speed of development.”(I2.3.15.D)

It is, therefore, clear that every individual no matter whether a manager or not, is always required to have high awareness of management, not only in terms of their own work, but also of the whole process and sequence of tasks. Figure 5.41 illustrates the richness and variety of elements for project management identified from participants’ statements, as shown in Figure 5.41: Project Creation, Project Feasibility Assessment, Task Assignment, Task Estimation and Scheduling, Project Monitoring and Control, Quality Assurance of Internal Processes, Risk Assessment and Management, Documentation of Project Activities, Summative Evaluation of Completed Project as well as Reuse of Information and Resources.

5.7.1.1 Project Creation

As shown below in Figure 5.42, researching the market, identifying opportunities and getting projects from customers compose the first stage in SW development and are a fundamental factor for success of project. Therefore, in order to explore the market for SW development and create new projects, one of the project managers stressed on the ability of exploring new trends from both the perspectives of business and technology:

“The understanding of the business and development trends helps me to explore new project ideas. In order to write the idea into a project proposal, I certainly should be aware of the current situation of in our business environment and also have an insight of its future technical development. More … I also need to the understanding of new trends in the software business and the knowledge of the latest technology, such as cloud computing, smart archives or big data.” (I32.4.20.PM)

Reinforcing this idea, another project manager claimed the importance of being aware
of new technology in creating a project:

“Yes … we need to propose a plan for next year’s project every year. Now is June 2013 and I am going to write a feasibility study of a new project for 2014. I need to think about it in advance. Of course, the plan needs me to explore and dig out what the new trends of the emerging technology are.” (111.8.41.PM)

![Image: Concept Map for Project Creation](image)

**Figure 5.42.** Concept Map for Project Creation

However, and potentially more importantly, in order to explore the possibility of establishing new projects with existing customers, participants expressed that gaining
ideas from the customers themselves was the easiest way to create new projects, as explained by one of the developers:

“When I write the proposal document, I first talk to our customers. I let them say what requirements they need, what is missing in their system and what functions they would like to have. Yes … I would collect some information from outside resources (such as the Internet), and also look at the expectations of other customers. Normally, our customers have higher expectations on functions than what you can identify from outside information on the Internet (laughs). Our customers have a relatively strong understanding of technical aspects as well, such as the State Grid Corporation who has installed information systems for many years.” (I12.4.10.D)

Participants, not only managers, also expressed that another good way to find new ideas for projects is by seeking, identifying and analysing external experienced case-studies “in the same field of business” (I12.4.9.D) but “abroad” (I12.4.9.D). The perception in this case, is that ideas that have been tried before, but not yet in China, may bring an easy competitive advantage as suggested by one of the managers:

“Like I just said, it would be good to go abroad to study [others’ examples]. The purpose to specially mention this to you here is I know we can learn a lot from foreign companies’ practices that we can then sell to our customers. For example some foreign companies are doing management of electronic records in very different ways … we can also apply this to our customer companies. Our competitors in more established SOE companies often do not have people with good English to do International research. So we can use foreigners’ experience to enhance our proposals and produce new ideas.” (I19.6.25.M)

One of the managers of Yirong who works mainly with archive SW for the Sate Grid SOE expressed that “the application of archives system in the State Grid is already very mature. It is very difficult to discover new breakthroughs for a new project. Therefore, it is very important to think from a multi-disciplinary perspective and bring
fresh ideas and explore new projects” (I11.9.19.PM). This multi-disciplinary vision was seen to be fundamental in the creation of projects that are not only innovative but more adapted to the needs of the customers:

“To make my proposal unique, I need to write a feasibility study to make the customers feel this is a new breakthrough and a new bright spot in the archive system, and this is not redundant reconstruction of the original system. [...] In order to this I may need something unique, such as a new knowledge from other disciplines and industries, or a recent finding in computing research.” (I11.9.18.PM)

Finally, participants of all three companies expressed that presenting and attending both industry and academic conferences is an additional way of not only acquiring new knowledge and ideas but also of maintaining and attracting new customers that also attend these conferences. This is a significant difference from practices in West, where companies do not attend academic conferences and academics seldom attend industrial ones. The difference here, may be due to a recent Chinese government policy entitled Industry-University-Research that aims at linking industry and universities through research. Many academic conferences are now sponsored and attended by industry operators and manufacturers, mostly the government sector and SOEs who are by far the major players in Chinese economy. In turn, the attendance by government and SOEs, who are often the major contractors for SW, strongly motivates SW companies to attend and present as well. This provides a great chance for companies to present their ideas, research and products as well as to establish links to potential SW customers, development partners and researchers.

“Well … the way to explore our market is to attend academic conferences and industry associations’ events. There are regular events for industry and academia to present the latest findings of e-archives, such as industry associations, research seminars, and marketing & sales presentations. We can then establish contact with potential customers and other developers and manufacturers during those conferences.” (I25.10.12.M)
Moreover, after understanding the new trends in business and IT and gaining new ideas from different sources, the real crucial aspect where experience has a significant role is the ability to combine these generic and at times theoretical knowledge into proposals that customers will be willing to commit to. Therefore, it is the applying of generic trends, research and ideas into practice that was seen as the key factor to ensure the approval of a new project. This point was strongly put forward by one of the managers from Yirong:

“For plan a new project, I may gain ideas from theoretical knowledge, like published in textbooks and academic journal papers… I could get some ideas from these more advanced and newest trends…Right … but the important thing here is that I am able to apply it into my customers’ situation and create a new project proposal.” (I19.6.22.M)

Consequently, “ideas are always good, but how to convince customers is difficult” (I19.2.29.M). This seems to be a constant concern with both managers and team members. Informants of this research clearly identified the ability of clearly express the ideas so that they point to advantages to customers as critically important:

“I think technology may not be as important as you think for new project creation. However, you need to enhance the quality of ideas you propose. For example, when you write up a new feasibility report, you could stress that you aim to improve the functions of archival compilation to a higher level, from an archives management perspective … not from a technical perspective. Then, it becomes a great idea that customers can accept.” (I11.2.31.PM)

Therefore, “business tenders require a very high quality of writing” (I11.8.8.PM), “especially in the technical requirements, you need to relate to each requirement and answer them one by one, which is what we call a point-to-point response” (I11.8.10.PM). Therefore, keeping a high quality of writing in response to business
tenders was seen as a fundamental factor, as explained by the same project manager:

“The bid report itself has high quality requirements. If there are errors of spelling or ambiguous words inside, it all might affect the result and then the bid fails.” (I11.8.18.PM)

“Because there are several companies all together bidding for this one project, if your bid report has problems of writing or response to requirements, it could affect the entire tender documents and you fail. Yes … I think the ability of careful writing is very important, especially when bidding.” (I11.8.20.PM)

Moreover, from a managers’ perspective, the way these new ideas are put forward may have severe implications for how the project is viewed by customers and appraised internally in the company. New ideas may not be directly connected to the price and budget of the project, which depend on both understanding of what is being proposed, how ideas are perceived by customers and how the implementation of these ideas impacts the project in terms of effort, development time and resources needed:

“We should have an ability to take strategic action on a new project, because users may think some features may be rather small, but we could make them bigger. This requires some strategies to be express in the proposal and project plan. For example, we may say a project needs a budget of one hundred thousand Yuan, or two hundred thousand Yuan. This is actually very abstract in terms of software project budgeting, because SW is very intangible stuff and not like other physical entities, such as a bottle of water. I can price one bottle as two Yuan or five Yuan. But for a SW system project, the assessment of its value is difficult and different. It all depends on how hard to program features we create are. Well… this needs a lot of thinking and work.” (I19.2.9.M)

Finally, in order to appropriately appraise projects, participants expressed the need to have an ability to conceptualize the project as whole:
“I think in the planning stage of SW development, we need to have strong abilities of conceptualising the project as whole. In fact, the project plan contains the whole project construction as well as the stages of post-implementation. Generally speaking, we have to use the business feasibility report to describe what we are going to build, how many people we need and how much money we are going to invest in this project.” (I11.7.26.PM)

5.7.1.2 Project Feasibility Assessment

Informants in all three companies stressed the importance of feasibility studies. These were seen to be fundamental to assess if the application required is technically possible and if the company has the resources and know-how necessary. This later point was particularly seen as crucial and be able to evaluate the team’s ability was perceived to be the essential factor to determine “if the team has the technical ability to achieve the functions required by customers” (I6.9.10.D) and “if the company can take charge of the project or not” (I5.3.10.M). Based on this consideration, one of

![Figure 5.43. Concept Map for Project Feasibility Assessment](image)
the managers expressed:

“If our team is not able to handle this project, then as a manager, I need to think how we are going to deal with it. Maybe we need to hire more employees, or we could find an outsourcing group for assistance? […]” (I5.3.1.M)

“If we decide to develop the SW by our own staff solely, then we may need to recruit more people. The issue here is that I have to face a long-term contract with these new employees. It may take more money than just paying for an outsourcing group. In this case, we would certainly prefer to use the outsourcing group.” (I5.8.27.M)

In order to convince customers, the initial planning and design report for the SW was used to show the background and qualification of the company to successfully accomplish the project. However, before planning and designing the SW project, it was also seen as essential to understand internal standards from customer companies and ensure that the project complies with them. For example, one of the customers from Yirong, the “State Grid, has issued a National Grid Company Informatization Architecture Management Standard” (I11.12.19.PM). For the design and planning report, they would “appoint people to check if there is compliance with their overall information system architecture management practices” (I11.12.17.PM), otherwise, the plan “cannot be approved” (I11.12.20.PM). Moreover, one of the installation experts described a vivid process of complying with standards that customers’ companies applied:

“I think it is very important to make an overall plan in the early stages of the implementation… We are dealing with customers who are mainly from the power industry. Firstly, we must have good knowledge about the requirements from State Grid Headquarters, such as what are the general requirements and overall objectives for the entire implementation. Secondly, based on the general requirements and objectives from the top, we must provide our own implementation plan according to the situation of each
provincial company. This provincial plan should comply with missions for this particular region that I am in charge of. Finally, based on the initial plan, we should go to the customers’ sites to communicate and gain their local support.” (I13.8.33.D)

Moreover, the business plan and design should be considered very carefully and comprehensively, especially when it connected to cost management.

“Writing the report for business plan requires a lot of experience. Because the preliminary plan also includes the budget plan for whole project. Based on the preliminary plan, the cost and budget estimations can be determined … you know … the length of time and the number of project members. Therefore, the plan at least should consider duration and resources to be invested in the project.” (I25.11.16.M)

5.7.1.3 Task Assignment

Division labour and task assignment should be based on the principle of being “fair to everyone” (I3.11.33.CM). However, this is a very vague principle and in order to make the project more efficient, managers “divide tasks based on their members’ skills and abilities” (I30.3.29.D). This opinion was strongly stressed by many team managers and members:

“For example, according to his working efficiency, I could understand that if he was good at this type of job or not. If the tasks I assigned were relatively familiar for him, then his work would be very efficient.” (I30.3.30.D)

“For example, there are two languages to achieve the function of module, one is the C language, and another is the Java language. If he is good at C language, we will assign it to him … We would decide the division of tasks according to who is good at what.” (I6.10.8.D)
“For example, different colleagues may have different capabilities … maybe I am only good at writing, but not good at oral presenting. For another colleague, maybe he is good at organising and presenting, but a little weak at writing. Then, we can negotiate and divide the tasks. Therefore, the strength of teamwork will be maximised.” (I8.6.18.D)

![Concept Map for Task Assignment](image)

**Figure 5.44.** Concept Map for Task Assignment

Moreover, before assigning the tasks, “I should have a certain understanding of individuals’ abilities … simply speaking … I should know what kind of person is suitable for each task” (I28.3.16.PM). Therefore, there is a need to evaluate the individuals’ abilities.

Participants identified several ways of estimating each member’s ability from
interaction with a number of sources, such as: Performance Evaluation, Previous Working Shared Working Experience, Internal Seminar Initiatives, Previous Leaders, Company Salesmen, Customers’ Feedback and Direct Communication with Team Members.

The most traditional and formal way to obtain information on the individuals’ abilities is by consulting their performance evaluation:

“Normally, manager [Name deleted] is in charge of quality control for project implementation and assessment of employee performance. Yeah … so I can go to him and get the assessment of each individual’s ability.” (I28.3.38.PM)

However, it was generally agreed by all managers and particular by team members that individuals’ abilities cannot be well expressed by traditional performance evaluation, due to its mechanistic and synthesised nature and, therefore, it does not show the whole picture of an individual abilities. So managers expressed the need to use different sources. For instance, many of the project managers interviewed preferred to use their own judgment based on the previous experience of working together:

“During the daily work, I we can observe each member’s activities, the quality of his tasks, and specially the circumstances of his communication with customers. Based on my own investigation, I will certainly have a basic understanding of his ability, and then I can arrange good tasks for him.” (I26.13.36.PM)

“From the previous work they have done and my daily contact with them, I could easily identify if they are suitable to do the work and to satisfy the users’ requirements.” (I25.26.7.M)
“For the newcomers, I can only make a preliminary judgment of them from his initial communication with other colleagues and their previous experience from the job interview. Of course, when I arrange people, it is certainly based on the understanding of them. What type of person is he? Is he senior or junior? All of these should be estimated.” (I19.7.24.M)

Since internal seminar initiatives are widely used in the companies, as discussed in section 5.6.3.1.2 and section 5.5.2.2, another project manager recommended a very different way by judging the individuals from seminars they provided:

“I can estimate his professional knowledge and ability from the training course and seminar he provided to our staff. It is really a good opportunity for me to review his ability comprehensively.” (I27.12.40.PM)

If there is no previous experience of working together managers seek the opinion of previous project managers that worked with the individuals in question:

“To understand each member’s ability, I could talk to other project managers about their past performance in previous projects. However, even if he is good and if this person only has a few months’ experience … surely… it is impossible to put him in charge of an important module.” (I18.4.6.PM)

Two of the companies studied (Yirong and Bosi) have staff working in very different cities for prolonged periods of time. These staff are away for months at a time and very far (thousands of kilometres) from both headquarters and their project managers. In this case, “salesmen” who travel to these cities on a regular basis can be useful source of information as well. “Salesmen”, as understood by these two, are in charge of customer relationship management, customer satisfaction and negotiation of new features. Due to their regular visits these salesmen are frequently in contact with the employees posted in the different customer locations and fundamentally are
also able to gage the nature and strength these employees have with the customers. The ability to maintain and nurture this relationship is considered to be very important by all project managers.

“I can get a lot of feedback from salesmen on our installation experts’ working performance, because salesmen travel to different provinces very often, and have more opportunities to get in touch with those on-site installation staff. When the salesmen came back to Beijing, I would have a chat with them and become familiar with the abilities of our installation experts through the salesmen’s judgment.” (I28.4.21.PM)

Since this customer satisfaction is seen to be of paramount importance in the success of the SW projects, some project managers would even consult the customers themselves and seek their feedback to judge the team members’ abilities:

“I also can understand individuals’ abilities through customers’ feedback … After working for customers so many years, I think I have good relationship with some customers whom I could easily ask about their opinions on my project members’ performance.” (I28.4.17.PM)

Finally, if everything else fails, direct conversation with the team members is also used to inform task assignment:

“Sometimes, I could gain an understanding of the individual’s ability through telephone communication as well. Our installation staff are located in various provinces. So I talk to them mostly by telephone. Through the telephone communication, I can assess what kind of situations they can solve and which they cannot … then make up my mind on their assessment.” (I28.4.4.PM)
After assigning tasks into each individual, participants attributed an important role to experience when estimating time and resources as well as scheduling these tasks in order to form the overall project.

“After assigning the tasks, in my own heart [meaning after careful reflection], I have set the bottom line of time for each task, including the upper and lower limits. Since I have done SW developing so many years, I could figure out how much time is needed for the tasks.”

(I1.3.1.PM)
The crucial role “experience and expectation” (I1.2.33.PM) in estimating and scheduling was explicitly mentioned by most of the interviewees and seems to be a well-accepted principle.

“In fact … time estimation … is mainly based on my own experience. For example, for the same module, I may need 3 days to develop it. If he is a beginner and not very skilled, then I would give two more days for him to figure out the way.” (I26.7.20.PM)

The accuracy and quality of task scheduling was very important to avoid “wasting time and redundant workload” (I32.4.27.PM). “Reasonable” (I32.2.25.PM) task scheduling should take into consideration “assessment of and reflection on each step and sequence” (I32.2.24.PM). This opinion was fully explained by one of the content managers and one of the developers:

“The issue is the logic of task sequence. We may have to further improve it. Because we always need to re-do the tests, it is certainly not a once only job. [...] We now need to do one job several times. It is about the logic that I mentioned above. You firstly change one part, and then later discover this is involved with other things. This result leads you to change the previous part again. So I think the logical order, really should be clear.” (I3.12.3.CM)

“ [...] It’s a problem of sequence. Because various projects have different patterns of operation. [...] When we implement one project, we may plan the sequence of tasks in a particular way, but we may find that this sequence is not suitable for the next one. In this situation, we need to change in order to enhance the effectiveness and speed of development.”(I2.3.25.D)

Lastly, it was recognised by informants that for a leader to schedule, manage, disseminate and monitor the progress of each task, suitable project management SW
is fundamental.

“In terms of implementation, such as time management, I use project software … you know Microsoft Project … for breaking down the specific tasks. It lists the content of main activities in terms of its tasks, who is assigned to particular tasks, and how much time is to be spent in each task, so I am always clear about the situation of the project and what has been done.” (I1.4.4.PM)

However, Microsoft Project is just an additional support tool to monitor the project progress. However, monitoring requires much experience and management knowledge that is discussed in the next section.

5.7.1.5 Project Monitoring and Control

Monitoring and control are fundamental project management activities and revolve around processes to “assess all the tasks and individuals’ working activities to ensure the project proceeds within scope, on time and on budget” (I1.5.5.PM). As shown in Figure 5.46, “a clear and comprehensive understanding of the project” (I1.7.17.PM) was seen to be critical for planning and controlling a project. This point was strongly stressed by one of the project managers:

“Only when you have an understanding of the entire project and the whole process from start to end, can you manage the project. If you do not know the project profile, the whole process, or the significant milestones, it becomes really difficult for you to plan and manage. Of course, you will also not be able write up a report of the plan.” (I26.5.25.PM)
Controlling the development process according to the plan was also seen as a fundamental factor to the development process, being able to keep the project within the agreed scope. In order to this, “constantly monitoring every future milestone” (I25.12.24.M) was seen to be necessary. One of the managers provided a detailed illustration of this process:

“Yes … we would make a regular summarisation and inspection of those milestones we finished. Well … it is impossible to have a meeting or exchange seminar every day … that would really affect the efficiency of work. So according to the size and content of project, we would harmonise the length of milestones into certain weeks or months. If the
project is relatively large, then we might make the milestone length just a bit longer. For example, if the project takes two years, then the significant milestones could be at the end of each season. Then we would have an inspection of modules and SW direction during each milestone. However, if the project only takes one month, then I might hold a meeting or inspection every day.” (I25.12.29.M)

The approach proposed by this manager is counter-intuitive and opposite to textbook practices that would advocate review of each milestone after its achievement, rather than artificially associate it with natural annual holidays. However, it clearly reveals pragmatic thinking informed by experience and provides an excellent example of what this research was trying to find.

Monitoring the quality of team members’ work is a necessary process to ensure the success of SW projects. For example, one of the managers explained the importance of quality in coding processes:

“I am also in charge of coding, but only direction of development and quality of coding. I do not do coding anymore. I am just in charge of auditing their work, supervising them, or sometimes making timely adjust meat to the direction of their work. Because programmers only focus on coding their components, how the whole thing is going to turn out … they don’t know and don’t care. For me, I need to tell them what it should be. This would make sure our project is developed the correct way.” (I4.2.1.M)

Moreover, regular monitoring the progress of the individual’s work according to the tasks assigned to is seen by participants as a constant supervision task. In order to do this, good communication practices by project managers and team managers need to be employed, as discussed in section 5.4 and illustrated by one of the installation project managers from Bosi at the Shanghai customers’ site:
“Because currently there is not so much work on the archive system, I can arrange for one of the newcomers to deal with it. I just need to communicated with him regularly, have a chat with him once in a while … then I can monitor all his daily work. Sometimes, I ask him to meet me or sometimes I just give him a call.” (I23.4.15.PM)

However, as stated by the same installation project manager the monitoring of the team member should not become overwhelming by putting too much pressure on the team. It should be done in an “appropriate way, so that I do not to push him too much and he can do his work” (I23.4.21.PM) or “I do not keep on asking about his progress such that he feels pressured” (I23.4.29.PM). He suggested that:

“I would set a small milestone, and in this time I want my things to be done. For example, I would arrange some tasks for him to do in the morning, and I would not to rush him during the day, but when the time passed a certain point, I would come and ask for the things.” (I23.4.21.PM)

“Of course, if the task is urgent, I would ask him to work on it immediately. But if the task is not so urgent, then I would give him a range of time to slowly arrange his work. Basically, I would not rush him anymore.” (I23.4.43.PM)

Although many project managers disagreed with “monitoring all the time” (I23.4.28.PM) which makes their members “more anxious” (I23.4.28.PM) and “very tired” (I27.14.18.PM), one of the R&D project managers from Bosi insisted on using this approach to maintain strong pressure on team members and push them to work:

“By using my way [maintaining strong pressure on team members and monitoring them regularly] to manage the team members, we can continually achieve our goals, and customers will be really satisfied and impressed by our fast work. Moreover, the management way of delegation authority needs a long time to reach a successful outcome. But in fact, I think my team members do not have high qualifications or self-control. They
have just graduated from university. As a leader, if I do not keep enough pressure on them, they would not have the sense of responsibility to complete their duties on time.”
(I26.11.22.PM)

However, this same project manager also expressed some doubts about his own approach, that is some “doubts on my own management style” (I26.11.12.PM):

“In fact, from my personal view, I think my way is more effective, but, from a long term perspective, this way may cost the company because we always lose people … because I know that people cannot keep on working under such high pressure conditions.”
(I26.12.13.PM)

This interesting contradiction in his own statements shows a process of learning through reflection on his own management practice and the effect of experience starting to change his initial very strict stance. In itself, this excerpt of data shows the influence of experience in changing a set of beliefs and is very strong evidence to support the importance of sharing tacit knowledge to encourage this type of learning and professional growth.

The above discussion also shows that “an appropriate monitoring approach” (I26.12.2.PM) is required not only for “alerting the leader about the current situation” (I19.7.34.M), but also allowing the individuals to work in “a relatively relaxed environment” (I23.4.29.PM) in order to achieve maximum efficiency in the work. Nevertheless, despite all the controlling activities discussed above, it became apparent from participants statements that frequently the reality of work did not match the designed plan. In these cases, there is the need to resolve the deviations from the plan, as explained by one of the developers:

“Eventually, there is a gap between the desired product and the thing you design, because the product is not like the one that you original estimated, or it does not achieve the desired
results. So, in this case, you need to reassess and re-understand some of the issues.”

(I2.10.2.D)

In the case of deviation from the initial plan, managers need to act and resolve the problem. If risk analysis was done in advance then the procedures discussed in section 5.7.1.7 are implemented. If not:

“The important issue is how to solve the problems when they cause deviations. We need to analyse the nature and character of these problems, and determine if these problems will affect the next stages, the progress and the milestones. Were these problem caused by human negligence? Were these problem caused by uncontrollable factors, like technical difficulties? If these problems can affect the key milestones, what is the situation going to be? If the problem would not create so much trouble, what will we do? Based on all these different situations and different reasons, the solutions can be totally different.”

(I25.13.1.M)

Participants concur that these deviations occur very frequently. The worst problem seems to be that “technical difficulties happen very often” (I1.7.28.PM) and take considerable amounts of time and human resources to solve and sometimes they even delay the projects. Therefore, the ability to resolve technical difficulties is seen to be very important in order to carry out the project successfully. “After years of working experience, it is possible to solve the difficulties with the help of known tools and resources” (I14.2.21.D). Moreover, resolving these difficulties may require a more flexible way: “Sometimes the indirect way may save a lot of workload. It is like the [Chinese] proverb says - saving the nation through twisted means” (I26.17.35.PM). This opinion certainly requires solid experience, which was strongly advocated by one of the developers:
“The more experience you have, the more flexible solutions you can provide… Right … so you would create more alternative conditions for yourself to solve this technical problem.”

(I14.2.28.D)

Consequently, assigning tasks, estimating effort, scheduling the work, monitoring and resolving deviations from the plan emerged from data as being highly dependent on work experience. This is therefore not a surprising set of findings since these are inherent part of SW development.

5.7.1.6  Quality Assurance

![Quality Assurance Concept Map](image)

**Figure 5.47.** Concept Map for Quality Assurance
Quality assurance is defined by ISO 9000 as “a part of quality management focused on providing confidence that quality requirements will be fulfilled” (ISO 9000:2005, Clause 3.2.11). However, the category that represents quality assurance emerged with a much more precise and pragmatic definition as the process of preventing mistakes or defects in designing, developing and delivering SW products and services. Respondents refer to the ISO by default, but their practices seem to be almost exclusively based on the Chinese national standards, such as the “Specification for Computer Software Quality Assurance Plan (GB/T12504-1990)”, which was often referred to the first quality guide to follow, as explained by one of the development managers:

“Understanding the Chinese software standards is really important for me. The SW architecture design must be based on those domestic standards. This serves not only to satisfy the customers’ requirements, but also to guarantee a quality level that can be certified by the authorities after the SW is implemented.” (I26.6.41.PM)

“Advocating standardised procedures” (I9.3.9.D) in the process of project development was defended and emphasized by all of the interviewed companies, in order to ensure the quality of SW products produced and SW services delivered. It was illustrated by two of the managers from Yirong and Bosi as follows:

“We have our own methodology of SW implementation. In other words, we require a standardized process for delivering SW products. For example, we currently have a system being implemented into the customers’ company. There is a set of standardized processes, from the beginning, that is from the initial workshop with all members [initial motivational meeting that is used to inspire, brief and prepare all team members to the work ahead, specific of the Chinese culture and also used in other Asian cultures such as Japan], to the data migration, and later, to the operational testing. Yes … all of these processes are standardized and need to be followed.” (I19.11.24.M)
“We have our own methodology of project development, specially the SW Implementation. We have developed it ourselves and always use it in combination with the specific customers’ needs. After several years of practice, the specification of the methodology has become relatively mature now. Again … this is best practice emerging of experience of doing the work combined with users’ real needs. This mature specification allows us to implement the system together with our customers in a more systematic and efficient way.” (I25.21.10.M)

Moreover, “Quality is not just a good program now. SW system architecture design requires a very high technical ability and experienced skills so that it can be easily maintained and expanded in the future” (I25.18.33.M). Respondents pointed out that SW architecture design needs to adopt long-term thinking in order to support future “customer’ further requirements and guarantee potential system’s development” (I30.7.37.D). One of the managers used a simple metaphor to explain this point:

“I will give you an example … The work of architecture design is like a complex kitchen decoration project. If the work on pipes and electric points is not done correctly and in coordination, then later you would find that the machines for the kitchen cannot work because they cannot be connected to the electricity. Design definitely needs you to plan in advance and have overall insight of further development. Thus, the system design, especially architecture, needs sufficient consideration of underlying protocols, public components and structures, interfaces, etc. […] Moreover, architecture design also needs to consider maintenance and sustainability of the system. Right … a comprehensive consideration of many issues. If the structure is not carefully designed in the beginning, and misses a specific interface, then the system would not be a complete system. Once the system is done, it becomes really difficult to modify the structure from the top. So, during architecture design, our thoughts should always be comprehensive and thoughtful.” (I25.18.11.M)

Since SW design and development is an activity that is very technical and produces a
tangible artefact that needs to conform to both a requirement specification and socio-technical environment where it is going to be used, it crucial that leaders clearly understand the nature and role of testing in the project. Testing and verification is seen as a process of checking if the SW system satisfies the customers’ requirements and fulfils its designed purpose. This understanding determines the choice of testing approach, method and the composition of the testing team. One of the project managers claimed that:

“Unit testing requires relatively low connection to coding from a macro perspective. Because each functional module is relatively independent, and not closely connected with others, we can test them independently. In this sense, it requires relatively higher quality of coding by programmers.” (I1.10.28.PM)

The same project managers also highlighted that the selection of testing method and team depended on the company size and resources.

“For now [we only do unit testing], there are problems of time and with the external environment, so we do not have the necessary conditions for system testing.” (I1.11.2.PM)

Nonetheless, as a crucial part of SW development, testing needs a tester that has acquired a specific set of skills and experience in order to be able to verify the quality of SW products. Before testing, it was important to understand the aims and criteria specified for the testing, as explained by one of specialist testers:

“Our company’s products would not focus on beautiful interfaces. We are not an Internet company, who needs to focus on the foreground and user-experience of products. For example for SINA, each page of its application needs be beautiful to attract users […] Our enterprise’s application products focus on functionality and specific features instead. Therefore, the aspects of what I test are different.” (I38.1.33.T)
Here, SINA is one of the biggest online media company which serves China and
global Chinese communities. Its digital media network of SINA.com (portal),
SINA.cn (mobile portal) and Weibo.com (social media), enable users to access
professional media services as well as user generated content in multi-media formats
from the web and mobile devices, as well as to share their interests and media objects
with family friends and acquaintances. The pilot case-study, the multi-media
company Baiduchuan, as a multimedia application company has a similar user and
service target. That company like SINA, put the aim of their development on this
type of “user-experience” (I3.10.37.CM), and has specialised content managers in
charge of testing “interface beauty” (I3.10.13.CM). Conversely, the two main
case-studies, Yirong and Bosi, targets business and corporate customers and therefore
focuses on the quality and adequacy of the functions and features of their SW, rather
than on user interfaces. Therefore, the purpose and focus of testing may be very
different as well as the experience and skills required for the different types of testing.

Informants interviewed in all three companies, stressed the importance of testing from
a customers’ perspective, especially from a customers’ operation practice. Because,
“if you want to test the system, you have to know is how the customer works”
(I21.7.31.D). This opinion was clearly expressed by one of the managers as well as
one of the project managers:

“Yes … I would follow the structure of customer requirements as indicated in the test
specification to test the functions. Sometimes, I would check if the features were designed
and developed following the customers’ way of operating … or if customers’ needs were
satisfied by use the feature when they start to use the system. I always test the system
from a customers’ perspective, with special consideration of customers’ operating needs,”
(I19.11.15.M)

“The most important thing in testing is to understand the system that I am going to test.
Yes … I should know what is the scope of customers’ use and frequency of their use. For
example, if one user only uses this system once a day, when I prepare the pressure test, if I test for a thousand times of daily use, then this testing is not meaningful. Therefore, when we do the testing, we have to know understand that information, such as the frequency of use, the objective of use, the scope of the use and the internet environment of the customers’ company. In other words, we should pay attention on all the background environment of the system and operational practice of customers.” (I10.7.32.PM)

Moreover, “when testing one module of the system, the modules that are related to this one, should also be tested.” (I20.3.11.D). So that “when delivering the system to customers” (I29.6.24.D), customers could use all the interconnected functions without problems. Therefore, the testing of related modules was considered of crucial importance during testing:

“Oh … I think logic is very important when testing the system. When customers use the system, their logic is to use it for their operational needs. For example, if they use one function first, what is the next function that they are likely to use? Therefore, we should test these correspondences and the links between these modules. In other words, we have to understand the customer’s logic as well as the system’s logic. Yes … comprehensiveness, we need to know the connection between the each module and corresponding workflow of the entire system.” (I20.11.11.D)

Importantly, testing work is totally different from designing and developing SW, because “developers and designers only need to complete their allocated functions, but testers need to consider the functions from an opposing aspect, that is, in what circumstance could these functions not be adequate.” (I38.6.31.T). Therefore, one of the testers proposed to use a “deliberately wrong” (I38.7.5.T) strategy to test the success of functions, as simply explained by one of developers:

“When I test the system, the input of correct data is to guarantee the integrity of features and the input of special data is to ensure the system does not have extreme bugs. For
some testing data, there are maximum and minimum criteria that are required. If the testing data reaches the maximum, the system should provide an alarm. If I do not enter any data into system, the system also should provide a warning. So my testing also must include wrong data that tests these restrictions and finds potential bugs.” (I14.5.40.D)

This sub-category is particularly interesting and challenges some of the prevalent prejudices in SW development that testing should be a mere mechanistic process of following test specifications predefined in previous stages of development. In fact, contributions of participants at all the different levels of the three companies seem to indicate a rich and complex process that requires capable and experienced individuals capable of contextualising testing in operational environments and work practices.

5.7.1.7 Reuse of Information and Resources

![Figure 5.48. Concept Map for Reuse of Information and Resources](image-url)
Reuse of code, information and resources was frequently mentioned in the interviews by both managers and SW developers. Reuse is considered as a very important strategy to save time, improve efficiency, and sometimes even improve the quality of work by reusing other’s experiences. This category emerged from the data as being composed of five aspects of the SW development process, namely: Reuse of Working Methods, Reuse of Public Code Libraries, Reuse of Own Code Libraries and Reuse of Algorithms and Reasoning Frameworks (see Figure 5.48).

Reuse of public code libraries is very common practice in the SW development world and is a way used by the vast majority of developers for both programming and development of new ideas and algorithms. One developer explained this as follows:

“To improve working efficiency, we mainly use open source code. For example, to import the data from our system into an Excel spreadsheet or XML files, we are using code that I searched for and found on an open-source website.” (129.5.17.D)

One project manager even listed a number of open source sites that he frequently uses for help, as follows:

“Right … [to reuse code] I would use code libraries from some open source projects, such as Apache. Apache is a software foundation which manages a lot of successful open source projects. It is a relatively well-known open source organisation. Another one is a company called Red Hat. They also display some source on their company website. Yes … these are all reusable components and libraries.” (132.9.40.PM)

Additionally, in order to speed up and better manage their work, many developers, especially programmers, also store the code they write in their own code libraries and then reuse these whenever similar functionality is required. Two developers gave very good accounts of how they do this as follows:
“Each time we produce code and materials for one job, we will collect that code. These are the things we collect. If we need to use this code again, we retrieve it, modify a little bit, and then re-use it. There is no need to code everything from the start to the end. This would be a waste of time. Because this is code you used before, if you keep it, you do not need to code it again.” (I14.5.1.D)

“I think that in order to improve my work efficiency, I do not want to repeat coding for similar modules. Yes … I do not want to repeat programming for functions that I previously developed, and use the code in the libraries I already have. Moreover, I can use this [existing] code to develop others functions. This is a perfect method to improve efficiency in software development.” (I31.5.31.D)

Moreover, it is very common that their own personal code libraries contain not only their own coding, but also those objects and functions that were developed by others in current and previous teams they were involved with. Often they also include original and modified code that was downloaded from open source web repositories, as clearly explained by a developer:

“Normally, I feel that my personal code library is quite good. However, if I have more time and energy, it is better to do more research on open source code, so that I can improve my coding ability. In fact, I study others’ code, learn from others, use their code in my own work, and eventually this code becomes a component of my own code library. It is a process of absorption and use. This library is the sum of my study from open source and my own experience.” (I30.9.5.D)

Furthermore, these libraries need adequately documented in order to be used in the future. As stated by interviewees, the documentation of these recourses can “save time and save the costs of the project indirectly” (I6.9.33.D).
“We need to pay attention to recording code or technology solutions that we have used in one project, and categorize and document them as well. […] Then, when we have a similar project next time, we can just search for them and use them directly. If we have documented them properly we will be able to use them easily, if not … no use.” (I5.7.12.M)

However, code is not the only work output that referred to as being reused. Project managers and some developers stated that they also document and reuse algorithms and reasoning frameworks used during programming. This was strongly advocated by one of the project managers. Instead of just reusing the code, he preferred to reuse the methods, algorithms and frameworks, which could help him transcend the programming language and specific development environment used previously.

“Now, instead of reusing code, I normally reuse the way of structuring and thinking for coding. There is no need to look at code. I already have that in my mind. If I change programming languages, for instance, library code will be useless, but the way and methods for coding are not so obviously different, they are just a continuation and evolution from other methods.” (I1.8.35.PM)

Additionally, informants also mentioned reuse of working methods and professional experience. Work strategies used in previous projects or, at times, in different companies and in different contexts were seen to be transferable to resolve current problems. “I sometimes use methods, used by the colleagues from my previous company.” (I1.9.11.PM). This was seen to be “twice as valuable as reusing code, so with this strategy I could be equally skilled [as when reusing code] but faster” (I1.10.37.PM).

This subcategory clearly shows that reuse of code, algorithms and working methods are of extreme benefit for professionals at all levels. It is clear that this reuse is clearly related to experience that guides what to reuse, how to reuse and what to store for the
future. The subcategory also goes beyond the predictable reuse of code through code libraries and expands this concept by proposing the reuse to algorithms and work practices that may be implicit in work practices but is not often referred to explicitly.

5.7.1.8 Risk Assessment and Management

Risk management and control is a crucial but often forgotten aspect of SW development. Risks are intrinsic to any project and risk taking is a necessary
component of any process of decision making. However poor risk management of an information system projects often leads to failure (Zhou et al 2008). The category discussed in this section indicates that informants for this research are actually more focused on controlling risk than on a holistic process of risk management, as shown in Figure 5.49.

Nonetheless, project managers in all three companies revealed an understanding of the need for an “awareness of risk and its prediction” (I25.13.27.M) associated with the “ability to forecast potential risks” (I19.7.4.M). Participants indicated that this risk identification and assessment is particularly important in the project planning stage and should be seen as a significant responsibility of the leader of the project, as explained by one of the managers:

“Risk prediction for a software project, in fact, is to assess and evaluate if your resources can complete the required tasks or not. […] Yes, there are two understandings necessary to control risk. One is the understanding of the company’s own resources, specially the employees’ technical ability and the company’s business management. In terms of my own employees, I need to know what their strengths are and what their shortcomings are. Another understanding is to understand the customers’ requirements and real needs. Until I am clear about these two factors, so only I can identify the problems and the possible risks.” (I25.13.28.M)

One of the more frequently mentioned elements of this risk control found in the interviews, was the need to fully adhere to the contract signed with customers, as strongly defended by one of the managers:

“Actually, we did the SW according to their requirements, we must fulfil the contract. Importantly, when we signed the contract, we always ask for a special section in the contract to cover extra charges if additional requirements emerge outside the initial scope, so […] the contract reflects all possible situations.” (I5.10.35.M)
Informants in all three companies see this adherence to the contract as a way of minimising any risks associated with producing SW that is not fit for purpose or in the emergence of new requirements not initially considered. Moreover, informants in all three companies use “design by prototyping” (I5.9.40.M) as a process of guaranteeing “the confirmation of customers’ requirements” (I5.9.40.M). Prototyping implies incremented development and testing with active involvement of customers. Therefore it is seen as a way to mitigate risks of not meeting customers’ requirements and risk during communication with the customer using less explicit methods such as reports and documentation:

“My favourite way to deal with capturing requirements from customers is the use of prototyping. After talking to the customers, based on the general understanding of their needs, I would design the prototype, such as an HTML interface. For early interfaces, I use computer screenshots to show them. Sometimes, I also allow them to directly use the prototype to show them the basic design. In this way, we let customers know our design principles and try to minimise any misunderstanding about their requirements.” (I26.14.35.PM)

The type of risks more feared by informants are those posed by external elements such as interfaces with other systems, co-development with other companies or outsourcing service providers, and even the poaching of valuable programmers by competitors and partners. This type of risk has a “high impact on the project and sometimes makes them uncontrollable” (I25.21.25.M). One of the Yirong’s developers gave a vivid example:

“We could learn a lot about risk control from our past experience. So, we really should put a lot of emphasis in risk control. For example, our system has to interface with other systems in order to access data, but those systems were developed by other vendors. Therefore, it is easy to monitor our internal risk, and it is difficult to control the risk that is
created by external parties, the other vendors, because we are able to very actively control our processes, but others do not necessarily care about what we do. To be more specific: our electronic records system needs data from other business systems, but other business sectors and the vendors for these other business systems would not be cooperative, because the rewards for the e-records information system construction do not benefit them.” (I12.5.18.D)

Here, it is necessary to explain that the SOE Company for which Yirong works for, will normally reward the company sections which have developed a better information system every year. Therefore, different sections of the company are in active competition with each other. The e-records system mentioned above was originally proposed by the archives section. Therefore, other business sections did not see this system as their own. As a consequence, “the person who was in charge of the ERP system, was not willing to communicate with us about requirements and interfacing with the ERP” (I19.7.7.M). The way to minimise the risk from external parties was not only “seeking support directly from the top managers’ so that they command, instruct and force them collaborate with us” (I12.6.1.D), but also adjusting our own strategy and time allocation for tasks in order to reduce the potential impacts:

“In order to leave an appropriate time for us to contact with other vendors […] we have two systems of time management for the project scheduling, one is for internal development, another is for external notification to other vendors. The time for external notification is longer which can buy us a little of time to catch up the schedule, if they do not cooperate. If a bad situation happens, we immediately seek help from the top manager in the SG [State Grid SOE as described above], and the SG managers will contact them [the other IS vendors] and force them to liaise with us. Basically, the command needs to come from a top manager or a relatively powerful manager.” (I12.5.29.D)

Participants stressed that instability of staff always “has a great influence on a developing project” (I28.3.1.PM). Therefore, understanding of “individuals’
willingness and intention to leave now or in the near future” (I28.3.1.PM) is fundamental in order to help leaders to manage human resources and control the risks of the project. In fact, this is such a common occurrence that, during the period of interviews, one of the staff members of Bosi that was already scheduled to be interviewed announced his “betrayal” (exact term used when the researcher was notified) and left to a competitor company. The absence of a strong employment legal framework in China, makes these occurrences even more dangerous and critical for the companies participating in this study. Therefore, managers become rather astute in anticipating employee’s movements. However some situations cannot be anticipated in advance, such as the example given by the same project manager:

“I have experienced some emergency situations during implementation of our SW. For example, one of our project members had a family emergency which was inevitable. So I had to let him leave the work… Ah …when this happened, the only thing I could do was to transfer another employee from another project to fill in his work.” (I28.8.36.PM)

In this case, in order to control the unpredictable risk caused by employee turnover, companies “reserve a certain level of human resources… We probably hire one or two more people when we recruit new employees. Therefore, there is always one or two people free who can be reassigned flexibly” (I28.9.5.PM).

Finally, informants also frequently referred to risks emerging from information security concerns. Two of the companies work for very large SOE companies that are under close control of the Chinese government and have to comply with strict information security guidelines. SOE companies are expected to compete in the global market in the near future and the Chinese government in keenly aware of risk involved in keeping national wide archives and databases. Therefore, the understanding of customers’ security requirement is significant issue in ensuring the success of the project, as expressed by one of the developers:
“When I design the data security mechanisms for our SW for the SOE customers, it is important that I know the requirements and standards of national information security. For example of the Chinese state secrets bureau [complicit smile] … they are very strict on confidential information and data protection in SOE information systems. I get the understanding of domestic requirements from these standards, such as how many bits are required for public-key [encryption] etc.” (I13.5.34.D)

This category is extremely interesting for this research as it shows that the entire process of understanding, identifying and assessing risk is closely linked with both experience and tacit knowledge of customers, work environments, work market and development standards. Maybe, somewhat disappointingly, informants failed to describe and discuss in depth aspects of risk monitoring and corresponding awareness of early risk signs and risk mitigation.

5.7.1.9 Summative Evaluation of a Completed Project

![Concept Map for Summative Evaluation of a Completed Project](image-url)

Figure 5.50. Concept Map for Summative Evaluation of a Completed Project
It became apparent from the responses of the SW practitioners interviewed that summative evaluation after completing the project is seen as a useful process of reflecting on work done, namely successes and failures and result in usable information for future use.

“[…] generally speaking, the evaluation of SW itself is significant, for instance the nature of functions and features that the SW includes. For example in my current project, we may find 20% of functions of the software are good, but another 80% might be relatively useless. Another example, for some specially designed features, we have spent a lot of human energy and time on them … but the results were not so good and feedback from users was negative. This is the evaluation I want of our SW products… There are the things that I need to pay attention to next time.” (I32.15.4.PM)

Moreover, the “wisdom of learning from failure is indubitable […] because] when there is no problem, everything is fine… but when the problems occur, the resulting stressful situation really allow us to acquire a lot of skills and experience” (I4.14.38.M). Therefore, summarising these lessons from failure was seen as crucial factor that enables reflection of the project that was just completed and helps securing success of the following project, as fully explained by a project manager from BOSI:

“I specially want to summarise the failures from previous projects. For example, if I have a delay in the project, then I want to reflect on which parts of the work the problems appeared, or on which parts I might put have put too much attention and consequently wasted too much time. It could have been pursuing the perfect solution, and devoted too many hours in search of that perfection. Therefore, I want to summarise the failures from these experiences of project management, and improve the future performance of my management.” (I32.4.5.PM)

This *learning by failure* process that emerged from the data seems to be not only
important for managers, but also for project team members, as illustrated by one of the developers:

“During the programming, sometimes an error occurs. In my previous project, there were many problems with system performance. Therefore, for these types of incidents, I always pay full attention on what caused the problems so that I can improve my programming for the next project to try to avoid them happening again and reduce errors that cause bugs in the system.” (I12.9.2.D)

Two interesting aspects were revealed by this sub-category. Firstly, this summative reflection on successes and failures does not seem to be formal or result in formal documentation made available to the entire company, as is considered good practice in the West. This may be due to Chinese culture aspects such as the need to save face (mianzi) and avoid public humiliation that would emerge from publically admitting to errors and failures. On the other hand, this lack of formal evaluation may just be due to the lack of awareness by project managers of the value of such formal processes. Secondly, practitioners seem to be engaging in rich and introspective reflection on their own practices that seems to increase “skills and experience” (I4.14.38.M). This personal reflection may, to a certain extent, be as effective as formal methods in the West.

This category mostly focused on the technical aspects of the management of projects. However, it became evident in the discussion that project work in the SW industry requires a team that works “together towards a common goal and who share responsibility for specific outcomes of their organizations” (Sundstrom et al. 1990). A team, in the context of this research, is therefore a group of SW practitioners and professionals that work together under the coordination of a project manager in order to develop specific SW. This working in project teams has, therefore, two components that emerged from the data as separate subcategories: the management of the team and the working in the team. These two subcategories are discussed in the
following sections.

5.7.2 Management of Projects Teams

One of the categories most explicitly mentioned in the interviews by both project managers and developers was the need for high levels of experience in order to be a good project manager. Participants seem to value good leadership in particular. According to their view, leadership seems to influence both the daily running of the company and the success of individual projects the companies undertake.

“In my opinion, as a leader, the really important experience from my working practice comes from establishing the company management system and managing several SW projects. I kept writing down my learning and acquisition of this soft skill of leadership in my personal notes. I apply this learning and reflection in my daily management work today.” (I25.9.8.M)

This differentiation is rather important in the SW development industry as virtually all the operational work is done through projects. Team members may belong to a project team today and another tomorrow. Leadership roles may therefore be found at departmental, project and even team levels.

“I will encourage all my members to participate in the internal training courses on project management, no matter if they are team managers or developers… After all, the main business in software companies is done in projects …everyone will find their own leadership roles within the projects eventually.” (I27.12.26.PM)

Therefore, leadership is seen to be fundamental both in the outcome of the projects and the harmonious work of the project teams, as well as having an impact in employees’ daily working practices within the organisation.
In terms of working in projects, participants identified general leadership experience as well specific knowledge on how to manage and facilitate work in teams.
Therefore the “Management of Projects Teams” category was divided into two main sub-categories, as shown in Figure 5.51, namely: Leadership, Management of Teams, and Enabling Efficient Communication and Knowledge Sharing.

5.7.2.1 Leadership

Figure 5.52. Concept Map for Leadership
The findings showed that different leaders in the development process have been using different methods and styles to make decisions and manage their subordinates. As shown in Figure 5.52, it was found that these characteristic ways of leading in SW Projects can be subdivided into two main subcategories: Scheduling and Monitoring and Enabling Individual Development.

5.7.2.1.1 Scheduling and Monitoring
One of the fundamental roles of the project manager is to assign and schedule tasks. This is not always an easy task, as the boundaries between roles and activities may be difficult to establish, as explained by one the developers for Yirong:

“Big companies have their own operating procedure. These are rather mature and clearly define everyone’s duties. Yes, so … if you are a developer, you do not do the systems analysis; if you are tester, you do not do development … you understand … but in a small company, it is different. The company has to consider the costs of staff against profits from the project, so people have multiple roles in one project.” (I14.1.25.D)

Nonetheless, the leader must be able to define, assign and schedule clear tasks that enable teams to work together.

“I think that no matter how complex the relationships [between each individual tasks] are, in order to have a good running of the project, it is necessary to determine the responsibilities of each person. Regardless of how many people are in the team, the division of labour among each team member must be clear. Otherwise, the project would be in chaos.” (I28.10.27.PM)

This need for clear and unambiguous division of labour is further reinforced by another developer:

“That is, the division of jobs must be clear, then each member can take responsibility for their own tasks. This will be helpful with no redundancy of human labour, and no conflicts due to unclear boundaries. This is very important.” (115.2.16.D)

However, the scheduling process is not enough. Participants often expressed the view that leadership roles require a firm attitude, the capability to transmit work
requirements and the ability to make hard decisions required in certain situations.

“The management role is very different, depending on which position I have in the project. If I am in charge of my people, my role might be as a tutor who needs to support them … but monitor them as well. In this case, the relationship between me and my people will be like that of a teacher and students instead of friendship … that is … I need to guide them, monitor them, and sometimes even push them.” (I19.2.29.M)

“Sometimes I am required to communicate difficult requests to my team members … like commands. For example, today we need to work overtime to solve customers’ urgent problems. I need to tell everyone what we need finish today and how long it will take. Therefore, we might need work overtime, and they need to stay for several hours more after normal work time, but I feel I am relatively weak at giving this type of command. So I still need to learn from this administrative job and leadership work.” (I10.2.33.PM)

It is necessary to mention here, that working after normal working time is an endemic event in SW companies in China (maybe universally), as stated by one of the department managers “we need to work overtime very often […] because] the customer from State Grid has very strict requirements about time and final deadlines, and the tasks are always particularly heavy” (I19.8.7.M). Sometimes, these situations are “caused by those uncontrollable external conditions” (I19.8.15.M), but often these are created by problems of scheduling and monitoring, or just inadequate project management.

“More often, during the process of project development, different issues would arise, such as a shortage of staff, slow progress towards milestones … then we end up into time big limitations.” (I5.7.43.M)

“Currently, our electronic records system is a relatively large project comparing with archive systems. Therefore, our company and our partners have invested a lot of human
resources in it, especially during the preliminary investigation. Ah ... we had one project manager before ... there were many problems that occurred ... our project had really bad feedback from our Shanghai customers, negative evaluation from headquarters, and nearly no support from other project members. Later, the new manager, who held a PhD degree in project management, became in charge of the situation. So, based on his management, there are relatively strict boundaries between everyone’s responsibilities, and we cannot think to rely on someone else.” (I24.2.2.D)

Therefore, the success of a project seems to be closely linked with the capacity of the leader to assign and explain tasks, to establish boundaries and links between these tasks and to convince subordinates to follow established schedules, deadlines and milestones. Leaders should be able to negotiate with the team member, describe the assigned task and explain why this was assigned to him/her.

“We need to let them [team members] know about the concept behind the task and how it actually works in the project. […] But sometimes, they may also raise some questions about it … and then well … I listen to them and give further explanation.”(I2.11.44.D)

As part of this negotiation, leaders should adapt their communication to the elements of the team they are talking to. One of the managers provided a very interesting example, distinguishing between the communication with team members of sales, with IT technicians, and with installations experts by adapting the discourse to their level, as follows:

“People from sales department are mostly outgoing and good at speaking. So it is easy to talk to them. However, the sales have been in contact with the customers too often who are outside of the company. They have a lot of ideas and ambitions. So, before I communicate with them, I need to be careful. There is a not communication barrier with sales, I just need to think carefully. […]"
When I communicate with technical people, I may need to encourage their willingness to communicate and identify where their enthusiasm lies. Technical people are generally too shy to talk. Well … my main method is to capture their interest during our communication, then exploring this point of interest, [so that] we might have better communication. […]

Compared to the design and development department and sales department, the installation experts are easy to communicate with. First, because they have good technological skills. Second, because all of them have been working at customers’ sites for a long time. Based on the constant communication with users, they have developed a good ability to communicate. Therefore, the communication with installation people is quite successful … well … relatively easy.” (I25.15.39.M)

Furthermore, informants expressed that an important aspect of the above mentioned capacity to schedule, monitor and control is the ability of appropriately delegating authority. This was considered to be another way to make management more effective, as proposed by two of the project managers:

“In the process of management, after assigning the tasks into different people, it is necessary to consider how the tasks are going to be completed … and that means how to complete the project and achieve the necessary quality after it is finished, instead of knowing every detail from each individual’s work.” (I1.5.17.PM)

“I will tell my second in command manager about the overall mission, and let him take charge of the arrangements of staff. Otherwise I would be very tired, if I am in charge of everything. [laughs] I only need to control a general direction of the project. If the direction is ok, I would not interfere with his decisions in leading his people. I am giving him full confidence and freedom to further divide and control labour.” (I27.14.17.PM)

Another aspect referred to by participants is the need to mitigate negative impacts in
the study caused by emotional responses by individuals caused by assignment of tasks, scheduling and working ways of the company. These emotional responses were seen as potentially very serious problem for a leader. Therefore, leaders should have the capability of managing individual’s emotions. In order to do this, leaders should, in a first instance, have the awareness to “observe and understand individuals’ emotions” (I5.3.22.M). For instance, one manager and one project manager explained that:

“After he has been trying to solve the same problem in two or three ways and still did not figure it out, he [referring to a programmer] will become irritable and sometimes a little bit emotional. In this situation, I need to talk to him […]. So this is a kind of emotional communication and it is also an important skill to coordinate work.” (I4.8.32.M)

“Emotional fluctuation in individuals’ moods have a great influence on our projects. Simply speaking, I need to be able to understand if he is satisfied with the recent work? If he has the predisposition to leave soon or maybe in the future? … and more. All of these aspects I need to be able to detect in advance. Then I need to find a way to meet his demands and stop his intention to leave, for instance.” (I28.3.1.PM)

Another element of this emotional management is the ability of helping individuals resolve and release negative emotions. According to participants this should involve “communicating with my team members” (I28.2.26.PM). Importantly, one developer remarked that even though “the talk with leaders would not have any substantial effect, but would let me realize that the leader is concerned with me” (I7.6.20.D). Therefore, leaders have developed strategies to support and “comfort members’ emotions” (I19.8.3.M):

“The first strategy is [complicit laugh]: I need to make sure there is definitely premium pay for such overtime work. The second is: I would organise and pay for the occasional dinner [laughs again] so that people have chance to adjust their unhappy mood caused from
too much work [it should be noted here that being invited for dinner by a superior is seen as
great honour and a sign of care and friendship in China]” (I19.8.3.M)

Finally, one important aspect closely related with emotion management is the ability
of providing positive feedback to team members. This was perceived by participants
to be a very important strategy to motivate and encourage team members and
maintain the good relationship with them, as illustrated by one manager:

“When someone seeks advice from me, he always assumes that he is right, and asks what
he should do when someone else is wrong. This is a very common situation. […] In this
case I would give him advice assuming that he is right. I would also ask him how his
assumptions have impacts on the external and internal aspects of the project. This helps
him reflect and sometimes understand that is wrong. Yes … It is a kind of teaching really.”
(I4.7.2.M)

This emotional management associated with the capability of providing of
explanations and listening to team members is seen as particularly important and
helpful when leaders have to change assigned tasks:

“I would let him know that the task has changed and explain. I would not just throw the
changes at him. I could let him know what happened to change things, what we are
supposed to do now and explain why this new task or changed task was assigned to him.
Sometimes … it is just that time is limited now, so I need him to do more work.”
(I1.9.25.PM)

Since everyone “plays a different important role in project work” (I1.8.16.PM), SW
companies seem to treat every individual as a valuable asset. Moreover, one
manager from SME Baiduchuan recommended that “as a small company, we have
relatively comfortable environment based on human care” (I4.5.41.M). Therefore,
valuing of each individual is a strategy aiming at maintaining the stability of staff and
reducing the risks of turnover as discussed in 5.7.1.8. One of the installation project managers from Yirong gave a very good example illustrating his concern for team members:

“The communication about life [of individuals] would take a lot of time, but it is really necessary. For example, if we work together on overtime, I would ask where he lives and how long the subway takes him home. If the time is past ten o’clock [in the night], I would ask him to go back then in order to catch the last subway. Even if the work has not been finished, I would let him go back then.” (110.2.42.PM)

Another installation project manager from Bosi shared the same opinion:

“I usually would greet them (my members) warmly, sometimes even phone them in order to show that I care. This is necessary because many of my installation people are in the customers’ sites alone.” (127.6.22.PM)

An important part of this communication aspect of leadership is the capacity to listen to others. This was seen by the participants as a crucial characteristic for leaders to negotiate successfully with their teams and customers in order establish agreements before decisions are made and tasks assigned. Developers’ perspectives emerging from the data shows leaders should seek team members’ opinions in order to make better decisions.

“Different people (such as programmers, designers, and implementation experts, etc.) are in charge of different parts of the project. So, as a leader, you need to listen to everyone’s opinions, try the coordinate the work, and then you can make better plans and decisions for the project.”(12.6.26.D)

Leaders should not only be able to communicate, but also to be able to facilitate communication among team members and specially with customers, as fully
explained by one of the project managers:

“When we meet with customers to discuss the building of the interface, I always take one of my technical team members. I expect that he will mainly discuss technical details. In this case, I only want to control the progress of the conversation and the due process of the meeting. Sometimes, I also need to adjust the atmosphere when there is too much fighting between my technical members and the customers.” (110.6.31.PM)

This code is therefore also closely associated with the Communication within Project Teams sub-category described in Section 5.4.2.1 and Knowledge Sharing within Project Teams sub-category described in Section 5.6.3.1 and Enable Efficient Communication discussed in 5.7.2.3.

5.7.2.1.2 Enabling Individuals Development

It emerged very clearly from the data that one important role for a leader is enabling individual development. This was considered to be very important both from personal and organisational perspectives. This enabling role is therefore closely linked with what was discussed in 5.5.2 and in particular 5.5.2.2. The leader should therefore consider providing opportunities for further development for everyone in the team, not only in order to enhance the performance of the team, but also to allow for personal development, satisfaction and motivation, as stated by one of project managers:

“I need to take care of the development of my team members. Firstly, I might ask him which direction he is interested in and willing to explore. Secondly, after a long time of staying and working with me and his colleagues, I will understand which areas he is good at and in which areas he has shortcoming. Then, according to their own wish, I could
Most managers and project managers expressed their commitment to enable their team members to learn more and improve themselves. This usually involves requesting the provision of training (as described in 5.5.2.2) at organisational level.
Two of the developers, one from Yirong and another from Bosi, introduced a good example of training by a more experienced senior colleague:

“Our company really pays attention on training for new employees. For example, when the new employees come in, there is always a senior staff member that is assigned to each newcomer to introduce the company and work processes. Yes … it works. He will also work together with the newcomer, guide and coach him for a while. It is a mentoring system in which senior staff tutors new staff.” (I8.4.3.D)

“Since the company arranged him as my tutor … and you probably know this … he definitely has some abilities and working styles that are worth to learn, such as the way he communicates with customers, and the methods he uses to solve problems … I had the opportunity to learn his techniques as well as his working style.” (I33.12.3.D)

A more traditional training strategy identified was the use of training courses, as also discussed in 5.5.2.2. These courses would provide more systematic overviews of current methods and theories related to SW development, as noted by one of the project managers:

“When you train your employees, you should have a logical thinking and clear idea about what you are presenting. For example, in order to configure the system, you should let them know each step of the processes involved. During the training, you should give a break between each session to let them have time to think and practice. Moreover, each session should be related to previous sessions and well organised. You can train them by using one “actor” [meant as role in the project] account and follow the processes needed for that actor, such as the installation person. You could describe one module first, and then associate it with other modules. You should not train them the way that programmers think … they only know about their modules and often could not care about anything else … and yes … it is very difficult to understand the role of each separate module, unless you can show that they are all logically connected. Right?” (I26.8.42.PM)
Another training strategy identified by participants is the use of online training systems. However, this approach was deemed difficult by managers and requiring that is made “mandatory and encouraged” (I9.5.24.D) as discussed in 5.5.2.2.

One last training strategy was identified and also discussed in 5.5.2.2 consists of inviting the experts to provide seminars on issues and subjects where the company lacks expertise, as explained by a developer from Yirong:

“Currently, the company does have some strategy to help us to learn unfamiliar things. For example, if we really do not know much about something, the leader would get help from outside, from those who are more senior and experienced … sometimes even professors from Renmin University [the School of Information Resource Management of the Renmin University of China in Beijing is the leading research institution in archive studies which is the area this programmer was working on]. If the leader asks, then the company will ask these external people to come and give us a training course.” (I13.7.23.D)

Finally, individual learning as discussed in 5.5.2.1 should also be encouraged by leaders in order to improve efficiency of both individual and team work and retain the company’s knowledge assets. Therefore, individuals need to be encouraged to improve their weaknesses.

“Well, since the human resources [in the company] are rather limited, so the duty for each person is always relatively heavy. Therefore, it is our responsibility as managers to develop strategies to make sure everyone has a great job under such pressure, and work collaboratively as a team. For example, […] I usually talk about his strengths first, then summarize his shortcomings, and finally encourage him to avoid his shortcomings.” (I25.3.13.M)

This improvement requires the acquisition of both reflection and recording habits.
“In the past, we did have one member of staff who did well on this area [documenting experience]. He would document the knowledge acquired from the project, classify the recordings according to the different technological functions, and give a description of each category. Then when he left, it was very easy to catch up with his job and continue his work. That is the type of thing I want to encourage more.” (I5.14.27.M)

5.7.2.2 Management of Teams

![Concept Map for the Management of Teams](image)

*Figure 5.55. Concept Map for the Management of Teams*
Apart from general leadership skills, participants expressed that in order to succeed with SW development project teams leaders need to be able to manage the team itself and deal with associated dynamics, challenges and problems. As shown in Figure 5.55, this research found that team management should include aspects (codes) such as: Holistic Understanding of the Technical Nature of SW Development, Understanding the Nature of the Project, Understanding the Nature of Teamwork, Understanding the Role of Colleagues in the Project, Fostering Awareness of Teamwork, and Fostering a Sense of Growing Together.

All the managers interviewed seem in agreement that leaders should have the ability and experience to understand the nature of the project before starting to divide, estimate and assign tasks, as clearly stated by a project manager:

“I should have a comprehensive and in-depth understanding of my own project. Then it will be relatively easy to handle the arrangements, personnel and task allocation.”

(I1.4.30.PM)

According to the data collected, team members seem to share this expectation. Their leaders should have a holistic understanding of issues related with the project, its technical issues and the context of the development. This expectation seems to be fundamental in their acceptance of their leader’s decision-making and their respect for the leadership. For example, one of the developers stated that “when people start to deploy a system into the customers’ site, the work involves the Internet, the databases and the hardware … yes … but also some coordination skills with the customers.”

(I8.7.15.D) Therefore, one of the installation developers in the customers’ sites claimed:

“As an expert who is in charge of the implementation SW, I really think he [referring to the project manager] needs to understand everything … at least in general. This will make
things more easy and smooth. What I mean is that an overall knowledge of things is required, such as information system integration and the Internet.” (I8.7.20.D)

This finding was reiterated by one of installation project managers in a different company:

“During the process of implementation, I need be familiar not only with the software development itself but also about the aspects of business that the SW will support. I also need to have a comprehensive technical ability to solve problems that I may encounter. For example, if I cannot not access the server, then I should search for where the problem is … such a problem could be related to the software itself, or a problem of connection to the IT facilities. Right … another example … if the internet was broken, then the problem might come from the switch or the router. Therefore, there is the need for the skill to make a judgement and solve the problem.” (I32.12.23.PM)

Another project manager presented another example that illustrates the need for this overall holistic understanding of issues when writing the feasibility study report and planning the project:

“The feasibility study report contains the technological solutions that you are going to use, what design scheme you are going to adopt, and what project scheduling you are going are proposing. In fact, it requires that you understand the entire process of software engineering, my team and the customer needs. So, I think that to plan the project as a leader, I need a relatively strong comprehensive understanding.” (I11.7.29.PM)

It was clear from participants’ responses that this knowledge is required from the beginning of project when manager starts to plan it, as this will determine technical approaches and development methods to be used by the project.
“It is important to understand the specific circumstances of each of the projects. For instance, if this project is much more complicated and time is really tight, then a framework based on open source will be faster to develop and basically can still meet the customer need.” (I1.6.33.PM)

This holistic understanding of the project should also include a good understanding of the colleagues’ roles in the project and their individual capabilities as discussed in 5.7.2.1.1.

“One important issue is the understanding of my colleagues. That means that according to this understanding, I can make reasonable arrangements and distribution of tasks.” (I1.4.21.PM)

This same project manager is of the opinion that “people must also be considered as one kind of resource” (I1.3.6.PM), which needs to be well managed, confirming the discussion in 5.7.2.1.1. This was clearly reinforced by a senior manager, who stated that in order to “get a variety of people to work together” (I4.7.37.M), he needs to “consider how to coordinate them” (I4.7.37.M). However, “many developers have different levels of ability and communicating skills” (I4.7.37.M). Therefore, understanding and knowing colleagues are a significant factor of success in teamwork.

Additionally, participants expressed that in order to successfully manage a team, it is important to understand that teamwork aims to fully use everyone’s ability and decrease the impact of an individual’s shortcomings (I4.7.13.M). This view of teamwork was very well articulated by two of the managers:

“During the implementation, it is a team on behalf of the company that completes the project. So the quality of the implementation depends on the overall strength of the team, rather than any individuals.” (I25.24.22.M)
“There is an advantage of teamwork. That is the company can provide different types of support, propose ideas, training or assistance, which will help minimise the disadvantages and inconveniences of individual weaknesses. This is one good reason to have teamwork.”

(I4.7.13.M)

However, this awareness of teams and teamwork is difficult to implement both at team and individual levels, as stressed by one of the managers:

“In the beginning, most people only think about themselves and will not consider the interest of the team, because they never really worked in a team before. However, as an individual, regardless of his own personal career or company development, we would want him to be developed into a good employee, and start to think of the collective interests. This is necessary for everyone to go forward and develop. So as part of our management strategy, we would try to teach the value of teamwork.” (I25.3.30.M)

Therefore, fostering the awareness of teamwork emerged from the data as one of the significant responsibilities of project managers. For instance, one of the managers would use “performance evaluation to trigger the collective consciousness of individuals” (I25.3.41.M). Another one would use his management style to influence the individuals, as stated by one of the installation experts who claimed that one of his leaders had done very good job on awakening his own awareness:

“Well, there is one thing I want to stress. By talking to you, I suddenly remembered my experience of one project team in Beijing. I was new and did not know much at that time. I started on doing simple work, and moved to the next level which was to be in charge of picking up the telephone and try to answer customers’ problem. I felt pretty comfortable with that project manager, because he kept us feeling like we were a team. Even though sometimes some of us needed to work very late, he still waited for us and we went home together. Moreover, the other team members were also willing to wait together without
any offensive comments. I felt that the environment was good, and the efficiency of the teamwork was very good.” (I9.8.32.D)

It is important to mention here that Yirong, the SOE SW company where this installation expert works, will rent flats for the employees who need to implement SW in cities other than Beijing - their headquarters. Very often some of these implementation experts live together in the same flat. This is exactly the case reported by the installation expert in the quotation above. What was particularly interesting in that quotation was the mention of “home” by the installation expert when referring to their living accommodation. This is particular significant in Chinese culture where communal accommodations are never referred to as home. Therefore, this very clearly showed a very strong identification with the team.

Participants also mentioned more traditional organised social activities “intended to enhance individuals’ cohesion and awareness of a team identity” (I34.6.21.PM), as illustrated by one developer:

“Every Friday afternoon, the company organises us to play sports [playing badminton in this case] outside, to give us a chance to communicate with others, and know each other better. It is great and it works.”(I36.4.38.D)

However, participants acknowledged that in the end it is the day to day motivating and encouraging by the project manager that makes the team work. Leaders are expected to “inspire individuals’ ability and keep their passion on their work” (I26.11.3.PM). The manager is therefore responsible to provide an environment that enables the team to growing together, as stated by one of the project managers:
“Sure … we all know that we need to grow professionally, but more important is that we all grow together. If one of my team members grows, I am also growing with him in experience and skills.” (11.10.19.PM)

### 5.7.2.3 Enabling Efficient Communication and Knowledge Sharing

Enabling Efficient Communication and Knowledge Sharing is certainly a crucial aspect in the success of any SW project management. However, this sub-category has a total overlap with the Communication within Project Teams sub-category described in Section 5.4.2.1 and the Knowledge Sharing within Project Teams sub-category described in Section 5.6.3.1. Therefore, it would be redundant to discuss these issues again.

### 5.7.3 Working in Project Teams

![Concept Map for Working in Project Teams](image)

**Figure 5.56.** Concept Map for Working in Project Teams
An important aspect of SW development project work is the ability to work in teams. The data analysis identified that the essence of successful working in a project team involves two very important aspects, namely the ability of bonding with fellow team members and the capacity to contribute to team building (see Figure 5.56).

5.7.3.1 Team Bonding

Participants in this research suggested that experience and ability to bond with other team members is fundamental in order to create a productive working atmosphere that can bring the team together, stimulate team identity and the spirit of belonging. Participants also stated that this bonding process in the responsibility of each individual in the team and could be qualified by five main aspects (codes), namely: Understanding the Nature of Teamwork, Interpersonal Skills, Willingness to Help Others, Willingness to Work with Other’s Code, and Using Commonly Agreed Coding Norms (see Figure 5.57).

![Figure 5.57. Concept Map for Team Bonding](image-url)
Understanding the nature and power of teamwork, was perceived by interviewees as the foremost factor in successful working together, since “[…] the teamwork can only have a significant effect when the team members start collaborating with each other” (I12.2.31.D). Moreover, “the completion of a project does not depend on one individual, it is depends on the whole team.” (I36.2.31.D) One developer used a house building metaphor to describe a SW development project as follows:

“Because software development is similar to building a house … everyone is playing different roles. For example, the design and development employees are like construction workers, who are in charge of the actual work. I think that if team members coordinate well with each other, the efficiency of work can be highly increased, and the quality of the work will be correspondingly increased.” (I31.2.41.D)

Another developer stated that teamwork was also a way to combine strengths, because “one person’s strength is always limited” (I36.3.11.D). One of other developers gave a good example of synergy at work when working with other colleagues.

“The way to improve efficiency of work is to engage with others as a team. For example, if I have a task to fill a lot of testing data into spreadsheet and I do it alone … it would take me a lot of time. But if I can collaborate with another colleague, both of us could work together to find out a better and more efficient way to import data. Otherwise, we need to do it manually. In my opinion, two people will always figure out a better solution than one. Well … this is just a simple example to describe teamwork … but this type of situation happens often in our daily work. Two heads are better than one (laughs).” (I24.12.33.D)

In particular, one installation experts working at a customers’ site declared that even the mere company of colleague would help him cope with his work better:
“Yes having a colleague working with me is always better. I think that if the job was only me sitting in front of a computer everyday, typing on the keyboard everyday, and programming in C [language] everyday … I could not take it [laughs]. It is really sad and depressing to work without colleagues.” (I21.8.17.D)

Unfortunately, when projects come to an end and only maintenance is left, the company only leaves one person, mostly due to financial considerations. Thus, being left alone at the customer’s site can lead the individuals’ motivation and emotional state to deteriorate to a point where it can affect the work. Company managers started noting this and, as discussed in 5.7.2.1.1, started issuing strategies to make the isolated individuals feel a part of his team or even to arrange for teams of two people to working at the customers’ site (I28.13.30.PM).

Since the teamwork requires that people work together, interpersonal skills emerged as an important aspect in enabling team bonding as one of the developers noticed:

“An issue we have not discussed here is related to interpersonal and social problems. Sometimes, if I am not familiar with a colleague, I may say something not appropriate which ... Yes ... causes some bad emotional responses. It then affects the work a lot.” (I2.14.6.D)

Interpersonal skills are particular important in SW development, since “technical people are generally too shy to talk […] they do not want to talk to me or their colleagues, they just want to be left with their coding” (I25.15.39.M). This natural tendency for withdrawal is clearly shown in Fig 5.58, where despite being forced to work in a “long bench” communal area (discussed in 5.4.3) one of the programmers prefers to sit at the edge of the bench and isolate himself from his team. These issues were discussed in depth in 5.4.3.
Another important aspect of team bonding is the willingness of the team members to help each other. Informants stated that this usually brings satisfaction and bridges distances between team members. For example, one of SW developers was found to be very helpful in advising the SW maintenance people on how to solve some problems, since they “also have experience of developing which is useful for the maintenance” (I20.4.36.D). However, this helping of others needs to be carefully considered in order not affect the helpers own tasks and thereby affecting the whole group progress, as explained by one project manager

“No, no … of course it is very good to help others with technical difficulties. But, they need to weigh the strengths and weaknesses of that helping others. For example, if it is a small thing … of course I can help other colleagues to deal with it. But, if it is too much … it will affect the progress of my own of work. Then, I better consider it more carefully.” (II.14.1.PM)

A simple way to help others is to document code that may be used by others. This can be done with minimum cost of time and effort and may help others in the team.
This can also save considerable time and effort for others as well as avoiding conflicts and problems in the team. This aspect of code documentation is discussed in depth in 5.7.5.1.

“I always put notes in my written code. This will explain the function of this code. This will also allow others that may want to use the code to understand it. […] in this way they will not blame me when they have problems and we work together better.” (I29.6.6.D)

Another aspect that was perceived to help with team bonding and harmonious SW teamwork is the use of commonly agreed coding norms. This is seen by participants as a very effective strategy to make individual programmers work and avoid inner conflicts in the team.

“In order to reduce differences in people’s coding, it was necessary for us to develop a unified coding standard for the whole company. All the projects use the same standard, sometimes even the same coding style and documentation habits. [...] Yes, this unified coding standard makes people’s code look similar, avoids programmer fights and eventually improves its readability.” (I26.16.30.PM)

Another developer agreed with this opinion, and gave an example as follows:

“Different people would have different understanding of the SW features, as well as the coding methods to achieve those features. So we had the need to create a unified standard … a specification really … for the coding. Right, this is important because otherwise, the same feature might be developed in different ways and styles. Then, in the end, the code would need to be rewritten.” (I29.5.26.D)

Even though documenting and normalising code seems to work well as team bonding mechanism and in helping the understanding of each other’s code, ultimately the willingness to work together is one crucial factor. The facet of this willingness to
work together that most affects teams, is the willingness of programmers to read and engage with each other’s code. In order to acquire the ability of reading and working with others’ code, one project manager suggested to “look at and read constantly the code written by others” (I26.16.34.PM). Eventually, this repetitive work would “improve the ability of reading” (I26.16.38.PM).

The importance assigned to team bonding by participants is part of a highly collectivist Chinese culture. From a Chinese perspective, belonging to, being accepted by, and being respected within a group is fundamental for individual performance as much as group performance. This may be very different from the West, where competition within teams rather than harmony may lead to good group performance. In the context of this study however, project managers and programmers alike seem to aspire to harmony and cooperation and these terms were repeated throughout the interviews across the different companies and roles of the participants.

5.7.3.2 Being a Responsible Team Member

In order to establish a strong team, team members need to understand themselves, their strengths, their weaknesses, and their own abilities and take responsibility for their contributions. Therefore, being a responsible team member is an integral part of working in SW projects and, as clearly expressed by participants in the study, is related to the seven main aspects (codes) that compose the subcategory discussed in this section, namely: Time Management, Ability to Logically Organise Own Work, Self-Estimation of own Ability, Being Active to Ask, Being Brave Enough to Ask, and Identification and Reporting of Technical Difficulties (as shown in Figure 5.59).
Scheduling and monitoring tasks are the responsibility of the project management. This often includes complex relationships between tasks, with some being the predecessors of others. Therefore, in order for the team to operate efficiently and harmoniously, team members need to take responsibility over their tasks and engage in tight self-time management. This was deemed to be particularly difficult by participants and it required both skill and experience. This need for time management is closely associated with the ability to keep up with estimated deadlines, so individuals do not “drag down the progress of the entire project” (I6.10.26.D). Two of the programmers illustrated how they implement their own time management:

**Figure 5.59.** Concept Map for Being a Responsible Team Member
“Basically, before deciding if I can meet a milestone, I would estimate the time for myself … the time that I would need to complete this task. Based on this time evaluation, I would make my own plan and schedule and assess the time limitations.” (I30.6.11.D)

“When I do my programming work, I always make sure to complete it in advance [of the schedule deadline] and also that I can keep to be good quality of code, because, if I finish the task earlier, I have time to test the code myself in advance and then bugs and problems are exposed earlier. Then, I can arrange my own time to fix those. If I do this then my bugs will not affect the progress of the whole project.” (I14.4.29.D)

It is clear from these quotations that good time management is dependent of the ability of team members to self-analyse their own ability to complete the tasks. This self-estimation can even be used by project managers when producing the project plan as explained by one of the developers from Baiduchuan:

“For example, if I am asked how many days you need for this functional module? Then I need to estimate the time I need according to my own ability. Then he [referring to the project manager] will estimate the time that shows up in the project plan.” (I6.12.31.D)

Another aspect related to taking full responsibility over the tasks assigned to team members was deemed to be a “strong logical thinking” (I18.5.14.PM) that can form the basis to “develop a logical way or method of thinking” in SW development (I17.5.9.D). This logical thinking is expected to enable individuals to organise their work so that the connections with work of colleagues is smooth and deadlines are kept:

“Before I even start programming, the first attention is to plan … define each step of what I need to do. […] First, you should look at the overall logical structure [of the unit of code being programmed], and list all the elements [classes and objects] and relationships
between them. Then, using the overall structure aimed at, you code each the modules, and work on them step by step logically.” (I17.5.18.D)

Additionally, in order to resolve problems early and avoid a crisis at deadline periods, team members should be both proactive and brave in seeking clarifications, guidance and support. Being “active in asking and reporting problems” (I1.6.30.PM), was identified by participants as fundamental in guaranteeing that deadlines are met. One of the installation developers who was “in the process of taking over work” (I20.17.8.D), took “the initiative to ask a lot from the previous employees, so the handover would be faster” (I20.17.9.D).

“Do not wait until someone else comes to teach you this or that to start learning about it. When you see stuff you do not know, you have to take the initiative and ask. To be truthful, my company mentor [shifu <name deleted>] was particularly lazy. If I did not ask him questions, he would never tell me anything, but if I encountered a problem and I asked him, he would tell me. At the start, when he guided and trained me, I think I was asking too little. I should have taken the initiative to ask him a lot of things. If, I had done so, I would not have had so many difficulties in the implementation process, as I did after he moved into another city.” (I20.16.2.D)

This may seem an odd statement for a Western reader; however, it makes perfect sense in the context of an extremely hierarchical Chinese culture. Seniority is clearly defined in Chinese companies and newcomers often lack the courage to “bother” (I20.16.12.D) their mentors or tutors.

“In fact, I am too afraid to ask or communicate with my superiors, especially when I am in a new and unfamiliar environment. [embarrassed laughs] …it is related to my personality.” (I17.3.8.D)

Consequently, to ask many questions requires a novice to be brave enough to ask
(I17.3.20.D) in order to avoid misunderstandings and wrong interpretations of tasks and objectives set by project managers. Otherwise, these misunderstandings “might create delays in time or take the work in a wrong direction, then consequently it would affect the progress of project” (I37.3.17.D). One developer used her own story to explain the importance of asking for clarification on assigned tasks.

“Well, in the beginning of this employment, I have encountered a problem. The superior arranged a task for me, but after struggling for a long time, I still could not understand it and complete it. Then I asked another colleague. He suggested I ask my superior to make sure what my superior wanted. Then I asked, and it turned out that my understanding of the task was totally wrong. Well … to be honest … I was too embarrassed to ask such a simple question in the beginning. Now, I am much better at asking in order not to waste so much time.” (I17.3.26.D)

Finally, a responsible team member should be willing to “timely” (I1.6.40.PM) identify and report technical difficulties to the leader. Failure to report such difficulties delays the engagement of support strategies by project managers and was deems by participants to have the potential for significant negative impacts on the project.

“If a team member encounters a problem, he better put it forward in a timely manner and report to me […]. This could save a lot of time.” (I1.13.37.PM)

“Basically, it is technical problem … if it takes more than half a day …. maybe a day to solve, then it is absolutely necessary that he brings it to us to discuss. Otherwise it may affect the progress of the entire project.”(I1.6.34.PM)

The following statement by one of the programmers from Yirong perfectly summarises what was expressed in this section as a responsible team member:
“It is good to always honestly present our own situation to the project manager. We are the person who deals with the tasks assigned by him. It is necessary and good to let him know where we are and how many tasks are left. Moreover, if we encounter any problems, it is better to communicate with the project manager in time to solve the problems.”

(I9.2.21.D)

5.7.4 Interacting with Customers

The main business of SW companies is usually associated with software design and development aiming to provide both products and services to other companies. Customer satisfaction is therefore the main criteria for successful SW completion and acceptance and is a crucial factor of project success. This customer satisfaction is highly dependent on the way the team and project managers interact with customers during the whole process of design and development. The importance of this communication with the customer was very strongly supported by one of the managers, who claimed that:

“The more communication with customers, the more I understand why we do the software, and what makes the software valuable to them. That is, no matter how good the development of your software is, if no one pays the bill, then it is not useful. By contrast, if the software is not well developed, but the customer is satisfied with it, then it is good software.” (I4.2.19.M)

Therefore, there is a need to build and maintain close and trustworthy relationships with customers that are built upon repeated interaction between the development team and the customer. As such, interacting with customers was seen to be paramount in guaranteeing and sustaining success in this sector. It was interesting to verify, that contrary to traditional stereotypes, even programmers seemed to be aware of the importance of interacting with customers. Four sub-categories were identified by the
analysis of the transcripts: Understanding of Customer Characteristics, Understanding Requirements, Negotiating with Customers, and Providing Training to Customers (see Figure 5.60).

Figure 5.60. Concept Map for Interacting with Customers
5.7.4.1 Understanding of Customers’ Characteristics

Figure 5.61. Concept Map for Understanding of Customers’ Characteristics
Understanding the customer’s characteristics prior to and during interactions was perceived as fundamental by participants in this research. Aspects of these characteristics are the type of business of the customer organisation, its organisational features and the individuals in the organisation the team needs to interact with.

5.7.4.1.1 Understanding the Business

![Concept Map for Understanding the Business](image)

*Figure 5.62. Concept Map for Understanding the Business*
Due to the context dependency of SW development, it is very important for all in the development team to understand the business and organisational environment where the SW will be used. The first aspect of this statement refers to understanding and knowledge of the business and was perceived to be fundamental in the acquisition and negotiation of requirements as well as in the development of any enterprise application SW, as explained by a Bosi manager:

“It is very important to have sufficient business knowledge and the understanding of industry in which you are implementing the system in, because the people you are interacting more often are the customers’ operational staff, who do not care about technical issues and only are concerned with the functions that the SW can provide. Therefore, you should have a general business knowledge as well as system knowledge so that you can explain and discuss functions. Yes … [reflects for a few seconds] … In order to acquire this understanding you need to reflect on your interactions with them and your own experience of development. Only then, will you be able to communicate and negotiate with the senior business managers and understand the requirements in the way they have asked for them.” (125.16.13.M)

It is important to note here that, in principle, new SW was developed to change existing working processes in order to improve working efficiency, create new features or enable the exploitation of emerging business opportunities. Therefore, there is a need to understand current business flows and existing business processes, as stated by one of the developers:

“First of all, you should have a good understanding of the business flows that are the base for customers’ work. So … when you talk to customers they will accept you as a good professional. If you are seen to be a professional expert, then the solutions you suggest have more credibility. Ahh … and also, if you are seen to be a good professional, you
would not have any barrier when you communicate with customers and their managers who are in charge of the operational work.” (I8.2.16.D)

This understanding was seen to be very helpful, not only for new projects, but also when maintaining the SW previously developed and installed, as very clearly explained by one of the developers:

“You should be particularly familiar with business flows when you maintain the system. For example, the Office Automation Software, you should understand the process in the operation of documents, such as writing, filing and distributing documents. If you know all there is to know about these business flows, then it will be relatively simple when you solve problems.” (I7.2.29.D)

An important aspect in understanding the business, operations and business flows in organisations, is being able to understand and use the business jargon employed both in the sector and the organisations. This was perceived to be of fundamental in designing SW that can be easily used and operated by the customer company. Jargon was defined by participants in the study as “the meaning of some terms, source documents and even balance sheets” (I8.2.13.D). One of installation developers offered the following explanation:

“The requirements I gain from the finance department, I need to translate into the computer language … you know, all those financial terms. I need to translate to a language that the developers can understand.” (I8.6.2.D)

Understanding customers jargon also enables a more effective and productive communication with customers. Therefore, participants in the study, such as the project manager quoted bellow, advocate that there is a need to prepare in advance, that is, there is the need for systems analysts and project managers to make an effort
to familiarise themselves with the business and business jargon they are going to work with.

“Another example, when I communicate with customers, if I had not graduated from archive studies, I would not know the meanings of all those general archive and archival concepts. So, I would run the risk of sometimes not knowing what they were talking about and consequently run the risk of not getting the correct requirements from them. Therefore, before I talk to the customers, I need to gain the basic knowledge in the field, such as archival coding and catalogue classification. Then when I talk to the customers, we can really exchange ideas. At least it always helps us to reduce the barriers in the expression of professional language.” (119.9.33.M)

In addition to the understanding of the business and operation of the customer organisation, it is also important to acquire and understanding of the organisational infrastructure, culture, dynamics and behaviour. These aspects were deemed equally important in the acceptance of the SW and requiring experience to be understood.

5.7.4.1.2 Understanding the Organisation

Capturing customers’ requirements is usually done within the specific context of the customers’ company. Therefore, in this case the communication with customers needs to be carefully considered when individuals stay at a customer’s company site. This interaction needs to take into account and try to understand the company socio-technical environment and culture of the customer’s company. One of the developers gave an interesting example:

“I was very familiar with my own company’s corporate culture already. However, the more important is the customers’, their company’s culture. Specially, in the case of State-Owned Companies, the deeper understanding you have, the easier you can figure out
what they want and what they need. Also, you will now what you can say and what you cannot say in front of customers.” (I8.2.29.D)

Moreover, participants also expressed the need to “stay out of trouble and maintain a good relationship with customers by respecting the customers’ habits” (I33.10.15):

“I need to pay attention to customers’ own working habits when we go into a strange environment at the customers’ site. I should not disrupt their working habits. For example, in this company … I found that the customers like to take a nap after lunch [they take the nap on their working desk in the shared working space where the participant also worked], so I decided that I should not type on my laptop’s keyboard while they are sleeping and also not responding to my phone.” (I33.10.25.D)

**Figure 5.63.** Concept Map for Understanding the Organisation
Being familiar with Customers’ IT infrastructure is another key factor mentioned by the SW practitioners. It enables the team to work effectively for the customers’ company, especially when individuals are developing and installing the new system:

“Before installing the system in the customer’s company, we must communicate with them because we need the customers to provide access and resources, not only the servers and commuters but also access to other databases, other information systems and also their intranet. Otherwise, we cannot do our work.” (112.10.7.D)

Importantly, “the SW developers always emphasise on technical operations, but the customers, as users, would naturally stress on aspects of practical application and convenient use of the SW.” (I29.3.5.D). Thus, in order to satisfy “these two conflicting minds” (I29.3.6.D), the capturing of requirements requires a very good understanding of the working environment of the customers as well of their working practices, as explained by two of the developers:

“It is quite difficult to produce a good application from a technical perspective only. People [refers to systems analysts, usually the project manager in the case of Bosi] need to bridge between us [the developers] and the customers. It is a very hard job, they need to find a balance between the best technical designing and programming and practical use.” (I29.3.6.D)

“In order to understand customers’ demands, you should know their working background. If they want a special feature … Why do they want this one? … I need to think. If they ask for it, that will result in a module or function that must be related to their knowledge of the background or working needs. For example, one of my current customer’s demands was an archive data collection function. This made me investigate and try to understand his work and current archive handling processes related to data collection. This is a professional skill, but requires a lot of experience.” (I20.8.23.D)
5.7.4.1.3 Understanding the Individuals

The interviewees also claimed that “after having basic business knowledge” (I25.16.22.M) about the project and the customers’ organisation, the individual who engages with the customers needs to capture requirements. Moreover, since
interactions with the customer may involve very different types of individuals, (i.e. managers, IT and technical experts or operational employees) analysts need “according to different types of customers, to prepare and use different language to let them understand” what is being proposed as the new system (I2.9.41.D). This was clearly explained by one of the managers:

“I think first of all you should have an understanding of the system. Yes, you certainly should have a profound understanding of the system. For example, your customers are coming from different sectors working on this project, thus you should be familiar with all the aspects of the project … technical and business knowledge. Let me give you another example: With archive systems, you must be very familiar with this business, for instance … What is catalogue classification and what does an archival code mean? Right, this is the most basic knowledge in the archive business, but if you talk to the customers who are from the technology sector, you definitely need to talk about the architecture and databases the system is going to use. Then you can introduce the architecture to them and have a conversation with them.” (I13.2.5.D)

One of the developers reinforced this need for differential discourse as follows:

“There is a difference between talking to the business people and technology people from the customers’ company. According to my personal experience, when I talk to the technical people, the communication should be straight to the problem and solution, aiming at solving the problem in a short time. However, the problems from business people are relatively more complicated and all about the application of their business functions. The business people like to make more comprehensive comments and engage in deeper exploration around one issue. So the communication with them always takes longer, because often even if started around a specific issue, the conversation always tends to expand to other areas or other related issues. It is different from talking to technical people where the communication is straight to that one theme.” (I25.2.35.M)
One of the managers also claimed that “the approach to communicate was certainly not the same when you face customers who are of different classes [meaning different hierarchical levels in the company]” (I25.2.28.M):

“When you communicate with leaders from the customers’ company, you should put yourself in a lower position and listen carefully to his suggestions about the system, but their detailed knowledge of operations and systems needs may not be the best. However, if you talk to the customers who are in the same level of a hierarchy, you could listen to them and also provide your own constructive opinions to them.” (I25.2.31.M)

This is an aspect where the lack of experience exhibited by this manager, may cause severe problems in a Chinese culture that is extremely power distant and hierarchical. If individuals lack this experience interact with the different “classes” in the customers’ company, they would tend to pay almost exclusive attention to leaders’ opinions and thus produce systems that may not be aligned with operational needs, as explained by one of the developers:

“When we go to collect the requirements from leaders, we always take more people than when we deal with lower level’s customers. First, the company likes these big delegations that give them importance … mainly the SOE leaders are the ones taking all the decisions. Sometimes, only one of his orders will lead the whole company to run and follow his instruction, even if wrong. So, when we go collect the requirements, the higher people we can reach the better effects we get. If we go and visit the person who is doing the practical work, no matter how many requirements you captured … one word “no” from the leader, and everything is declined. Even, if they make sense and are needed.” (I13.5.18.D)

This very Chinese hierarchical attitude may result in extreme stances in detriment of usability and functionality of the system as one of the installation project managers stated:
“In fact, I would not ask about requirements from the staff, those who work with archives. In fact, I sometimes even ignore them. The main requirements are always collected from the Director of Archives. It is always the Director’s decision to add an additional feature to the system or not. For the other staff, I do not even consider what they say seriously.” (I23.4.2.PM)

This approach is totally contrary to what is expected in the enterprise application requirements analysis in Western literature. The researcher assumed that the requirements should come from the people who are actually doing the practical work at the bottom level, and ultimately will the actual users of the system. Maybe more surprising is the fact that the researcher also collected data referring to complaints about this rigidly hierarchical behaviour from other installation experts in the same company. These experts bitterly complained that some leaders in the customers’ company did not have sufficient professional knowledge about the business and this had severe impact in the SW produced. One of these experts commented that “the Director of Archives [name deleted here] does not come from an archives background […] He kept on changing the rules for coding archives and giving us contradictory requirements.” (I21.6.3.D).

Therefore, some other participants offered a more predictable opinion that selecting the appropriate individuals from the customer company in order to capture correct requirements from customers is the essential factor in requirement understanding and collection, especially when the systems need to interface with “multiple business sectors” (I24.5.3.D). One of the installation experts gave an example as following:

“For example, the e-records system that we established for the SOE company needs to interface with the marketing system. The management structure in the SOE is a pyramid management structure. Thus, there are several subordinate offices under the marketing department, and under each subordinate office there are a great number of offices.
Meanwhile, different technical people are responsible for different systems. In order to collect the requirements to interface with these different systems from the marketing department, we need to find the corresponding person who is in charge of IS in marketing department and then take decision on how to allow interfacing with e-records system.”
(I24.5.10.D)

These apparent contradictions, statements and positions are characteristic of the modus-operandi in Chinese companies and of the Chinese culture that is a structured, very hierarchical society with extreme power distances. Therefore, analysts need to develop both very good negotiation skills (discussed in 5.7.4.2) and very good skills of unambiguously documenting and representing requirements. Otherwise the acceptance of both requirements and ultimately the SW developed may be compromised.

5.7.4.1.4 Understanding Requirements

According to virtually all the participants in the research, understanding, representing and documenting systems requirements requires close interaction with customers. This interaction needs “preparing in advance” (I12.7.6.D) in order to enable a rich and meaningful interaction communication with customers and the investigation of customers’ requirements.

“Before we go the customers’ site, we must be very clear about scopes of our requirements’ investigation. Moreover, we need to establish the objectives and framework … I mean the method for capturing requirements. Then during the investigation, we just follow that framework so that we ensure the outcomes from the communication.” (I12.7.6.D)
Part of this preparation consists in selecting an appropriate questioning and interviewing method and techniques. This was to be a fundamental and significant skill in enabling the effective communication, as stated by one of the developers:

“The techniques of questioning the customer must be right. Otherwise, there would be a lot of nonsense talking without getting the real requirements from customers. […] You should hit the nail on the head and be professional.” (I6.7.29.D)

Another of the aspect of this preparation consists in preparing the interview scripts
and questions before going to customers’ site:

“Prior to the requirement investigation, we should have a basic understanding of our customers’ business. We must to make a list of questions. Moreover, we need to understand what the current working situation of the customers’ operational people is… and, of course, what outcomes they want after this project. So, we need to list all the issues before going to the customers’ site. Then, we are ready.” (I18.4.22.PM)

These two latter aspects may sound trivial to a social science academic researcher, where data collection frameworks and tools are always set and prepared in advance. However, for SW engineers and computer scientists, who usually have very little experience of data collection in complex socio-technical environments at the start of their careers, this is an important realisation that can only be acquired with experience. The fact that so many of the senior project managers refer to it, is also a clear symptom of the importance given to what social scientists would consider a given issue.

In order to confirm the suitability and quality of the requirements for the system’s design and development, there is a need to “compare and refine customers’ ambiguous requirements” (I6.6.31.D). Therefore, one of the project managers suggested:

“I relation to requirements … I mainly look through them to see if there are ambiguities or some technical difficulties before we develop them. If there are some ambiguities, we will go back to talk to the customers … if there are technical difficulties, I need to go learn and investigate about these and deal with them.” (I11.6.1.PM)

This going back to the customers to resolve ambiguities does not seem to be very problematic. According to the same project managers that sated in 5.7.4.1.3 they would mostly consider the top managers decision making, the process of
disambiguation of requirements seems to involve mostly operational staff at the customer’s site and these are easy to access and talk to.

“It is easy to communicate with the customers at the bottom levels. For example, if we found out something missing after one day’s investigation with the bottom customers, we could always go and ask them on a second day. It is easy to find them. But for the leader, we need to make an appointment in advance.” (I13.5.18.D)

Identified requirements should then be represented in diagrammatic form for both negotiation with the customers (see 5.7.4.2) and communication with the more technical elements of the development team. This was identified as another important skill that requires significant amounts of experience in order to convert the conceptual and sometimes abstract ideas from customers’ requirement into workable designs.

“This work of capturing requirements results, at first, in very abstract concepts. I need to transfer these into diagrams and formalize them into a document which can then be easily used by developers and implemented.” (I2.3.17.D)

Participants also referred that experience in requirement capture itself may help analysts in better understanding of customers’ needs, even though “you are not coming from this business field, such as the field of archives management” (I12.7.15.D). This strong understanding helps when “some clients cannot specifically describe their demands, or they cannot express them clearly” (I20.8.21.D), as stated by one of the developers:

“After you reached a certain level, once you see the requirement, you probably will be able to understand how this software is going to be, or how specific functions are going to work.” (I6.6.22.D)
Experience here also helps in understanding the context and reason caused by new requirements and in solving problems:

“For new demands, I would try to understand the cause of problems through the presentation from our installation experts. What kind of background generated these demands? I would consider the functional features that the users ultimately want. Then, I can find a solution to develop these features.” (I30.2.33.D)

Furthermore, experience also helps because the customers “sometimes do not understand the working process of the system” (I29.2.12.D), their “new needs might destroy the balance and process of our original system” (I29.3.14.D). However, the decisions of new requirements still should be made by customers, as stated by one of the developers:

“We would present the strengths and weakness of customer’s new requirements, and specifically analyse these for them. But, in the end, they have to assess if it’s worthwhile to add the new requirements.” (I2.12.14.D)

Understanding the business, the organization, the individuals and requirements are important aspect in the interaction with customers. However, all these only contribute to the process of constant negotiation that is required during the process of development.

5.7.4.2 Negotiating with Customers

The acceptance of new requirements for a new project (or for a new maintenance project) is difficult balance between satisfaction of customer needs and accruing of benefits by the SW company. Therefore, negotiating an acceptable range of requirements with the customers requires not only significant skill, but also significant experience, as explained by one of the managers:
“For the new requirements we have to understand the demands that users asked for, and understand how much they are prepared to compromise. Based on these two understandings, we need then to negotiate how many concessions they can make.” (I25.24.25.M)

This process was seen by participants as extremely difficult and requiring “a full understanding of the individual customers we are going to interact with, including their temperament and manner” (I25.16.24.M). This section describes this difficult negotiation process and those aspects of experience deemed important by participants.

![Concept Map for Negotiating with Customers](image)

**Figure 5.66.** Concept Map for Negotiating with Customers

As described above, negotiation of requirements requires significant amounts of
interaction and conversation with customers, thus it became important leaders are able to select an adequate profile for the team engaging with this negotiation process. One of the managers stressed that “the one who is good at technology may not be good at convincing customers of needs to be done” (I4.10.35.M) and that he preferred “the one who has mixed talents” and “a flexible mind” (I4.10.35.M).

“When we go to talk to customers, the person I take with me should have wide knowledge, a relatively rich social knowledge and a good industrial knowledge. Another ability that is required is that he can explore issues in different areas of the customer’s business […] Because the clients we meet are coming from different industries, then the team that goes to talk to them should have overview knowledge on their industry and also be able to interact with them on their own terms.” (I4.9.12.M)

According to the interviewees, an important component of these “mixed talents” for negotiation is the ability of listening patiently to customers, as explained by one of the project managers:

“It is important when facing customers to be able to listen to them and respond adequately to their comments. […] The main point is to be patient and to be able to accept customers’ statements and demands. If they mention something wrong and you do not have the patience to explain that to them without offending them, it could cause a lot of trouble. This is absolutely unacceptable.” (110.8.35.PM)

Another project manager gave a more interesting example:

“Archives Director [name deleted here] believes that the [city name deleted here] archives systems are great and better than in any other province. He always wants to show me how proud he was of his accomplishments, and keeps talking to me about this every time when I go there have a chat with him. Even if he is not right, I listen to him before talking about changes in processes or new requirements for the system. I make him happy and in the
Because, SW companies deal with very different customers, one aspect of negotiation that was deemed to be very important was selecting an adequate discourse for each type of interaction. This was seen to be a difficult skill to acquire and highly dependent on experience, since “the same discourse for the same purpose may cause very different reactions in different people” (I5.11.42.M). This point was strongly expressed by one of the managers:

“Before you speak, you need observe. You need to think how I am going to say it, and what different consequences it might cause. […] because the level of their acceptance of your ideas may not be the same.” (I5.12.3.M)

An important aspect of negotiating with customers is the ability to translate and represent complex requirements of socio-technical environments into diagrams or prototypes that can be understood by both customers and developers. These diagrams were reported by interviewees to be widely used to assist in the communication with customers and present ideas to customers in a way that requirements and solutions can be easily understood. Two developers gave examples that illustrate this use of diagrams and prototypes:

“Capturing the requirements and understanding what customers want is a continuous process of getting feedback and validation from them. After a first communication with customers, we will use a form of document or produce a prototype to present our ideas to them. Then we show this to them and discuss it with them. We then go back and modify the more specialised requirements and then achieve the final version.” (I12.6.10.D)

“For example, we needed to re-do the searching interface for one of our clients. Then I did a temporary demo to demonstrate the interface. Based on their advice after playing
with this demo, we finally could ensure that we understood their requirements and confirm the functions that need to be changed.” (I35.7.1.D)

Being flexible in responding to customers’ demands and being able to negotiate solutions that both beneficial to the customer and the team was seen to be a very difficult skill and requiring considerable experience. This skill was seen by participants to be fundamental in balancing the satisfaction of customers’ requirements and practical considerations of the SW company, such as minimising development costs or reusing previous code libraries and programmed solutions, explained by two of the project managers:

“For example, if customers want one feature, which could use a very complex and convoluted design to achieve … this could cost us a lot, if we design and develop it directly. However I could work in another smart way … use code that we had for other projects and use this outflanking tactic to achieve this feature. You know it … this is like what we Chinese say: saving the nation through twisted means.” (I32.7.5.PM)

“Customers usually have simplistic and naïf ideas for a new requirement. So you have to understand their needs, and determine if we can do it or not. Sometimes you need to identify if our system has this function already or not. For example, there is one requirement A. Actually our system has the functions A1 and A2, none of them is A. But the two functions A1 and A2 could achieve the same effect A. This is what I call a flexible solution for a new requirement.” (I26.4.40.PM)

As a related issue, participants in the research stated that often “requirements expressed by customers are not actually what they want” (I13.4.8.D). This can create severe problems and analysts need to rely their own experience, namely “clear and logical thinking” (I13.4.28.D) to “guide them in the right direction” (I13.4.9.D).
“I certainly have to guide our customers and negotiate system requirements. For example, they might have a lot of knowledge about their own business. But, in my experience, even this business knowledge from a lot of people was distributed among many people, decentralized and not organised systematically. When we went there to investigate the requirements, we expected to see relatively integrated information for requirements. Since I had done this kind of investigation several times before, I clearly know what I want to know and also have a form or a template to follow during the interview of investigation.”

(I19.9.29.M)

This understanding that customers may not know how to express what they need in terms of requirements and functionality of the SW, was further explored by one of the installation experts. This expert expressed that “mining customer needs is the job” (I20.4.14.D) and so she sees her duty to “actively excavate broader demands and further insights of the software without being limited to the expectation of customers” (I20.3.19.D).

“When you capture the requirements from customers, you should not be limited to what customers expect. If you do so, you would only produce a low quality product. On the contrary, you should think of the requirement that the customers did not think about, but it may be particularly good for them.” (I20.3.19.D)

Moreover, “capturing requirements from customers requires a lot of teamwork” (I6.7.16.D). This opinion was fully illustrated by one of the installation experts from Bosi:

“I think it would be good to have a person to work with me when I collect the customers’ requirements. Sometimes, I might misunderstand the customers’ questions or forget some important requirements. In this situation, if I have co-workers, I could discuss these with others. If I am alone, I may not accurately capture the customer needs and impose my ideas. However, if there are two people or more working together, any omissions from my
understanding could be complemented by others and my ideas and solutions can be discussed and criticised.” (I20.9.18.D)

This may be the reason why, some of the managers put so much stress on teamwork when negotiating with customers:

“Normally, we allocate at least two people to capture customers’ requirements. These two people should be complementary. Sometimes it is possible that there are differences between these two people’s understandings, so these two together can exchange each other’s ideas and fight it out. Sometimes, I have to intervene [laughs]. Moreover, two people together can serve as a backup for each other … Yeah, I mean that … for example, one person may miss some points mentioned by customers, then the other one could complement for him.” (I19.10.8.M)

The importance all of the participants, project managers, analysts and developers dedicated to this aspect of negotiation was typical of the SW industry. Nothing in their statements suggested that it was a Chinese specific problem of associated to culturally induced behaviours. Negotiation here seems to be associated with the translation of business and operational requirements into technical and company capabilities: a problem faced by any SW company anywhere in the world.

5.7.5 Building and Maintaining Customers’ Trust

China is a “Guanxi” society, that is, a society that is based on the establishing of personal networks of trust that enable all kinds of deeper business and social interaction. Without trust, and ultimately without the power of influence of guanxi, business is not possible. Guanxi reflects the depth of feeling within an interpersonal relationship, “renqing” (人情), the moral obligation to maintain the relationship and return support or favour received, as well as the idea of maintaining personal and
group image and reputation - “face” (面子). Therefore, Guanxi has a major influence on the operation and management of businesses based in China. One of the developers proposed to socially connect with customers for maintaining the trust, such as:

“The important point is you should try to be able to get into your customers’ social network. For example, in the normal daily life, if you also share leisure activities with their staff that are either our link with their company or even using the system, then this can improve our work in their company’s site and guarantee a better acceptance of our SW.”

(I13.9.8.D)

![Figure 5.67. Concept Map for Building and Maintaining Customers’ Trust](image)
This reveals a close to unique situation in China, where working well and professionally may not be enough to guarantee the success of the project. In fact, building and maintaining customers trust was seen by informants at all levels as extremely important. This is quite characteristic of the Chinese way of doing business and is one of the emerging sub-categories that most reflects the context of this research. This subcategory is illustrated above in Figure 5.67, and includes codes such as: Having a Good Awareness of Providing Service, Building Trust with Sincere Attitude, Socially Connecting with Customers, Including Customer as a Member of the Team, Satisfying the Extra Demands from Customer, Maintaining Trust through Sustained Communication, Maintaining Trust through Transparency, Maintaining Trust beyond Own Work Responsibilities, and Staying Away from Customers’ Internal Conflicts.

The main business of SW companies is usually associated with software design and development. This could be seen both as the provision of products and services. Technical people and software developers are very good at understanding the concept of product, but less so in understanding service provision. Therefore, informants stressed the need to understand the concept and nature of providing a service when dealing with customers.

“I think we should have an understanding of service. Because we are in contact with customers who are going to use the system, so we should have the awareness of providing them our service. For example, when the customers encounter some problems, we should not be impatient, otherwise we might get a complaint. Sometimes, we could receive dozens or hundreds of phone calls for help. In this case, a sense of service in dealing with customers’ questions is really important.” (I13.10.19.D)

As part of this service provision and in order to build trust in the sense discussed above informants stressed the importance of having a “sincere attitude” (I20.13.32.D).
This is related to the concept of “renpin” (人品), or perception of moral standing and bearing which is seen to be fundamental in establishing trustworthy relationships.

“If you only stay two days in the customers’ site, customers would not care about what kind of person you are. But if you are staying for a long time, it is like we say in China, a long task proves the sincerity of a person. If your attitude is not good and sincere, the customers will not like you. There will be no trust.” (I20.13.41.D)

Another aspect of gaining trust was raised by a different developer who was very aware of the role of customers and the need to involve them into the process of development so that they can become a member of the project team. This was perceived by the informants to enable better communication with customers as well as help customers know that there is “nothing to hide” (I23.13.20.PM). This is a more common concern in SW projects worldwide and not specific of the Chinese context.

“Basically, our projects require teamwork. But, not just teamwork within internal technical team, but also a teamwork including the external customer … you know them being in the same team with us, communicating with us … sharing our solutions.” (I2.14.32.D)

Sometimes, in order to maintain a good relationship with customers, companies even try to satisfy any “extra requirements” (I23.10.17.PM) from the customer, as stated by one of the project managers from Bosi:

“In my opinion, one important skill is to maintain a good relationship with customers. After all, our electronic records management (ERM) system is just starting to be applied in the industry. Moreover, the State Grid is using the Shanghai Electric Power Company as a pilot project for the whole group ERM system nationally. So if we do well in this case, we could get more business from all the other provinces. If we keep refusing their demands, then customers would have complaints and we might lose our future projects. Therefore,
if some simple and new requirements emerge during development, I will satisfy them … even if they were not in the contracted requirement specification.” (I23.10.26.PM)

This meeting of extra requirements that were not contracted may not be a desirable attitude in Western projects. Any extra requirements in the Western context would meet with demands for extra funds and time, however in the Chinese context these are met with flexibility in the hope for closer relationship with the customer and opportunities of future business. This flexibility was perceived by informants to be of fundamental importance in gaining a good reputation in the market, as explained by the same manager in Bosi:

“The Shanghai Electric Power Company is a considerably large customer, and usually used as a model case for the informatization … even when comparing with other provinces from the State Grid SOE. Moreover, Shanghai is a really good marketing case for us since they have very large, demanding and high performance information systems and always require very high standards of quality. Therefore, if we are seen to be able to satisfy the customers from Shanghai EPC, it will give us more influence in the market and bring more potential customers our way.” (I23.10.24.PM)

Interviewees expressed that once trust is gained; it should not be taken for granted. They further suggested that trust by the customer is “accumulated by contacting with you” (I4.9.30.M). This “accumulation” of trust was seen to be long term process requiring sustained communication and “mutual understanding” (I20.14.6.D), as explained by one of the developers:

“We are the first contact with the customer. So, we are the ones that need to have a better understanding of customer. Yes ... and then through the process of discussion of requirements and designs with them, we gain mutual trust and understanding of each other.” (I2.7.29.D)
Reinforcing this view, one of the project managers gave a very vivid illustration of the significance of this sustained communication:

“It is important to communicate with customers actively and continuously, which means I need go to our customers and inform them of the progress of the project one regular basis. I only started using this communication strategy since I took over the electronic records management (ERM) project. Actually, last year the ERM project was under the leadership of another person sent from [company name deleted here; company is one of their external business partners], but he was removed. The main reason for that was that during his management of this project he only listened to his own company’s boss, and did not actively talk or listen to customers. Then the customers were upset, they felt disrespected … they even thought that he had his own agenda and that he was hiding something. They were not satisfied with his work. By learning from this previous lesson and another’s’ failure, I have changed the way I run the project and deal with our customers. Even though they do not have any more requirements, I still go there and have a little chat with them. The idea is to let them know that I am paying full attention to their project and their needs.” (I23.13.16.PM)

As part of this sustained communication and in order to let customers trust you, participants stated that it is really important “to be straight with the customer” (I4.7.32.M) during the communication, as explained by one of the managers:

“General speaking, I would tell the customers directly that I don’t know about this technology, or ask them to allow me go back to negotiate with technical staff or the boss. This needs to be honest. You can’t pretend that you know it. Because of the Internet, many clients are almost as expert on the software as you are […]” (I4.9.34.M)

In order to cement this trust and a strong relationship, participants stated that they were prepared to go beyond the scope of the project and their own duties and responsibilities. Developers and installation experts of all three companies claimed
to be prepared to provide “technical support” (I15.4.36.D) as a way to maintain the relationship with customers. These experts claimed to have provided technical support and advice to customers in areas such as the selection of suitable HW equipment, networking SW or even in the choice of devices such as printers or scanners, as fully illustrated by one of the developers:

“In my opinion, after our customer relationship reaches a certain level, we should not be too strict in establishing boundaries between our tasks as assigned by our own company and customers’ tasks. Sometimes, if the customer needs help, we extend our service, even though the request is not within the scope of our work. This is a process to building a long-term cooperation … Yes … to build a relationship of trust. Currently, the director of Centre Archives does trust me very much. He even asked my advice for purchasing desktops and printers. Of course, I would do my best to help him.” (I15.4.42.D)

This statement may also be surprising according to a Western view. Advising on aspects outside the scope of their responsibilities would be perceived as a non-professional attitude and could place a Western developer and his company in trouble in case the advice proves to be less than adequate. Conversely, in China due to the guanxi culture mentioned above, this is perceived to be common, a sign of trust and a basis for return of favour in the future. In fact, this need to accommodate this guanxi culture may go even further. As discussed above, at least the “technical advice” (I15.5.10.D) is related to the SW produce and service, however, in order to keep customers satisfied, sometimes installation experts have to deal with tasks that are not even connected with IT. For example, installation experts from Bosi explained that it was “difficult to refuse” (I21.2.22.D) work such as paper-based archives management (as shown in Figure 5.68).
“For example, there are some paper-based documents from other business departments that need to be processed and managed. The archives of customers that we work for like us to process these documents and scan these materials into the digital archives system. So … well, we need manage the paperwork, make the cover sheet, stamp them with their archival code … all of this work is paper-based management. Not our work at all. […] Our company does not require us to do this manual work … [silence] … Of course, customers cannot force us to do these things really … [Laughs] … But … sometimes we just cannot refuse them.” (I21.2.17.D)

Finally, participants claimed that staying away from customer’s internal politics and conflicts was of crucial importance.
“Conflicts between customers have nothing to do with me. You pay attention to what I say … we should never be involved with conflicts, fights or contradictions of customers.”

(I28.7.5.PM)

This was deemed to be particularly difficult due to the close coexistence of some of the project team members who stay on the customer’s site for prolonged periods of time. However, as it was important for maintaining customer’s trust in general, participants stated that they should keep away from taking sides in customer’s internal conflicts:

“I have been working at the customer’s logistics department for a while now and I had the opportunity to observe so many things. Interestingly, one day there were two customers in the office where we work and they started shouting at each other. After this fight, the leader of that department these two for the reasons of the fight and also did not ask any of their colleagues. Instead, he took me to his office and asked me why these two people were fighting in that morning. I knew … but I said I had arrived just before they started shouting and therefore I did not know why they were fighting. But I also said that it did not seem to be serious enough to be worried. Like this I did not take sides, protected them both and I did not lose face with the leader. Hard to do sometimes [smiled].”

(I28.6.40.PM)

Like many of the categories discussed in this chapter, this section is extremely influenced by the Chinese culture. As discussed, building and maintaining a relationship with the customer includes aspects that would be contradictory to Western practices.

5.7.6 Providing Training to Customers

In order to make the information system efficient and accepted by users, interviewees suggested that significant effort should be placed on training the customers. This
training should clearly show all the functionality of SW as well on how to use it efficiently, as referred by informants from all three companies. Findings of this study identified two types of training commonly used by their SW companies, namely written handbooks (including online help and internet handbooks) which provide guidance on how to operate the system as well as face-to-face demonstrations to the customers (both individual demonstrations and workshops), as shown in Figure 5.69.

Figure 5.69. Concept Map for Providing Training to Customers
Interviewees suggested that when providing handbooks and operational guidelines to customers, it is necessary to understand users’ responsibilities and their daily work routines, so that these documents are useful and show how the SW supports their needs. Therefore, these documents in paper, internet or online help format should be adaptive and inclusive in order to support all the different types of users.
“The main point is when we write the training documents, we must describe the use of the SW from the customer’s perspective. That is … we need to consider what functions are relevant for the users, and which operation processes are connected with the users’ daily work. If we write the documents only from the perspective of the programmers, then we might describe the features of the SW module by module … no logical links with the users’ work. The customers would not think this way, they do not think about modules, only about operation. For example, I am a storekeeper. I would only care about the features that connected to my work about storage. If I am a department director, I am most concerned about management of the overall data. These are the angles that we should consider when writing the operation guidelines.” (I18.6.10.PM)

Additionally, “in order to allow users to understand our handbooks and also to show a professional attitude” (I7.11.20.D) participants expressed the need to use the company jargon, the business terminology and objective terms when writing the guidelines.

“When you write the operation handbook, you just need to describe the functions of the system in terms that they can understand. […] Basically, it is an objective description, not subjective.” (I7.11.27.D)

Finally, informants from all three companies stated that they preferred to draw flow “diagrams and graphics” (I20.15.15.D) when they needed to describe the different steps of the operation of the SW, “because customers often and easily ignore written text” (I20.15.21.D). Reading flowcharts was perceived to be easy and the charts themselves perceived to “capture people’s attention” (I20.15.23.D). One of the installation experts illustrated these perceptions as follows:

“My way to present the operation manual is by graphics followed by very few sentences. I do this according to the customers’ working processes and try to give them guidance on what they need to operate the SW … for instance I would give them a screenshot from the system and then write simple text to explain this figure. […] The benefits of this approach
According to interviewees’ statements, in addition to the written handbooks, the training of users also includes different forms of face-to-face training. This is an
important type of interaction with the customer that requires presentation skills, careful preparation and experience to be successful. Training for all three companies was done by the developers and installations experts. This was seen to be a difficult task by the interviewees as they are not trained in training themselves and not naturally inclined to speak to audiences of lay users. Therefore, experience here was seen to have a particularly important role.

In more traditional workshop type of training, instructors “have to prepare in advance before they train the customers, including the PowerPoint slides, documents and speech” (I23.14.28.PM). Instructors should also prepare materials for the training sessions, such as “hardcopy documents, like relevant operating manuals that would allow the customers to concentrate on listening and watching, and also allow them to make annotations with their own understanding and ideas during the training workshop” (I25.23.16.M). This need for preparation of everything related with the training session was clearly illustrated by one of the developers:

“In fact, we need organise all the things before we provide the training. We need to negotiate with our customers and deal with all the stuff needed, such as arranging a conference room and providing the necessary equipment, like a laptop and internet access. In order to ensure the training runs effectively, we really need to negotiate with customers and push them to cooperate with us. We need to prepare very well.” (I13.9.29.D)

Referring to this preparation of training, one of the project managers specially pointed out that rehearsal before training would give the trainer a lot of confidence. This is a realisation that developers may not have the best oral communication skills and therefore may need to rehearse their sessions:

“The best way for preparing the oral demonstration is to practice the speech and rehearsal several times. Moreover, if you are unfamiliar with the system, lack training experience, or have poor communication skills, you definitely need to prepare yourself in advance and
In private. After practicing several times, your presentation becomes better … even for a programmer [laughs].” (I23.14.31.PM)

In addition, one of the more experienced project managers claimed that the training environment could seriously affect the quality of training. It is common in China, mostly for stated-owned companies, that the trainees coming from all the branches in other cities where the SW is to be used, are gathered “in one location” (I25.24.13.M) for the training sessions. The selection of an appropriate location was therefore deemed to be a crucial issue:

“The training environment should not be too entertaining; otherwise the trainees would not listen and study … sometimes go visit Beijing and not come to sessions. For example, we generally would choose the training room that is far away from the city, like a training centre in the suburban districts. It is interesting that we have done an experiment before. If we chose a room inside of building located in the city centre, the effect of training was much worse. … they go out in the night … sometimes during the day … to play or shop, the effect would not be very good. In contrast, if the trainees are far away from city in the suburbs there is no entertainment and other activities, so they concentrate on learning and studying.” (I25.23.43.M)

The best approach for training according to the interviewees is a practical one, that is, an approach that allows users to also practice in the operation of the SW. During the training workshops the “most effective way to train the users is to provide them with practical operation guidance step by step” (I21.9.8.D). This gives users the chance to operate the SW in front of the training instructor and request clarification when needed, as explained by one of the project managers that was actively involved in training:

“The best way to train users is through practical training. They should have computers in front of them, while I am describing and demonstrating the system. Then after I have
completed my teaching course, they can operate the system in front of me. This way would give them an opportunity to ask things they do not understand and provides them with strong impression of key processes of operation.” (I25.23.12.M)

Additionally, informants from all three companies expressed the view that “the content of training course must be dependent on the user audience” (I8.7.14.D). Interviewees suggest that adopting differentiated training strategies according to diverse customers’ characteristics is a key strategy in ensuring the quality of training.

“The training instructor must be aware of the nature of the trainees. You should have an understanding of the people who you teach to and communicate with. Because trainees have different levels of business or technical skills, you have to understand their business and technical levels, and prepare an appropriate level language to use in the workshop. If the customers’ level is not high enough, you should not use sophisticated technical terms. They will just not understand it and then not pay any attention to what you are saying. This is very very important because then the training loses its impact.” (I25.23.20.M)

Finally, “clearly understanding your position and identifying your own importance” (I20.15.3.D) as well as showing respect for customers was seen essential during training, as discussed by one of the installation experts:

“Whether the training audience are customer leaders or operational people, they are all experts in their own working area. So when we provide training to them, the important aspect to bear in mind is to respect them. Mostly because … well … we might be trainers there, but we are just a younger generation and probably lack experience in other business areas. So the basic attitude is respecting them, even though they do not know a lot about SW.” (I20.14.39.D)

Similarly to other categories discussed previously, this category could be perceived to address aspects that would look trivial to any experienced trainer. However, it is
significant that interviewees devoted such importance to these issues. This is due to two important aspects. First, most of the trainers are developers and installation experts, technical people that were educated and trained in technical subjects and not in training. Second, training is a key issue in acceptance of the new system by the users and may in itself determine the success of months, if not years of work.

### 5.8 Professional Attitude

![Concept Map for Professional Attitude](image)

**Figure 5.72.** Concept Map for Professional Attitude
An appropriate professional attitude is considered to be one of the most important factors in being successful in workplace (Valadez, 2007). This was confirmed by interviewees who stated that appropriate professional attitude in the workplace determines the good delivery of the SW, better SW development productivity and beneficial interpersonal relationships. This professional subcategory was structured, as shown in Figure 5.72, and includes the following: Self-Motivation, Self-Reflection, Self-Adjustment, Self-Stress Management, and Self-Confidence.

5.8.1 Self-Motivation

![Concept Map for Self-Motivation](image)

Figure 5.73. Concept Map for Self-Motivation

Participants expressed the view that having an “earnest working attitude” (I14.4.34.D) was fundamental in the professional execution for one’s own duties and important requirement to accomplish assigned tasks. This earnest attitude requires
self-motivation and commitment to one’s work. One of the content managers from Baiduchuan gave a good example to demonstrate the importance of adopting an earnest work attitude and how this influences both the final product and the team:

“One of my colleagues is very serious about his work. Basically, I do not need to say anything and we usually finish the tasks without mistakes. But another one is totally the opposite. He always says “It’s almost the same, why do you care so much about it?” or says “Oops … is this necessary to change? I think there is no difference.” I am the one who needs to monitor their work … because the company is relatively small, we do not have clear job title distinctions. So he thinks I don’t have the right to critique him just because I have been in the company two years longer than him. For example, recently he made a lot mistakes when we edited the pictures. Therefore, we had to re-work these together. I really do not like this type of person who is not serious about their own work. I think this is very irresponsible.” (I3.7.22.CM)

This self-respect that is needed in both being a responsible team member and a productive worker was identified as a basic professional attitude that people should be proud of in their work, as the same content manager describes:

“He [referring to a web site editor] said ‘if there are not enough pictures on the website then just do not put them out. In any case, no one will look at our website’. This kind speech made the other two editors really uncomfortable, considering that he is also a web editor and one of them. This diminishes everyone’s work and makes use all feel small and unimportant … Yes … if you do not respect your own work, how can you expect people to respect you?” (I3.9.8.CM)

Self-reflection was also considered as an element of self-motivation and a fundamental aspect of professional attitude. Participants indicated that the ability to understand yourself is the key to “increase your professional value” (I31.4.24.D).
One of the project managers illustrated how this is fundamental as a leader in order to develop their own skills and review the effectiveness of their team management.

“If someone did not finish his task by a particular milestone … First, I need to blame myself, why I did not discover this before it happened? Because if I were a good project manager this mistake would not have occurred. I should have detected it and not allowed the team member to fail to fulfil the task. A good manager can feel it. […] Therefore, I must do a self-examination and understand where I lacked in supervision or lacked in monitoring.” (I25.12.40.M)

This aspect of self-reflection is also naturally and closely linked with the Individual Development main category as discussed in 5.5.

In addition, and as part of the self-motivation category, participants strongly suggested the need for enjoyment in work. This is expected to give “passion and enthusiasm” (I31.4.33.D) and help people in achieving professional recognition and ultimately they professional goals:

“When you deliberately make an effort in your work and you enjoy doing it, then you will start thinking of ways to do it better. You plant a fruit tree and eventually you will harvest the fruits, that is, you commit and enjoy your work, eventually you will have a success. It is important to motivate yourself.” (I2.9.23.D)

5.8.2 Self-Adjustment

As shown below in Figure 5.74, being able to adjust to different working conditions and contexts was also mentioned by participants as fundamental in surviving in an industry that is essentially project based. This project nature of the work in the SW industry means that individuals work in very different types of companies, sizes of
projects, and organisational contexts, and they may also have to adopt very different roles (e.g. developer, analyst, tester and project manager). The ability to be able to work productively under these varying circumstances emerged very strongly as an important aspect of professional attitude in this industry. The resulting sub-category described in this section includes the following codes: Adapting to Large Workload, Adapting to New Working Environments, Adapting to Changing Situations and Adapting to New Roles.

![Concept Map of Self-Adjustment](image)

**Figure 5.74.** Concept Map of Self-Adjustment

Participant managers and developers described the process of developing SW as systematic, methodical and containing significant components of repetitive work. In addition, SW development usually includes large and time pressing workloads. This creates significant amounts of stress as discussed in the next section, but also requires developers and testers to adapt to these difficult work conditions. Furthermore, often programmers work as testers for each other’s code. This in turn requires being able to adapt to different roles within the same project. Therefore, adapting to large workloads methodically and with patience was seen as an important element in SW
development work, as explained by one of the department managers:

“Software testing has a heavy workload, but it is not difficult. But … it has to be done, so we need to adapt. It is the job.” (I25.20.18.M)

“Well, software testing has a heavy workload. Business application systems, as I said before, are relatively large. The different modules of the system that we need to test may have tens or hundreds of functions. So when we test … we just need to be patient in dealing with the very large workload.” (I25.20.21.M)

Moreover, a new working environment is an “inevitable circumstance” (I41.10.8.PM) in the real life of the SW industry. Therefore, on order to make sure that the project runs smoothly, there is the need that individuals settle and adapt quickly into the new organisational environment, as highly stressed by one of the installation project managers:

“Implementing work often requires that our people stay in the customers’ site for a long time. There, the working environment will be totally different from our own company. So, I definitely consider the individual’s ability to adjust to these new working environments and their mood when they do so before I send them out to customers’ sites. In fact, the company is asking them to move and live in a strange environment … sometimes away from family and friends … and probably for a very long period of time. Therefore, during the recruitment interviews, I would ask the candidates how long they can accept working and living in other cities. Sometimes, they all would say that as long as the company asked. But once I tell them it might be as short as two months or as long as three years, they usually are very surprised and not all can accept it.” (I28.14.27.PM)

According to participants, adapting to change may be even more dramatic as it may actually happen within the same project. Changes may in practice happen as the
project progresses. Plan, requirements and even implementation strategies can potentially change during the implementation of the SW. Therefore being flexible and capable of adapting to the changes is very important as claimed by one department manager:

“The implementation plan changes constantly according to customers’ needs. So installation staff should have sufficient patience to accept these changes and adapt to the changes. Sometimes, the plan may need to be changed several times. … you know … The customers keep on having new or different requirements and ideas. Thus, the people who are working one customers’ site must be flexible and should have the patience to accept these changes and have the ability to adjust to change.” (I25.21.40.M)

Moreover, interviewees stated that roles in projects may change. One developer could act as team member in one project and as leader in the next. Therefore, it is crucial that developers realize the nature of these changing roles and are able to adjust to them quickly. These changes of roles may even happen during the running of one project as one of the developers noted:

“When I was working in the Jiangsu Electric Power Company developing their archives system, the people working in that team were changing all the time. When at the time I went to Jiangsu, [name deleted here] the installation manager at that time left, and then the project manager was gone too. I was the only one who stayed there from the start to the end. By the end of the project, I was project manager. In other words, I needed to adjust to the different roles each time the team changed, from a junior at the beginning, assistant in the middle and manager at the end. During this period of time, I also needed to collaborate with the people being sent by the headquarters and act as liaison with the company … as different roles, you understand … I needed to do what was needed to maximise the efficiency of our team.” (I24.14.33.D)
5.8.3 Self-Stress Management

Constant changes, very high workloads, late work hours and needs for self-adjustment, as discussed and described above are, according to participants, a constant source of stress. Therefore the capacity of self-stress management was deemed crucial to survive and succeed in the SW industry. One of the developers claimed that this capacity to deal with the stress and pressures of project work, allowed him to “have clearer ideas and be able to consider all the aspects and related problems of requirements” (I2.5.3.D) when he designed the SW architecture:
“An attitude of stress management is very important, because when you take responsibility of designing the whole system, you are required to be in a good state of mind. Otherwise, if suddenly there are too many things to do and to think about and you not able to adjust your own mood and attitude … it becomes chaos.” (I2.4.4.D)

Another installation developer provided a better illustration on the need to control stress when working under pressure by customers:

“We definitely need a strong capacity to work under pressure, mostly when customers’ start making continuous extra demands. […] We are responsible for developing the system according to agreed requirements, if the system we design has problem due to those requirements, we would surely deal with it. However, they always bring this extra work to us … we cannot refuse it … so we had to do it with our extra time. If you cannot cope with this, then you will not be successful and customers will not be happy with you.” (I7.10.27.D)

Therefore, project managers of all three companies emphasized that their team members must have this ability of self-stress management.

“As a programmer, you have to have the capability to work under pressure. I will explain … sometimes, due to deadlines, I may have to ask that the work of three days is finished in one day. This is often needed to catch up on the progress of the project. Sometimes is not their fault, sometimes the customer asked for more things or they wanted to show it to some important person from their headquarters … it does not matter … you will have to do it under strong pressure.” (I18.5.18.PM)

One of the fundamental aspects in this self-stress management, according to an experienced leader, is the capacity to balance work and personal life:

“The work in the software industry is quite tedious and very boring. So, I should balance my work, the family and my social life. The important skill is to make arrangements for
time to have some fun with family and friends. Because the work itself is quite busy and hard, I need to have good time management to be able to have time to be together with friends, keep myself surrounded by a group of good and happy friends, and have spare time for the family to keep my family happy. When am not able to do this, my mood is bad and this influences the outcome of my work.” (I25.5.11.M)

Moreover, in order to help the employees to adjust to the work and relief the stress, other participants claimed the importance of leaders being able to help individual’s emotional management, as discussed in 5.7.2.1.1.

5.8.4 Self-Confidence

Self-confidence is also seen by participants as an important professional attitude. Being confident allows individuals to have “positive view of their own situations” (I1.8.1.PM) and therefore accept tasks, take responsibility over their assigned work and trust their own abilities and knowledge. Moreover, self-confidence requires “years of practice to build” (I1.8.26.PM) and is, therefore, not acquired overnight.

“After so many years of working with SW, I have more experience and I have gained more confidence in my work.” (I1.7.41.PM)

“During the process of working in many projects, and because I have done the same type of thing many times, I now have more confidence to deal with them.” (I1.17.36.PM)

Furthermore, confidence in very technical aspects such as coding can only be gained from acquired experience and not easily gained directly from education and training. One project manager commented as follows:

“After many years of coding, I am relatively confident. When I face different challenging and new circumstances, I have my ways to process them. Basically, I am able to resolve
them by using ways I used in the past, similar algorithms or even solutions I had in other programming languages, like Java or C++.

Participants also indicated areas where experience and solid knowledge are needed to build up their confidence, namely: Confidence in Using Different Coding Languages; Confidence in Maintenance from SW Coding Experience; Confidence in Technical Tools and Frameworks; Confidence in Reporting Skills and Written Language; Confidence in Presentation Skills and Oral Language (as illustrated in Figure 5.76).

![Concept Map for Self-Confidence](image)

**Figure 5.76.** Concept Map for Self-Confidence

Rather predictably, one of the foundations for self-confidence identified by participants is the capability of good coding and experience of coding in different languages. Programming skills and methods are transferable across languages and
the ability to understand and use different coding languages was a skill emphasized by many developers and project managers as being able to help select an appropriate language to accomplish specific functional tasks, enhance the programming efficiency and improve the codes’ quality. One developer gave the following example:

“In terms of the skills for programming, the first is to understand these different technology languages … Yes … different languages. For example, we are decided to use the java language now [...]. We must first understand its function, and what system functions this language can achieve. Then we can select the language to achieve the functions according to the needs of our customers.” (I29.5.8.D)

Moreover, this confidence in the coding experience acquired was seen to be useful not only in new projects but also with maintenance projects and activities. Many developers are not very confident with maintenance tasks. This is due mostly to the fact that they need to work with other’s code and lines of reasoning. This makes maintenance very hard for inexperienced programmers. However, having obtained experience of designing and developing systems allows developers to be much more confident in this type of task, as the following examples demonstrate:

“Because we have developed this SW, we are the ones who have a better understanding of the whole project. Therefore, we are in charge of maintaining the key modules and problems, that can’t be resolved easily by inexperienced programmers … these modifications and the internal core problems need a lot of programming work with code that was not written by us. Very, very hard work … new members are never confident to do this.” (I7.2.19.D)

“During the maintenance, a few of the tasks require very good programming skills. We are the group for the operation and maintenance of SW, who are actually mainly dealing with emerging problems and technical difficulties. Therefore, all of us have a lot of previous experience of programming … If you have experience, you can have better
understanding of the logical frameworks and a clearer mind to solve the problem.”

(I7.12.19.D)

In addition to good coding skills, participants expressed the need for confidence with technical tools and frameworks. This was very strongly stressed by one of the project managers who believed that SW design needs people who can assure him of their capabilities in selecting the appropriate design tools and SW design and development frameworks and methodologies:

“I have been involved in a few successful apps [referring to iPhone Apps] development projects in the past two years and I have gained a lot of experience of using methods and frameworks to plan and implement our work. Not like you read in textbooks, but how we can apply them in practice, for instance UML [refers to an object oriented framework entitled Unified Modelling Language]. Yes ... so now I am more confident in the use of this framework in practice and I know it works.” (I1.7.41.PM)

“I stick to my framework, I do not know if you heard about it … it does not matter, it is the way I work because that is my expertise. In fact, I have provided several training sessions for our colleagues and to another company that asked me for it, so I am confident that I can discuss with our leader and debate him why we should use it.” (I1.8.4.PM)

Finally, according to participants, professional self-confidence is also closely linked with the ability to express themselves effectively, both orally and in written format. This confidence in their own language capabilities is a critical part in “individual’s performance” (I4.2.32.M).

This language ability emerged from the data as divided into two types: presentation skills and oral language; and reporting skills and written language. The ability of efficiently express themselves orally was particularly linked with the need to be able to communicate with customers (linked with 5.4.2.4) and more importantly to be able
to negotiate about requirements, designs and solutions with customers (as discussed in 5.7.4.2).

“For example, when the archive practitioners consult you, they would not ask you about your knowledge of archiving. They may ask you how the SW supports their needs and how to operate it. Then you certainly have to communicate with them in a way they understand. If you only know how to design and use the system yourself, but do not know how to explain it to people, it is a big problem.” (I20.2.43.D)

Similarly, written language competence was perceived by participants as a highly important issue due to all the written documents usually associated with the SW development process, ranging from customer requirement specifications to training materials and including internal documentation such as code documentation, design specifications, internal reports as well as external documentation such as project proposals. This is understood by developers and project managers alike as the examples below illustrate:

“I think document writing skills are very important for me. For example, after I finished an investigation of a customer’s company, I have to write a report for the customers to review. Therefore, the capability to use the right phrases, structure and graphs is quiet important, is the ability to draw pictures.” (I8.3.1.D)

“Skills of document writing are important, because the plans I made should be clear, and the entire arrangements should be understood by each of my team members. Moreover, if it is well written, my report will be easy to read by my leaders and the customers and they will more easily agree with my plan.” (I12.5.16.D)

In contrast to many other categories, professional attitude seems to reveal universal set of concerns in communication, self-motivation, self-stress management and self-adjustment that can be seen as universal and not specific to the Chinese context.
5.9 Summary of Findings

This chapter has presented a grounded theory generated from qualitative data that aimed at identifying and explaining what experience in the SW development industry in China means. All the categories, sub-categories and codes that form this theory are represented in the ontology in Table 6.1 and synthesised in Figure 5.77.

The whole of the theory is explained and discussed in this chapter and could be summarised by stating that experienced SW development practitioners in China should:

- Be able to understand the nature and value of experience in the SW industry;
- Effectively communicate with peers, leaders and customers;
- Be able and motivated to actively engage with continuous professional development;
- Share knowledge with peers and the profession at large;
- Effectively work in projects, assuming and adjusting to different roles when required;
- Exhibit a sound professional attitude both internally to their own company and externally to customers, partners and even competitors.

![Figure 5.77. Main Theory of Professional Areas that lead to Experience in the SW Development Industry in China](image_url)
This theory of experience was based on two very strong perceptions that emerged from the data and are reflected in the two following quotations, already used above on this chapter, but are reused here for reinforcement:

“For technical people, if you only know technology, then your career is finished.”
(I20.5.23.D)

“Moreover, there is very little work related learning in the universities. After graduating, you will find you are not capable to work in practice, because in the school or university, the knowledge you learn was just the basics for a beginner. Certainly, there is more and in-depth experience required for work.” (I6.3.8.D)

These two perceptions, that emerged very strongly throughout the interviews, reveal that although technical skills are seen to be the basis of practice in the SW industry, there are many other competences that need to be acquired through experience and cannot be taught directly in universities or training courses. These perceptions imply that experience in this field can only be acquired through learning by doing, through reflective practice and continuous professional development.

This is a particularly interesting finding, since traditionally in the SW sector most of the concerns have always been on more technical issues rather than on often belittled soft skills. This overreliance on technological aspects was recognised almost universally by all the participants, but the general perception was also that, as careers progressed, these technical skills become less important.

“For a novice, his technical skills are the most important thing in our SW industry, but after a period of time, the more important is the understanding of business and how we do the work.” (I15.3.33.D)
Figure 5.78. Evolution of Conceptualisation of Experience in the SW industry in China
In truth, this research infirmed from the influence of the same traditional school of thought in SW development, that is, assuming that practice in the SW development industry is compartmentalised in distinct areas of specialisation (e.g. analysis, design, development, testing, etc.) and that experience and skills are just associated with that technical compartmentalisation. However, this assumption was proven not to correct and even programmers were in accordance that soft skills and experience in non-technical aspects was fundamental for professional success. This is reflected in Figure 5.78 which shows the progress of conceptualisation of experience in this research, as understanding and explanatory codes enabled the theory to be established. This aspect will be further discussed in section 6.1.

Finally, the theory that emerged from this study mostly contains aspects what could be assumed to generic traits in the SW Industry and therefore could conceivably be transferable to other context other than the Chinese. On the other hand, there are a number of such traits that are clearly linked to the Chinese context, as presented in Table 5.4. These contextual aspects are naturally linked with the specific features of the Chinese culture wish are apparent in professional communication, knowledge sharing, interacting with customers and working in projects. Additionally, aspects related with Chinese Higher Education and the professional training and market seem to be also of importance in an individual’s professional development. Finally, the nature of Chinese IT and SW industry and its job market seem to have a strong influence on aspects of risk identification and assessment. Naturally, these contextual factors reflect experience in the Chinese SW industry as opposed to experience in the same industry in other contexts.

The significance of these findings as well as their contribution to the current body of knowledge are discussed in the next chapter.
<table>
<thead>
<tr>
<th>Category</th>
<th>Sub-category (2nd Level)</th>
<th>Sub-category (3rd level)</th>
<th>Sub-category (4th level)</th>
<th>Code</th>
<th>Chinese Context Influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td>Communication with Different Agents in the Development Process</td>
<td>Communication with Leaders</td>
<td>Understanding the Characteristics of Communication with Leaders</td>
<td>Leadership in China is characterised by a very hierarchical structure and extremely high power distances. Therefore, power distance between leader and his team affects in the SW industry and is made apparent in this category.</td>
<td></td>
</tr>
<tr>
<td>Individual Development</td>
<td>Motivation for Continuous Professional Development</td>
<td>Acknowledgment of the Need for Training Beyond Academic Learning</td>
<td>Participation in specific training programmes</td>
<td>Participants indicated that an antiquated and misadjusted pedagogical model is still being used in Higher Education in China. Despite all programmers coming into these SW companies with either one or even two university degrees their capacity to be productive seems very low. An awareness of this inadequacy of pedagogical models by both programmers and employers seems to have originated specific and lucrative training market that is now actively sought for by programmers and companies. This type of formal professional training is considered as a specific mode of learning in order to acquire practical knowledge.</td>
<td></td>
</tr>
<tr>
<td>Knowledge Sharing</td>
<td>Knowledge Sharing with Different Agents</td>
<td>Knowledge Sharing with Internal Colleagues</td>
<td>Sharing through Annual Seminars</td>
<td>The annual seminars and annual company retreats occur just before the Spring Festival holiday. These usually take two to three days that are divided into reflection meetings in the morning, social or sport activities in the afternoon and entertainment in the evenings. Once a year individuals are given an opportunity to voice their ideas, complaints and opinions during this seminar.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Knowledge Sharing with External Parties</td>
<td>Knowledge Sharing with Social Circles</td>
<td>Social circles are formed within the context of Chinese ‘guanxi’ social networks, which may play a more important role than mutual trust. These become a main issue in knowledge sharing.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working in Projects</td>
<td>Management of Projects</td>
<td>Project Creation</td>
<td>Discovering Projects through Conference Attendance and Presentation</td>
<td>A recent Chinese government policy entitled “Industry-University-Research” aims at linking industry and universities through research. As a consequence, SW companies present and attend both industry and academic conferences, not only acquiring new knowledge and ideas but also of maintaining and attracting new customers that also attend these conferences.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Risk Assessment and Management</td>
<td>Control Risk from Human Resources</td>
<td>Chinese SW companies are under suffering from severe employee turnover. Moreover, the absence of a clear and strong employment legal framework in China, makes these occurrences even more dangerous and critical for the companies. In order to control this risk, managers become rather astute in anticipating employee’s movements and prepare the reservation of extra human resources in advance.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control Risk by Understanding Information Security</td>
<td>Stated-owned companies are under close control of the Chinese government and have to comply with strict information security guidelines. SOE companies are expected to compete in the global market in the near future and the Chinese government is keenly aware of risk involved in keeping National wide archives and databases. Therefore, there seem to be must stricter security regulations and procedures that need to be followed. Understanding of customers’ security requirement is significant issue in ensuring the success of the project.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Summarisation of Aspects that Influenced by Chinese Culture

<table>
<thead>
<tr>
<th>Category</th>
<th>Sub-category (2nd Level)</th>
<th>Sub-category (3rd level)</th>
<th>Sub-category (4th level)</th>
<th>Code</th>
<th>Chinese Context Influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management of Projects Teams</td>
<td>Summative Evaluation of Completed Project</td>
<td>Management of Teams</td>
<td>Fostering Awareness of Teamwork</td>
<td></td>
<td>Chinese culture focuses on aspects of preserving face (mianzi) and avoiding public humiliation that would emerge from publically admitting to errors and failures. Therefore, contrary to Western practices, summative reflection on successes and failures is done informally.</td>
</tr>
<tr>
<td>Working in Project Teams</td>
<td>Team Bonding</td>
<td></td>
<td></td>
<td></td>
<td>In Chinese culture, communal accommodation is never referred to as home. Therefore, the quotation about “home” clearly shows a very strong identification with the team fostered by their leader.</td>
</tr>
<tr>
<td>Being a Responsible Team Member</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>From a Chinese perspective belonging to, being accepted by and being respected within a group is fundamental for individual performance as much as group performance. This is part of a highly collectivist Chinese culture.</td>
</tr>
<tr>
<td>Interacting with Customers</td>
<td>Understanding of Customers’ Characteristics</td>
<td>Understanding the Individuals</td>
<td>Differentiated Attention to Customers’ Characteristics</td>
<td></td>
<td>This is an aspect that may cause severe problems in a Chinese culture that is extremely power distant and hierarchical. If individuals lack the experience in interacting with different “classes” in the customers’ company, they would tend to pay almost exclusive attention to leaders’ opinions and thus produce systems that may not be aligned with operational needs.</td>
</tr>
<tr>
<td>Building and Maintaining Customers’ Trust</td>
<td></td>
<td>Satisfying the Extra Demands from Customers</td>
<td></td>
<td></td>
<td>In the Chinese context, extra demands are met with flexibility in the hope for closer relationship with the customer and opportunities of future business.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintaining Trust beyond Own Work Responsibilities</td>
<td></td>
<td></td>
<td>In China, due to the guanxi culture, working on aspects outside the scope of their own responsibilities is perceived to be common, a sign of trust and a basis for return of favour in the future. In fact, this need to accommodate this guanxi culture may go even further.</td>
</tr>
</tbody>
</table>
Chapter 6. Discussion of Research Findings

This thesis reports on a PhD research project which aimed to identify tacit knowledge associated with professional experience that is required during the process of SW development. The overarching research approach adopted was inductive Straussian Grounded Theory. Therefore, the last step in such inductive process is to position the emergent theory in the existing body of knowledge and in doing so define contributions made.

The purpose of this chapter is to discuss and conceptualise the research findings, then position the emergent theory, presented in Chapter 5, in the light of existing literature review, and finally define contributions made by this study.

6.1 General Discussion of Findings

The above stated aim for this chapter to position the emergent theory in the existing body of knowledge proved to be more difficult than initially expected. In fact, the term “experience” is very often used in close relationship with both SW development and tacit knowledge. However, no published research was found that reflects, defines and attempts to categorise what experience actually is. The term seems to be referred to often, but always in generic terms and almost always with a semi-colloquial meaning.

It is universally accepted that experience is fundamental in the success and effectiveness of SW development and design (Basili et al. 1992; Boehm et al. 1995; Edwards 2003; Rech & Ras 2011; Dingsoyr 2002). Experience is sometimes referred to as “lessons learned” (Davenport et al 1997), “know-how” (Sallinen & Hirvonen 2000; Kim et al. 2013), “informal internal knowledge” (Dingsoyr & Roeyrvik 2003; Chen et al. 2011; Ismail & Ahmad 2011) or more elaborately as “all
kinds of experiences gathered from projects as well as other state-of-the-practice notions” (Basili et al. 2002). However, there was no study, that the researcher could find, that would elaborate, describe or categorize the nature of the “lessons learned” or what exactly should be the “experiences [that] should be gathered from projects”.

This lack of definition of experience in clear and precise terms, maybe be due to the fact that the term is used very often in colloquial and professional environments referring to professionals that have years of activity and are therefore more efficient than newcomers. This loose definition is certainly not enough if experience is to be used as basis to understand tacit knowledge and thus as a basis to externalise it.

As discussed in the literature review, tacit knowledge is so thoroughly grounded in experience that it cannot be expressed in its fullness (Sternberg & Horvath 2009). In fact, in the term, tacit knowledge, is commonly used interchangeably with this type of human knowledge, that knowledge that is strictly bound to the activity and effort that produced. Nonaka (2005, p.55) proposes that tacit knowledge is deeply rooted in “an individual’s actions and experience as well as the ideas, values, or emotions he or she embraces” as well as stating (Nonaka 2005, p.162) that “the key to acquiring tacit knowledge is experience”. However, even though there is a considerable amount of research on tacit knowledge describing the importance of the experience (Haldin-Herrgard 2000; Mascitelli 2003; Cavusgil et al. 2003), the situation here is in all aspects similar that one of the SW industry, experience is neither categorised or defined in terms of ontologies that allow it to be externalised, captured, stored and retrieved.

Furthermore, there is published research reporting SW practitioners as stating that individuals’ experience and corresponding tacit knowledge is very important in SW development. This was recognised from the very early days of the SW industry. For instance, Boehm et al.’s (1995, p. 86) research suggests that efficiency and cost drivers associated with personal experience “reflect the strong influence of personal
capability on software productivity”. Jones (2000) demonstrates that management and staff experience contribute 120% to SW development productivity, while effective methods/processes contribute only 35%. More recently, Siemens researchers Fichtinger, Paulisch, and Panholzer (2012, p.97) claim that “many of these products and solutions are [relying on] systems people’s experience either directly or indirectly in their everyday life”. However, none of these studies or many others discussed in the literature review, attempt to categorise experience in detail.

This realisation led Dingsoyr and Conradi (2002, p.410), among the few researchers that attempted at studying knowledge sharing of tacit knowledge to state that “empirical analysis of how experience sharing actually works is lacking”. However, this explicit statement does not seem to have triggered any published research or empirical studies. The literature review effort revealed only two significant studies in this area since then. One by Boh, Slaughter and Espinosa (2007) uses a deductive statistical approach to establish the relative importance of the different types of experience at individual, group and organizational level. However, apart from the acknowledgement of this multilevel characteristic of experience, the study adds no significant characterisation of experience itself. A second study by Adolph, Hall and Kruchten (2011, 2012) describes a number of behavioural traits related with the role of experience in reconciling the different perspectives within agile SW development processes. However, this Glaserian Grounded Theory study, probably the most interesting and innovative of all those found and read by this researcher, still does not provide a characterisation of experience in a way that it can be externalised, classified, stored and then retrieved to support dissemination in organisational settings.

The study reported in this thesis aims exactly at a providing such a clear categorisation of experience in Chinese SW industry characterisation of experience. The ontology shown in Table 6.1 synthesises the process of identification, categorisation and explanation of the different components of that experience in the Chinese SW industry context that are discussed in-depth in the previous chapter.
6.2 Reflection on the Nature of the Findings

6.2.1 A New Ontology to Express and Categorise Experience in Terms of Tacit Knowledge

The ontology proposed in Table 6.1 is composed of the categories, subcategories and codes that emerged from the Grounded Theory process adopted and discussed in detail in Chapter 5. It represents a first contribution to define, qualify and categorise aspects of experience and corresponding tacit knowledge in the SW industry in China. It is expected that:

- This ontology will allow the capture of tacit knowledge associated with experience;
- This ontology will allow the creation of descriptive and structural metadata for the purposes of discovery and identification of experience as well as defining structures and relationships between the different aspects of that experience.
- Through the creation of metadata the ontology will allow record keeping, retrieval and dissemination of that tacit knowledge within organisations.
- Therefore, the ontology will allow the creation of knowledge management and knowledge sharing models to keep, disseminate and exploit experience in the SW industry.

Although useful and the primary aim of this research, this ontology can be further conceptualised in terms of the relationships between the main categories identified.
Experience in the Chinese SW Industry (ECSW) Ontology

<table>
<thead>
<tr>
<th>Understanding the Nature of Experience</th>
<th>Self-Learning</th>
<th>Documenting Technical Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding the Characteristics of Communication with Leaders</td>
<td>Self-Selective Learning based on Current Work</td>
<td>Knowledge from Own Experience</td>
</tr>
<tr>
<td>Communication with Business Partners and Competitors</td>
<td>Learning from Others</td>
<td>Specific Learning Resources</td>
</tr>
<tr>
<td>Being Considerate</td>
<td>Learning by Training Others as Instructors</td>
<td>Communities of Practice</td>
</tr>
<tr>
<td>Keeping Communication Professional</td>
<td>Learning from Company</td>
<td>Internet Message Boards (IMBs)</td>
</tr>
<tr>
<td>Understanding the Characteristics of Communication with Business Partners and Competitors</td>
<td>Tutoring Schemes</td>
<td>Search Engines</td>
</tr>
<tr>
<td>Communication with Customers</td>
<td>Learning from External Case-Studies</td>
<td>Importance of Knowledge Domains</td>
</tr>
<tr>
<td>Ability to Use Different Communication Modes</td>
<td>Learning from External Professional Training</td>
<td>Knowledge Transfer from Experience as Asset for Turnover</td>
</tr>
<tr>
<td>Email</td>
<td>Learning from Internal Training Initiatives</td>
<td>Important Influence from Experience</td>
</tr>
<tr>
<td>Face-to-Face</td>
<td>Learning from Invited</td>
<td>Knowledge from External Parties</td>
</tr>
<tr>
<td>Formal Documentation</td>
<td>Learning from Leaders</td>
<td>Knowledge Sharing with External Parties</td>
</tr>
<tr>
<td>Instant Messaging</td>
<td>Learning from Online</td>
<td>Knowledge Sharing with Social Circles</td>
</tr>
<tr>
<td>Personal Preferences</td>
<td>Learning from Team Members</td>
<td>Knowledge Sharing with Social Circles</td>
</tr>
<tr>
<td>Telephone</td>
<td>Taking Notes and Memoing</td>
<td>Knowledge Sharing with Social Circles</td>
</tr>
<tr>
<td>Individual Development</td>
<td>Ability to Use Different Annotation Tools</td>
<td>Knowledge Sharing with Social Circles</td>
</tr>
<tr>
<td>Motivation for Continuous Professional Development</td>
<td>Recording and Reflecting through Computer Application Software</td>
<td>Knowledge Sharing with Social Circles</td>
</tr>
<tr>
<td>Awareness of Challenges Posed by a Very Fast Changing Technical Environment</td>
<td>Recording and Reflecting through Diagrams and Abstractions</td>
<td>Knowledge Sharing with Social Circles</td>
</tr>
<tr>
<td>Awareness of Personal Development Needs Beyond Technology</td>
<td>Recording and Reflecting through Mobile Apps</td>
<td>Knowledge Sharing with Social Circles</td>
</tr>
<tr>
<td>Awareness of the Need for Training Beyond Academic Learning</td>
<td>Documenting Innovative Procedures</td>
<td>Knowledge Sharing with Social Circles</td>
</tr>
<tr>
<td>Modes of Learning for Continuous Professional Development</td>
<td>Documenting Reusable Resources</td>
<td>Knowledge Sharing with Social Circles</td>
</tr>
<tr>
<td>Individual Learning</td>
<td>Documenting SW Problems and Solutions</td>
<td>Knowledge Sharing with Social Circles</td>
</tr>
<tr>
<td>Continuous Learning</td>
<td>Learning from External Case-Studies</td>
<td>Knowledge Sharing with Social Circles</td>
</tr>
<tr>
<td>Just-in-time Learning</td>
<td>Learning by Doing</td>
<td>Knowledge Sharing with Social Circles</td>
</tr>
<tr>
<td>Learning from External Case-Studies</td>
<td><strong>Table 6.1. Professional Activities that Lead to Experience in the Chinese SW Industry (ECSW) Ontology</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communication with Customers</th>
<th>Understanding the Importance of Experience Beyond Textbook</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication is more</td>
<td>Knowledge Sharing with Business Competitors</td>
</tr>
<tr>
<td>Communicating Efficiently</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Communication is more</td>
<td>Sharing Based on Good Personal Relationship</td>
</tr>
<tr>
<td>Important than Technology Skills</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Communication with Different Agents in the Development Process</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Communication with Colleagues</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Adapting Language to Different Agents</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Building Communication Bridge with Leader</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Building the Cooperative Relationships</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Communicating with Team Members</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Knowing how to Seek Advice Negotiating with Colleagues</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Sharing Responsibility of Tasks</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Communication with Leaders Being Cautious</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Being Respectful</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Being Straightforward</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Presenting Clear Ideas Reporting Progress Solving Problems</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Taking the Initiative to Communicate</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Management of Projects</th>
<th>Project Creation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to Apply Theory into Practice</td>
<td>Knowledge Sharing with Business Competitors</td>
</tr>
<tr>
<td>Ability to Clearly Express the Value and Usefulness in the Proposal</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Knowledgeability to Conceptualize the Whole Project</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Ability to Gain Ideas from Customers</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Ability to Seek Ideas from Customers</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Keeping High Quality of Writing Business Tenders Exploring New Trend for SW Development</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Capability of Appraising a Project</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Discovering Projects through Conference Attendance and Presentation</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Ability to Seek New Ideas from Other Disciplines</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Project Feasibility Assessment Comprehensive Consideration for Business Plan Evaluation of Team's Technical Ability</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Understanding of the Internal Standards from Customers Task Assignment Ability of Dividing Labour</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Experience in the Chinese SW Industry (ECSW) Ontology</th>
<th>Knowledge Sharing with Business Competitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Sharing with Business Competitors</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Sharing Based on Good Personal Relationship</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Knowledge Sharing with Business Competitors</th>
<th>Knowledge Sharing with Business Partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Sharing with Business Partners</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Sharing Based on Good Personal Relationship</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Knowledge Sharing with Business Partners</th>
<th>Knowledge Sharing with Business Partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Sharing with Business Partners</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
<tr>
<td>Sharing Based on Good Personal Relationship</td>
<td>Knowledge Sharing with Business Partners</td>
</tr>
</tbody>
</table>
6.2.2 The Nature of the Theory Proposed

The theory presented in Chapter 5 and synthesised in the ontology in Table 6.1 was established on very strong perceptions that emerged from the data and are reflected in the following quotation, already used above on Chapter 5, but reused here as reinforcement:

“The knowledge and experience are unlimited and tremendous like the sea. In order to deal with the infinite experience, there is a need to identify and classify. Following this identification and classification, you can easily create and use this knowledge, like using the drawers for your clothing. If have no drawers, you will just heap everything inside, the more you import in, the more chaos it is going to be. Therefore, there is always a need to identify, define and classify your own experience and that of your employees.”

(I25.28.17.M)

The effort of identifying, defining and classifying professional experience within the context of the Chinese SW industry resulted in six main categories, namely: Understanding the Nature of Experience, Communication, Individual Development, Knowledge Sharing, Working in Projects and Professional Attitudes. These categories may at a superficial glance seem very generic, but they emerged and were discussed in Chapter 5 grounded on the Chinese SW industry context. They are the result of axial coding and encompass detailed subcategories and codes that are both specific to the SW Industry and the Chinese context.

Furthermore, these six categories were found to be mutually influential and centred on the core aspect of SW development: working in projects. The identification of this central category is the result of selective coding. The resulting theory is shown in Figure 6.1. Experience of working in projects as the core category was defined by integrating subcategories such as Management of Projects, Management of Project
Teams, Working in Project Teams, Interacting with Customers, Building and Maintaining Customers’ Trust, and Providing Training to Customers.

As shown in Figure 6.1, working in projects was clearly seen as the core activity in the SW Industry by all participants in the study. It reflects the design and development nature of the industry and was clearly identified as the area where experience had a larger and more important role to play. Directly related with working in projects are three other significant categories: Communication, Knowledge Sharing and Individual Development. These categories are represented independently as not all aspects of communication, knowledge sharing and individual development were referred to as being related to working in projects. However these three categories are clearly seen as enablers of working in projects. Finally, Understanding the Nature of Experience in the SW Industry and Professional Attitude are seen as drivers for the entire process of reflection, experience acquisition and tacit knowledge construction by the individual practitioners.

![Diagram](image)

**Figure 6.1.** Representation of the Integrated Theory of Experience Acquisition in the SW Industry (ITEA Model)

Since tacit knowledge can only be acquired and obtained through human experience
(Nonaka 1994; Lam 2000), understanding of the nature of experience in their world of practice is a fundamental factor in enabling the processes of reflection and practical application of competences and skills. This understanding is, therefore, one of the main drivers in enabling experienced individuals and experts in dealing with complex situations efficiently and effectively. Crucially, this understanding emerged from the data analysis as a core driver for the acquisition of experience in all other SW design and development aspects.

Professional Attitude was identified by the data analysis as the other core driver for the acquisition of experience. Since behaviour is driven by attitude (Valadez 2007), experience acquisition behaviours in the context of the SW industry were deemed to be driven by such an appropriate professional attitude in all aspects related to the four central categories in Fig 6.1, and in particular in what concerns Working in Projects.

On the other hand, “effective communication is a broader skill and involves a substantial body of knowledge that is not unique” (Edum-Fotwe & McCaffer 2000, p.114). This is also how the main category of “Communication” was defined in this research, that is as activities that require experience and skills to convey information through the exchange of thoughts and messages. This communication is therefore broader than the project context and consequently represented outside the scope of the working in projects main category. Similarly, the main category of individual development was seen as the activity that enables individual practitioners to adapt to the very fast changing and evolving SW industry, in very similar way to that defined by Edum-Fotwe and McCaffer (2000, p.111), that is by “relying on knowledge and skills acquired through training and experience”. Moreover, as claimed by Edwards (2003, p.23) the SW industry is characterised by very “high workloads that are, in part, a consequence of this high turnover [and that means] a lack of time for knowledge sharing”. Like the other two main categories discussed in this paragraph, “Knowledge Sharing” in this study is seen to be broader than just part of working in projects but being extremely important enabler in its success. Knowledge sharing
was also seen by the participants as highly dependent of experience not only in terms of understanding the need to actually spend time in what is perceived to be a low priority activity, but also in recognising what knowledge to share and how to share it.

“Working in Projects” in this research was, as stated above, defined as the core category for the emergent ontology. IT encompasses all aspects of working and managing developing teams as well as all interactions with customers for whom the design and development work is done. This project oriented aspect of the SW industry is problematic as teams form and disband on a regular basis, individuals are asked to engage with different roles depending on the nature and size of the project and stable professional relationships become very difficult. These persistent features of the work in the SW industry means that Working in Projects requires both experience of project specific activities, as discussed in 5.7, but it also requires experience of enabling aspects of Communication, Knowledge Sharing, and Individual Development. Finally, in order for SW professionals to actively engage in reflection and social negotiation activities necessary for experience acquisition they need to be driven by a sound Understanding of the Nature of Experience in the SW industry as well as an adequate Professional Attitude.

6.2.3 Transferable and Chinese Specific Aspects of the Theory Proposed

The aim of inductive research processes in complex human activity systems is not to create generalisable and universal theories, but to provide explanatory and detailed theories grounded and limited to the social systems being studied. What is hoped with this type of study is that the findings of the research may be transferable and used in similar social environments and phenomena.

Corbin and Strauss (1990, p.15) propose that transferability of Grounded Theory
generated theories can be achieved “through a process of abstraction that takes place over the entire course of the research”. This process of abstraction is achieved through axial and selective coding, as explained in 3.6, in which codes are grouped into categories that are, in turn, related to each other. In this research the explanation of codes and categories is made in detail in chapter 5. The detail is necessary to justify the formation of the subcategories and categories that lead to the final level of abstraction illustrated in Fig 6.1. Furthermore, Corbin and Strauss (1990, p.15) also propose that “the more abstract the concepts, especially the core category, the wider the theory’s applicability”.

The use of this advice could, in a simplistic and rather reductionist temptation, lead the researcher to declare the highly abstract theory in Figure 6.1 as fully generalisable. However, the fundamental premise of Grounded Theory is that to produce accurate and useful results, the complexities of the social (in this case the socio-technical) context have to be incorporated into the understanding, explanation and abstraction of the social phenomenon being investigated, rather than be simplified or ignored (Martin & Turner 1986; Pettigrew 1990; Orlikowski 1993; Laurence & Tar 2013).

In the case of this research and although on a very abstract level, the theory proposed could be seen as imminently generalisable to the whole of the SW industry, this statement needs to be carefully measured by the realisation that the conceptualisation that led to the abstraction is rooted exclusively on the Chinese SW industry context. Therefore, all the codes, categories and subsequent theory generation is specific to the Chinese context as clearly shown by the discussion and used of evidence in chapter 5.

This specificity and influence of the Chinese social environment is clearly shown in Table 5.4 and discussed in section 5.9. Table 5.4 clearly shows that none of the main categories that compose the abstract theory in Figure 6.1 lacks components linked either to the Chinese culture or the Chinese socio-economic environment.
All of these specific Chinese elements of the theory were discussed individually at the category level in chapter 5.

Finally, it is also important to note that, although Table 5.4 provides a significant amount of Chinese specific elements that were part of the categorisation and theory generation that led to the theory in Figure 6.1, these elements are a clear minority when reviewing the very extensive set of generic SW industry elements discussed in chapter 5. Therefore, this suggests that the theory proposed may indeed be of explanatory value when applied to other SW industry contexts.

This argumentation leads to the two flowing conclusions:

- The theory discussed in 6.2.2 is appealing and easily understandable due to its very high level of abstraction and clear connection to the world of practice in the SW industry. However, it was grounded on a very specific Chinese context and although it may be useful and transferable to other contexts, it should not be considered as fully generalisable.

- The use of this theory in other National and cultural contexts or even in other industries that are also project driven may generate further insights that may improve or change it.

6.2.4 Challenging of Traditional Perceptions of Compartmentalisation of Experience in SW Development

The theoretical sensitisation for this project, which emerged from the literature review presented in Chapter 2, suggested distinct and identifiable professional activities in SW design and development. It is clearly understood that what was termed in this research as “Main Operational and Management Activities” in SW
development and shown in Fig 4.4, repeated below for easy of reading, corresponds to stages in the process that may not be sequential or at times not even easily identifiable, but are generally accepted as being components of the SW development process (Bell & Wood-Harper 2003; McManus & Wood-Harper 2003; Edwards 2003; Avison & Fitzgerald 2006; van Vliet 2008; Tsui et al. 2013). In fact, even in the “Post-Methodology Era” advocated by Avison and Fitzgerald (2003), these generic stages discussed in 2.4.1 are still used today as the backbone for professional career structures, quality assurance standards (e.g. ISO or BSI) and professional competence standards (e.g. BCS or e-CF).

**Figure 4.4.** Main Operational and Management Activities as Identified in the Literature Review

The aim of adopting such a generic categorisation was to define those “activities that have to be accomplished to achieve the [SW design and development] process and objectives” (Fuggetta 2000, p.28). These generic activities were hoped to help explain what specific experience the SW design and development process requires. The aim was also to follow Eisenhardt’s (1989) proposal that theory building research should begin as close as possible to the ideal generic theory under consideration. The interview script was therefore built around these generic SW development stages as discussed in 4.3.3.

However, the analysis of the data showed a very different perception of professional experience that is illustrated by Fig 6.1 and in detail by the concept map in in Appendix 7 and the discussion of findings in Chapter 5. Contrary to an expected
A compartmentalised view of types of experience for each of the activities of SW design and development in Figure 4.4, the theory proposed here centres on a more holistic understanding of the profession and the understanding of a broad nature of experience, far beyond the specific task being performed on the current project. It was particularly worthy of note that programmers and installation experts, that are traditionally perceived in both professional and academic literature as unsocial technical minded people, advocate the need for experience and soft skills in professional interactions and social activities with customers, peers and leaders.

Therefore, the categories that form the theory proposed were seen by the SW professionals as transversal to the SW development process. For instance, aspects such as knowledge sharing or individual development seem to require experience and tacit knowledge that is not necessarily confined to one specific stage. This seems to challenge traditional perceptions that each stage requires very precise types of skills, experience and even individuals. Therefore, these findings challenge the traditional understanding of academics, professional bodies and SW development practitioners, by proposing, for instance, that technical developers should not only be good at technical work, but also have the ability to communicate and negotiate with customers, communicate with leaders and peers and take responsibility for self-development. For example, a project manager highlighted the value of experience when communicating with customers during the capturing of requirements as follows:

“It is important to understand customer’s intentions when I communicate with our customers. For example, they may want something a little bit different from the design draft that they did themselves. In another case, something they want is not reflected in the design draft. These require further communication with customers, because in the process of communication, I can understand what they really want, even if it is different to what they say.” (I1.5.7.PM)
More interestingly, one of the senior managers even made it clear that “the technology is fundamental, but not the key. [...] From a business perspective, I would say that good social skills are much more important than technology ones” (I4.4.13.M). This same perspective was supported by a developer who also claimed:

“In the company, the relationship between colleagues is very important. Because the technology is not necessarily the foremost issue. In fact, in teamwork, interpersonal relations are first, technology is the second, I think.” (I6.13.6.D)

This insight that emerged from this research is significant in terms of reconceptualising the SW design and development profession and the set of skills necessary to be successful. In that sense, this insight is far more reaching than just an academic research finding and may be used by organisations and professional bodies in terms of definition of soft skill and competences required in professional practice.

6.3 Positioning in the Body of Knowledge

Having defined the nature of the emergent theory from this Grounded Theory study, the next step is positioning that theory within the body of knowledge. As advocated by Strauss and Corbin (1998, p.51), “the literature can be used to confirm findings and, just the reverse, findings can be used to illustrate where the literature is incorrect, is overly simplistic, or only partially explains phenomena.” However, as discussed in the literature review in Chapter 2 and revisited in Section 6.1, there are no existing theoretical propositions specifically defining what experience is important in the context of SW design and development and none that proposes an ontology to qualify and categorise it. On one hand, the uniqueness of the theory proposed makes the identification and argumentation for the contribution to the body of knowledge easy,
but on the other hand poses a problem of where to position the theory within that same body. This placed the researcher in a somewhat unique position of having no theories in the body of literature that can be used to compare and contrast with the findings theoretical propositions in this thesis.

In an attempt to make sense of the theory proposed, the data collected was revisited with the aim of looking for participants perceptions of usefulness (“use” in Grounded Theory terminology) of the theory being developed. This meta-analysis revealed that some of them saw it as an important tool for future recruitment of staff. This was the case of the manager of the SME Company that explicitly asked for the report and results from this research, since he wants to use it as the basis for their future recruitment of staff.

“Could you send me a copy of the report or results from this research? I would like to use it for the basis on the future recruitment of our staff. I always have difficulties in knowing what to ask them other than the technical skills.” (I5.14.39.M)

Another participant saw it as an important tool for self-assessment development tool and personal benchmarking tool:

“Well, talking about all this now … I am a little curious, about what you think about me? What is the most important in all the experience and skills that you have researched? Because after this conversation, I also want to find out what my own shortcomings are and what I need for my management position.” (I26.4.30.PM)

A third perception of use for the research findings emerged from one of the project managers of the private company (Bosi), who saw in the classification of experience as a means of assessing his team members.
“Yes, yes, very interesting this classification of experience you are studying, do you think I can use it to evaluate my team members? I would like to know who is well experienced and qualified and who I need to improve.” (128.18.33.PM)

Therefore, and in addition to the expected benefits of providing an ontology that allows the qualification, classification and meta-dating of tacit knowledge based on experience, practitioners seem to value it as a cross proposition between employability and IT competency skills. Therefore, this suggests that this should be the natural position of the emergent theory being proposed.

6.3.1 Comparison with Competency Models

6.3.1.1 Competencies vs. Experience

Competency is a practice related concept, defined through a range of functional criteria against which professionals are rated as competent in one or more job tasks (Heffernan & Flood 2000). In this sense, Holt and Perry (2011) distinguish competence from competency. Competence is the ability to do a task well. Competency is an important skill that is needed to do a task.

“The key difference here is that ‘competence’ reflects the total ability of the individual, whereas a ‘competency’ is a single skill; (hopefully) one of many that the individual will hold. The sum of an individual’s competencies will make up their competence and it is these individual competencies that are assessed to provide an overall indication of competence.” (Holt & Perry 2011, p.2)

Pierce (1994) proposes that a task consists of deliverable outputs (occupationally specific job-task competencies) underpinned by associated abilities (behavioural competencies). Accordingly, ESI International (2006, p.6) proposes that that there are generally two distinct types of competencies for SW design and development practitioners:
- Behavioural competencies - those competencies that address organisational success. Such competencies are common across many jobs and demonstrate the key behaviours required for success regardless of position within the organisation.

- Functional competencies - those competencies that address success for a certain job. Functional competencies refer to an individual's ability to perform a given set of activities based on their particular job.

Therefore, a competency is a well-defined skill that could be seen as explicit knowledge. This makes a competency a very different concept from experience, which was defined in this thesis as tacit knowledge. However, there are some interesting similarities in the findings of the research and this division of competencies.

As discussed above, the data collection for this study was based on a theoretical sensitisation literature review that pointed to functional divisions in the SW development process. Thus, the starting position of this study was one of identifying functional activities that enable the acquisition of experience and the definition of experience based on those activities. In this sense, the initial position of this research was to identify experience that could support the acquisition of and improvement of functional competencies as defined by ESI International (2006, p.6), that is functional competencies that are specific and necessary to an individual's success and are required for successful performance of specific functional tasks.

However, and in an interesting consequence of the inductive approach adopted, participants unanimously indicated that it is in the acquisition of behavioural competencies that experience is required and fundamental. As discussed in section 5.9, participants suggested that functional competencies, although important, were not the key for success in the SW industry, but instead identified a very extensive and detailed set of activities that require experience and allow the development of
competencies that “all employees, regardless of function or role, must be accomplished in […] in order to contribute to the success of the overall organisation”, exactly as defined by the ESI International (2006, p.6).

Nonetheless, there is a major difference that crucially distinguishes the two concepts of competency and experience. As synthesised by Cheng et al (2005, p.26), “competency is not only an attribute of a jobholder, but also an attribute of the job itself”, whereas experience is an exclusively an attribute of the jobholder. A competency can be expressed explicitly and directly, experience results in tacit knowledge that cannot be easily expressed and needs to be externalised in terms of areas of work and behaviours that result in success or failure. However, the experience and competencies are naturally interlinked as suggested by Garavan and McGuire (2001, p.160) when arguing that experience is essential to superior performance in particular contexts, and “particularly so for more universal competencies such as creativity, risk taking and innovation”.

6.3.1.2 Competency Frameworks vs. Experience Ontology

The explicit nature of competencies, enables the creation of competency frameworks that can supports organisations with clear sets of criteria for recruitment, measuring performance, identifying training and development needs of individual employees, and rewarding effective performance for superior performers (Heffernan & Flood 2000). A competency framework describes a set of competencies that can be measured to demonstrate competence and are applicable to a particular field (Holt & Perry 2011). Therefore, a competency framework defines an explicit and clear set of knowledge, abilities and behaviours that professionals need to excel in the performance of their job functions (Rivera-Ibarra et al. 2010).

Since competencies are complicated, conceptual, and built around current realities,
every industry has some specific competency frameworks, as do most of the larger multinational organisations (Conger & Ready 2004). Therefore, these frameworks are used as standards and may be of very different nature as defined by Holt and Perry (2011):

- Generic frameworks - which apply internationally to a particular discipline;
- Industry-specific frameworks - which apply to specific industries and are usually owned by relevant professional bodies or industrial organisations;
- Organisation-specific frameworks - which apply to specific companies, particularly large ones;
- Regulatory or legally required frameworks - which apply to specific industries and are mandatory as part of a certification scheme;
- Technique or technology-based frameworks - which apply to specific use of well-defined techniques or technologies and require their own competence programmes to demonstrate an individual’s knowledge and skills for that technique or technology.

According to this classification of competency frameworks, the experience ontology proposed in this study is closer to industry-specific frameworks. This ontology does not aim at being regulatory, technology-based or organisation specific and is grounded on the Chinese specific context. Therefore it is not in a first instance an international framework. Furthermore, the ontology proposed is specific to the SW industry, therefore it has natural affinities with sector based competencies in this industry. A competency framework for the SW industry includes all competencies (conceptual, logical, physical or contextual) and takes into consideration all tasks and activities performed by a SW practitioner (ESI International 2006). A number of such SW Industry competency frameworks can be found in the literature, of which the most prominent are:

- UKSPEC - is the UK Standard for Professional Engineering Competence and is the cornerstone of all technical competency frameworks in the UK. The
UKSPEC is used as the basis for professional accreditation, such as Chartered Engineer (CEng) and Chartered IT Professional (CITP), and all UK professional bodies use it as part of their professional assessment. The UKSPEC is owned and managed by the Engineering Council (Engineering Council 2015);

- SFIA (pronounced ‘Sophia’) - is the SFIA Foundation framework that is geared towards the skills required by professionals in roles involving information and communications technology for the effective implementation and use of IS. The SFIA framework maps directly to the UKSPEC (SFIA Foundation 2015);

- INCOSE - is the International Council on Systems Engineering competencies framework, which is an international body that is committed to furthering the discipline of systems engineering. This competency framework also maps back to the UKSPEC and covers various cross-cutting concepts associated with systems engineering and aspects of professional activity in the SW Industry (INCOSE UK Ltd. 2009);

- The European e-Competence Framework (e-CF) - is the European Union competency framework aiming at providing a general and comprehensive set of competencies, specified at five proficiency levels that can then be adapted and customised into different contexts of the ICT business, including stakeholder application perspectives. It claims to use a common language to classify and describe competencies, skills and proficiency levels that can be understood across Europe (European e-Competence Framework 2014);

- SW Engineering Competency Framework - is a framework that emerged from a research project undertaken by the CICESE Research Centre (Centro de Investigación Científicay de Educación Superior de Ensenada), in Ensenada, Mexico. This framework aims to guide software engineers in identifying their training needs and in planning their professional development (IEEE 2015).

All of these competency frameworks, and many others that could be added to this list, can be synthesised and characterised by a classification of competencies that includes the following three main aspects (Rivera-Ibarra et al. 2010):
Technical - competencies that describe specific job functions performed by the SW development professionals (e.g. requirement specification);

Social - competencies that describe the abilities of the SW development professionals in interacting with their work environments (e.g. the ability to work in a team);

Personal - competencies that describe particular and personal characteristics of the SW development professional (e.g. the ability to learn by themselves).

According to Holt and Perry (2011), these competencies can be acquired through education, training and experience. The ontology proposed in this thesis relates to these competency frameworks by providing a clear identification of activities where experience can be acquired and tacit knowledge internally constructed. Specifically, the ontology proposed here is directly linked with the acquisition of experience of social and personal competencies.

6.3.2 Comparison with Employability Models

6.3.2.1 Employability Skills vs. Experience

Employability skills are general skills that are necessary for getting, keeping and doing well on a job (Robinson 2000). The term employability skills is used interchangeably with a number of others, such as soft skills, workforce readiness skills, or career readiness skills, but all of these refer to the basic skills that are required to acquire and retain a job. These are job specific skills that are built upon preparation or foundation skills usually acquired at school and university (Shafie & Nayan 2010). The perennial discussion in this field has revolved since the early 90s around issues of employers not believing that the traditional education system performs particularly well in equipping new entrants in the job market (Dawson et al. 1992; Kolding & Kroa 2007). The SW industry is not an exception with most
software engineering graduates beginning their careers lacking an appreciation of real-world conditions (Dawson & Newsham 1997).

This aspect was confirmed by the findings of this thesis as discussed in Section 5.5.1. This apparent disbelief in the applicability of university learning in the professional environments was expressed by many of the interviewees as evidenced by the following statement repeated here:

“Actually, the knowledge I learnt from the books in the university really did not help much. I only could participate in a professional project after I took training from the training institution, called DaNei. This training institution gave me a chance to apply my knowledge to the practical operation of projects. Of course, practice and exercise would be more helpful than just reading textbooks in the university.” (I33.2.9.D)

Therefore employability skills are built upon the traditional education foundation and aim to help individuals:

- Get their first job;
- Adapt to the reality of business methods;
- Start their own successful small businesses;
- Move more readily from sectors where jobs are declining to sectors where growth is strong;
- Extend working life through interesting part-time jobs and contribute their knowledge and experience to community organisations after retiring (Microsoft 2006, p.2).

The literature in employability skills offers a large variety of characterisations of employability skills. Fugate et al. (2004), defines employability skills in relation to the need for employees to acquire the knowledge, skills, abilities and other characteristics valued by current and prospective employers. Robinson (2000)
divides these employability skills into three categories: Basic Academic Skills, Higher-Order Thinking Skills and Personal Qualities. CBI (2007) proposes eight top employability skills that are sought by employers: self-management; team working; problem solving; communication; application of literacy; business awareness; customer care; application of numeracy; and application of ICT. McDonalds (2006) proposes motivation and enthusiasm, team working, oral communication, flexibility/adaptability, initiative/proactivity and ongoing development. Cranmer (2006) argues for a more pragmatic approach based on skills suitable for professional activates, namely communication skills, presentation skills, team-working, problem solving, planning, coordinating, organising.

Finally, the US Association for Career and Technical Education (ACTE) in a study for the Office of Career, Technical, and Adult Education, U.S. Department of Education proposed an employability skills characterisation that synthesises all of the above and is divided as follows:

- **Applied Knowledge** - the thoughtful integration of academic knowledge and technical skills, put to practical use in the workplace;
- **Effective Relationships** - the interpersonal skills and personal qualities that enable individuals to interact effectively with clients, co-workers, and supervisors;
- **Workplace Skills** - the analytical and organizational skills and understandings that employees need to successfully perform work tasks (ACTE 2015).

The ontology proposed was built on very similar principles as shown in Table 6.1, that is, on aspects of working in teams; communicating with peers, customers and leaders; active engagement in individual development and a sound professional attitude. However, the ontology does not focus on explicit entry skills into the profession, but on professional activities where these skills are necessary and where the application of these skills requires experience. In this sense, employability skills
could be seen as the basic entry skills upon which experience can be acquired while actively working in the industry.

6.3.2.2 Employability Skills Frameworks vs. Experience Ontology

Employability frameworks are very different from the above mentioned competency frameworks and the ontology proposed in this thesis. Employability Skills are more appropriately described for particular occupational and industry contexts by sets of facets or important work skills specific of particular jobs (Board of Studies NSW 2013). Therefore, employability skills frameworks with a level of detail as exhibited by competency frameworks and the ontology in this thesis are usually organisational and often job specific.

The literature in this field is extremely rich and extensive. A large number of propositions have been made for the last three decades and led to a collaborative effort to develop a characterisation of the skills required for modern employment and frameworks (Bynner & Parsons 2002; Krahn et al. 2002; Worth 2005; McDonalds 2006; Simmons 2009; Brown et al. 2010; Scarpetta et al. 2012; Green et al. 2013). This very rich effort in both industrial and academic research led to the creation of a number of generic frameworks that either focus on specific skills needed at work (e.g. ICT skills for the workplace) or generic roles (e.g. leadership skills). These frameworks can be very generic such as the one proposed by Fugate et al. (2004) that is based on three broad aspects: career identity, personal adaptability and social and human capital. Building on some of the dimensions of Fugate et al. (2004), Dacre-Pool and Sewell (2007) have developed an employability framework that is aimed at being used with young people and graduate students in UK and is based on the following essential components of degree subject knowledge; understanding the real world of practice, specific skills; generic skills; emotional intelligence; career development; self-learning and experience of work and life.
A number of more detailed and extensive generic employability skills frameworks can be found in the literature that are based on “basic skills generalisable across all jobs and occupations” (Bates & Phelan 2002, p.123), of which some of the most prominent are:

- The US Department of Labour Secretary’s Commission on Achieving Necessary Skills (SCANS) framework is seen as pioneering in the USA in identifying the skills that people need to participate successfully and competitively in the labour market (Bates & Phelan 2002) and is commonly used as a benchmark or basis for other studies (Green et al. 2013). This is a more detailed framework based on three types of foundation skills (basic skills, thinking skills and personal qualities) and five competencies (resources management, interpersonal competencies, information management, complex systems understanding and technology literacy (U.S. Department of Labor 2004).

- The American Society for Training and Development (ASTD) framework is another pioneering early proposition that left a mark in the field (Carnevale et al. 1990; Green et al. 2013) and is based on 16 skills presented in seven groups, starting from ‘learning to learn’ which is seen as a foundation skill and including: basic literacy skills (reading, writing and computation); communication skills (listening and oral communication); creative thinking and problem solving; self-esteem (goal setting-motivation and career development); interpersonal skills (negotiation and teamwork); and organisational effectiveness and leadership (Carnevale et al. 1990).

- The Employment and Workplace Relations (DEEWR) of the Department of Education in Australia (DEEWR 2012) has proposed an employability skills framework that can be used across sectors. This framework consists of two main parts, namely a main set of skills clusters (navigate the work; interact with others; and get the work done) and a set enabling factors (workplace support; culture and values at both workplace and individual levels; and external factors) (DEEWR 2012).
• The Jobs for American’s Graduates (JAG) framework was developed to guide schools and training institutions in relation to the skills that should be taught to help people become employable (Collura 2009) and is composed by a total of 37 skills clustered into the six groups: career development skills; job attainment skills; job survival skills; basic skills; leadership and self-development skills; and personal skills (Collura 2009).

• The UK Commission for Employment and Skills (UKCES 2009) proposed a framework of employability skills aiming to use these skills and knowledge in the workplace and so that they can be further developed through experience. Individuals are expected to adopt a positive approach to work based on basic skills (numeracy, literacy and ICT skills) which are deemed to have a fundamental supportive role in the development of core skill (self-management, problem solving, teamwork and communication, and business skills) (UKCES 2009).

• The European Commission’s Joint Research Centre (JRC) proposed a rather different framework, which although encompassing most of the aspects in the previous frameworks offers a rather different typology of skills. Green et al. (2013) propose a framework that is specially aimed at the diversity of contexts and cultures within the EU and is based on greater prominence accorded to enabling support factors and local contexts. The framework is composed by one overarching group of skills related to enabling support factors and five specific factors related to the individual and their context (individual factors, individual circumstances, employer organisational practices, local contextual factors, and macro level factors) (Green et al. 2013).

In contrast to these very generic, all-encompassing frameworks, a very good example of an area where specific skills needed at work have been addressed extensively for the last three decades is generic ICT Skills. The Board of Studies NSW (2013) on behalf of the State of New South Wales in Australia presents a report suggesting a very interesting framework of ICT skills on communication, teamwork,
problem-solving, initiative and enterprise, planning and organising, self-management, self-learning and technology literacy. Another recent proposition by Gallup (2013), in report of a study commissioned by Microsoft Partners in Learning and The Pearson Foundation in the USA, presents a framework of ICT skills based on collaboration, knowledge construction, skilled communication, real world application of theoretical knowledge, self-regulation, problem solving and technology literacy. There are hundreds of such propositions at UK, Australian, American, European National and EU levels, all revolving around the same type of issues and skills.

All of these generic employability skills presented in the above frameworks, and many others that could be added to this list, can be synthesised and characterised by the following classification of skills as proposed by the UK National Institute of Adult Continuing Education (NIACE 2009):

- Basic Employability skills:
  - Self-management;
  - Team working;
  - Problem solving;
  - Communication;
  - Customer care;
  - Application of numeracy;
  - Application of ICT (CBI 2007).

- Personal Asset Skills:
  - Motivation and enthusiasm
  - Teamworking;
  - Flexibility and adaptability
  - Initiative / proactivity
  - Ongoing development.

The ontology proposed and shown in Table 6.1 covers all these aspects with the
exception of Application of Numeracy. This is not surprising as the numeracy skills are expected to be extremely high at entry levels for SW engineering and IS programmes. Therefore, in terms of the SW industry, numeracy skills are an acquired skill and not one that usually worries employees and employers. With this exception, there is a very close affinity between the ontology proposed in this thesis and these generic employability skills. From a professional development perspective, the ontology proposed identifies activities where these foundation skills form the basis for further experience acquisition and tacit knowledge construction. The ontology proposed provides continuity in professional development and the bridge to the development of further professional competencies in the exercise of professional activities.

6.3.3 Positioning of the Theory Proposed

As argued above, one of the interesting contributions of this study is to bridge between employability skills and competency, as shown in Figure 6.2. Employability skills as entry skills are used and developed through experience during professional activities enabling the acquisition and development of further professional competencies. This study provides an entire identification and classification of these professional activities where experience is required, acquired and used to construct tacit knowledge in the context of SW development for both junior SW practitioners and experienced SW practitioners.
Employability skills represent the entry level into SW development world of practice. Through their professional practice they acquire experience that is constructed based on these soft and hard skills. This experience allows them to be successful and to progress in their careers. The ontology of professional activities in the Chinese SW industry that lead to experience shown in Table 6.1 offers an excellent way to explain the process of competency development and how experience can be the main vehicle in this process. The activities identified in this study and described in depth in Chapter 5 and the resulting Integrated Theory of Experience Acquisition in the SW Industry model presented in Figure 6.1 facilitate this understanding this process of competency development.
Software development practitioners are required to have a good set of employability skills as well as technical competencies to enter the job market. Through their professional practice they acquire experience that then forms the base for the construction of tacit knowledge. In order to reflect upon and build up experience the SW practitioners require a sound understanding of what experience means in their world of practice as well as a good professional attitude (the two drivers in the Figure 6.1 model). In order to internally construct and then externalise the tacit knowledge acquired through experience, the SW practitioners need to have strong motivation and understanding of the need for their own individual development (one of the enablers in the Figure 6.1 model). This externalisation of tacit knowledge will then enable practitioners to build up their professional competencies. This complex process is represented in Figure 6.3.

Therefore, the natural positioning of the theory proposed in this thesis is bridging
between two extremely large bodies of literature employability skills and competencies. Both these bodies of literature put their emphasis in explicit knowledge concerning skills and competencies that are defined so that they can be measured and assessed. The theory proposed is based on tacit knowledge acquired through experience. Thus, the conceptualisations and theoretical underpinnings of the theory proposed here is essentially different. Nonetheless, the affinity with employability skills and competencies is clear both the nature of the essential categories and concepts identified. The focus on experience and resulting acquisition of tacit knowledge allows a natural link between the employability skills and competencies in the SW industry that was hitherto not clear in the body of knowledge.
Chapter 7. Conclusions and Future Work

7.1 Summary of the Study

This study aimed to provide an ontology of professional activities in the SW industry that require and enable the acquisition of experience that in turn is the basis for tacit knowledge creation. The rationale behind the creation of such an ontology is based on the need to externalise this tacit knowledge and then record such externalisations so that these can be shared and disseminated across organisations. For instance, if tacit knowledge in the SW industry can be externalised through storytelling as proposed by Chen et al. (2009, 2011) and Dawson (2004), then how can these stories be transformed into evidential records, meta-tagged, stored and retrieved by electronic records management systems.

The traditional problem in this area is that the concepts of electronic records management and knowledge management are often discussed in isolation and at high theoretic levels. Therefore, these two processes are not always clearly integrated in the knowledge and information management practices in organisations. The justification for this gap seems to be problems of translation of highly theoretical principles associated with tacit knowledge and ill-defined quasi-colloquial concepts such as experience into tools (ontologies or classifications) that can be used by more technically and explicit knowledge minded practitioners of ERM.

The ontology produced and presented in Table 6.1 provides exactly such a bridge, by identifying what aspects of professional and personal experience should be captured and organising these aspects into an explicit classification that can be used to capture the tacit knowledge and codify it into explicit knowledge. Since such ontologies are always closely related to actual contexts of practice, the researcher decided to choose her own National context of China, where she had worked before and had good guarantees of industrial access.
This study used a multiple case-study Grounded Theory approach, as explained in Section 3.6. The decision for such an inductive approach was made based on the complete lack of literature referring to classifying and defining professional and personal experience of individuals in the design and development of SW. The lack of such previous research would make a deductive approach virtually impossible and Grounded Theory emerged as a natural option for the research. The research design itself included a literature review as an exercise in theoretical sensitisation as proposed by Glaser and Strauss (2009), in order to gain a general understanding on the core theoretical concepts around knowledge management and knowledge sharing as well as to obtain an understanding of the structure and main stages related to the SW development process (Chapter 2).

Data collection was conducted through semi-structured interviews in order to get direct interaction with practitioners in field and capture individuals’ opinions and perceptions, as well as interpret individual’s understandings associated with these processes. Furthermore, in inductive research, it is important to have variety of respondents in order to obtain fully explained theories of the phenomena being studied. Therefore, the interviews were conducted in three different types of companies (Small and Medium-sized Enterprise, Stated-owned Enterprise and Large Private) in an attempt to capture a rich variety of possible representative contexts in the SW sector in China.

Data analysis was conducted according to the coding procedures advocated by Grounded Theory, namely: open, axial and selective coding. All coding procedures and use of support methods are discussed in Section 4.4. Data collection and analysis was conducted until the emergent theory reached theoretical saturation and the “well-developed concepts” (Strauss & Corbin 1998, p.15) associated with experience in the Chinese SW industry were ready to be presented (Chapter 5) and discussed (Chapter 6).
The findings of the study were presented in the highest detail possible in Chapter 5, in order to explain the emergence and categorisation of the theory generated from the qualitative data that aimed at identifying and explaining what experience in SW development industry in China means. This basic theory is based on 218 different codes identified out of 797 representative quotations. These codes were grouped and organised into a category hierarchy that includes 6 main categories and 31 sub-categories, which are represented in the ontology in Table 6.1, concept map in Appendix 7 and is synthesised in Figure 7.1. This emerged theory indicates in a very concise manner that experienced SW development practitioners in China should:

- Be able to understand the nature and value of experience in the SW industry;
- Effectively communicate with peers, leaders and customers;
- Be able and motivated to actively engage with continuous professional development;
- Share knowledge with peers and the profession at large;
- Effectively work in projects, assuming and adjusting to different roles when required;
- Exhibit a sound professional attitude both internally to their own company and externally to customers, partners and even competitors.

![Figure 7.1. Main Ontology of Professional Areas that lead to Experience in the SW Development Industry in China](image-url)
This basic ontology was then further analysed by applying selective coding and resulted in the main theory presented and discussed in Section 6.2.2 and illustrated in Figure 7.2. The category of Working in Projects was clearly identified as the core activity in the SW Industry reflecting the design and development nature of the industry. This core category was also clearly identified as the area where experience has a larger and more important role to play. Directly related with the core category three other significant categories were identified as enablers: Communication, Knowledge Sharing and Individual Development. Additionally, Understanding the Nature of Experience in the SW Industry and Professional Attitude are identified as drivers for the entire process of reflection, experience acquisition and tacit knowledge construction by the individual practitioners.

Figure 7.2. Representation of the Integrated Theory of Experience Acquisition in the SW Industry (ITEA Model)

As an integral part of any inductive process of research, the final stage of this study was to position the emerged theory in the body of knowledge. As argued in Section 6.3, the theory presented in this study bridges between employability skills and professional competencies, as shown in Figure 7.3. Employability skills as entry
skills are used and developed through experience during professional activities enabling the acquisition and development of professional competencies that in turn forms the base for the construction of tacit knowledge. In order to reflect upon and built up experience the SW practitioners require a sound understanding of what experience means in their world of practice as well as a good professional attitude (the two drivers in the Figure 7.2 model). In order to internally construct and then externalise the tacit knowledge acquired through experience, the SW practitioners need to have strong motivation and understanding of the need for their own individual development (one of the drivers in the in the Figure 7.2 model). This externalisation of tacit knowledge will then enable practitioners to build up their professional competencies.

**Figure 7.3.** Detailed Model of How Experience Bridges Employability and Competencies in SW Development Practice Theory of Experience Acquisition in the SW Industry

This complex process, illustrated in Figure 7.3, suggests the natural positioning of the theory proposed in this thesis is to bridge between the two extremely large bodies of
literature on employability skills and competencies. Both of these bodies of literature put their emphasis in explicit knowledge concerning skills and competencies that are defined so that they can be measured and assessed. The focus of the theory proposed in this thesis on experience and resulting acquisition of tacit knowledge allows a natural link between the employability skills and competencies in the SW industry that was hitherto lacking in the body of knowledge.

7.2 Reflections on the Study Process

7.2.1 Response to the Research Questions

This study aimed to respond to a set of research questions clearly presented in Chapter 1. It is important at the end of the study to reflect if these questions were adequately answered by the findings of this investigation.

The main research question for this study presented in Chapter 1 was set as follows:

How can tacit knowledge related to experience within the working practices of the SW industry be identified?

In order to respond to this overarching research question, four additional and more specific questions were set:

1. What constitutes professional and personal experience in the context of the process of SW development?

Experience as discussed in 2.2.2.3 is closely associated with professional activities. The study identified a total of 218 aspects of professional and personal experience that were grouped into 31 sub-categories of professional activities in which
experience is required and acquired. There 31 sub-categories were in turn grouped into 6 main categories of professional activity as shown in Figure 7.1 and discussed in depth in Chapter 5. These categories and codes form an ontology that explains experience within professional activities in the SW Industry in China. In other words, the ontology allows the definition of types of experience and the identification of specific areas of SW design and development in which this experience is relevant, acquired and developed. Therefore the ontology gives an appropriate response to this question.

2. Which components of this experience can be clearly identified so that they can be captured, shared and appropriately managed?

The ontology provided enables the externalisation of tacit knowledge as well as providing the means to classify and meta-tag the products of this externalisation. For instance, if tacit knowledge related to experience can be expressed through storytelling, then the stories produced can now be meta-tagged, stored and retrieved effectively though the use of traditional ERM techniques. Therefore, experience can now be understood in terms of the activities where it is required. Tacit knowledge associated with this context specific experience can be externalised. The evidence of this externalisation can now become part of traditional record keeping, that is can be systematically captured, managed and shared across the organisation. This will be of theoretical significance, but also of practical value since tacit knowledge associated with experience can now be managed as an important knowledge asset to organisations in the very competitive SW Industry.

2.a). What are the relationships between these components of experience?

Figure 7.2 clearly shows the relationships between the six main categories identified. These relationships are described and discussed in Section 6.2.2.
2.b). How can this experience be explicitly represented in order to support its capture, storage and use in SW companies in China and elsewhere?

Individuals’ experience can be explicitly represented through reflection and reporting on the different professional activities (31 identified areas of activity and 218 activities) they engage with during their working practice in the SW industry sector. The ontology comprising of the six categories synthesised in Figure 7.1 enables a structured approach for the transference of tacit knowledge associated with that experience into explicit knowledge, which can then be systematically captured, stored and exploited through the use of structured electronic records management approaches.

Therefore, this study provided a considered response to all the sub-questions established at the start of the project.

7.2.2 Reflection on the Research Process

In addition to the formal research outputs discussed in Chapters 5 and 6, there are three additional aspects the researcher reflected upon at the end the process:

- Willingness of the participants in offering their time to do the interviews;
- Conduct of the Interviews;
- Success of the Inductive Approach Adopted.


7.2.2.1 Willingness of the Participants

Before conducting the interviews for this investigation, the researcher was anxious that the SW professionals would not cooperate willingly in a study of this type, because of a perception that programmers and technical individuals would not be interested in this type of topic and that, in a very competitive Chinese context, they would not be readily willing to express or share their experiences and tacit knowledge. Conversely, the researcher verified that the participants showed a significant appreciation for a unique opportunity for them to reflect upon and recall their previous experiences and working practices. Time and space for this type of reflection are virtually impossible for a professional group that is known for stressful and highly pressured daily work routines.

In fact, despite the previous participants, with one exception out of 44, did voluntarily offer to be part of the study and genuinely seem to have enjoyed the process. The time taken away from their routines and the semi-structured interview process seems to have helped them to enhance their own understanding of their personal experiences and professional practices.

Evidence of the importance given to this reflection during the interview process is apparent in the request of one of the SW developers (I2.15.13.D) for a digital copy of the recording of his own interview in order to reflect further by himself. Another sign of success of the interviewing process was the engagement of interviewees with the answers that resulted in all but 15 out of the 44 interviews lasting more than the planned 60 minutes, despite the efforts of the interviewer. One of the managers invited the researcher for lunch and the interview continued during the meal for a total of 2 hours of recording. Please note, that in Chinese terms it would be impossible for the interviewer to refuse the invitation. Another, indication of this success was one of the project managers (I32.12.31.PM) of the private company (Bosi) who requested the extension of the interview after all the questions were
finished by actually excitedly stating “let’s continue” in English. Finally, and as non-recorded evidence of this unexpected interest, another one of the project managers of Bosi called the researcher on the phone at 21:00 in the evening, stating that while going home on the subway, he had reflected on the “conversation this afternoon” and wanted to add a number of issues.

This interest and willingness to participate in the study were unexpected by the researcher. Noticing the interest and enthusiasm that these professionals placed on the issues being discussed in the interviews gave the researcher a lot of confidence and encouragement that the research topic was of value to the industry as well as academia. Furthermore, reflection on this aspect of interaction with the participants revealed that SW developers, like any other professional, are interested in individual development and career progression aspects that are related to experience. Moreover, it revealed that contrary to prejudices and preconceived ideas of SW developers, these professionals are interested in other issues than just technology and programming. In truth, the findings of the study are a testament to this statement.

### 7.2.2.2 Conduct of the Interview

Conducting interviews is difficult and complex. The researcher felt that the interview process improved as experience was acquired during the interview process. It became apparent to the researcher that when doing the interviews, it is necessary to concentrate on listening and reacting to the new issues that may emerge from the development of participants’ responses. In the pilot study, the researcher missed some issues by not bringing up questions in reaction to interviewee’s responses, due to lack of experience and, at times, lack of assertiveness. For instance, one of the project managers stated that:
“The previous company I worked for is of a relatively large size, and the flow of tasks in projects is strictly controlled. So if a problem is discovered, it needs to be reported up, then the process for dealing with it would be very long and sometimes it would not be resolved in time.” (11.12.16.PM)

However, since the researcher is doing the study in the particular context of the pilot case company, an immediate follow-up question should have been put to the participant, such as: “But, what is the process in this company?”. Unfortunately, this was not done and some important information may have been lost.

A few other incidents such as this were identified during the analysis of the transcripts. This allowed the researcher to identify this problem, reflect on it and change her approach during the main study. In subsequent interviews the researcher was more proactive in seeking better contextualisation and explanation of statements or emerging concepts during the interview, which resulted in very productive data from the main study.

### 7.2.2.3 Success of the Inductive Approach Adopted

The findings presented in chapter 5, the ontology proposed in Section 6.2.1 and theory presented in Section 6.2.2 are very interesting in themselves, but also confirmed that the inductive approach adopted by using Grounded Theory seems to have been very successful. The emergent theory seems to be indeed grounded in the context of case-study rather than biased by the prevalent literature review. In this sense, the findings of this research are very different from those that would have emerged from a deductive approach (for instance a questionnaire based survey) that would either prove or disprove a priori defined theories deduced for the existing literature on the field.
Figure 7.4. Inductive Evolution of Conceptualisation of Experience in the SW industry in China
This success of the inductive process is clearly shown on Figure 7.4. From a departure based on generic stages of the SW design and development process, this study identified a grounded and emergent theory that is very different both in structure and in nature. The processes of open, axial and selective coding as well as constant comparison and memoing enabled a departure from a traditional compartmentalised and traditional understanding of stages in the process of SW development to produce horizontal and transversal activities as perceived and indicated by participants in the study. This power of discovery and explanation of new and emergent social phenomena seems to have served this research well. Therefore, the choice of Grounded Theory for this study seems to have been appropriate and particularly useful.

7.2.3 Limitations of the Research

The main limitation of this study lies in the combination of research methods selected and discussed in 4.1 and 4.2. This study adopted Straussian Grounded Theory as the overarching research methodology to guide the analysis of data collected from a multi case study in the Chinese context. The problem is, as discussed by Yin (2003), that case study research provides little basis for scientific generalisation and similarly, like some other inductive qualitative research methodologies, Grounded Theory is often criticised as being limited in generalisability (Morse 1999). This suggests that the findings and theory proposed in this thesis are not readily generalisable. The findings have explanatory power of the phenomenon studied in the Chinese SW industry and are potentially transferable to similar contexts, but not directly generalisable.

Strauss and Corbin (1998) stated that, usually, a Grounded Theory research study aims to develop a substantive theory, which is “developed from the study of one
small area of investigation and from one specific population” (Strauss & Corbin 1998, p. 267). Such a substantive theory can give an explanation “specifically for the populations from which it was derived and to apply back to them” (Strauss & Corbin 1998, p. 267). This research project aimed at generating such a substantive theory applicable to the SW industry in China. Generalisation may be achieved by future studies by testing and validating both ontology and theory proposed in other National contexts or even in other project based industries.

The entire process of coding and interpreting the qualitative data relied on the researcher’s own interpretation as well as theoretical and contextual sensitivities. This was compounded by the fact that this project is the first inductive qualitative research conducted by the researcher. Therefore, despite the support of her supervisors and interaction with colleagues using similar inductive approaches, her interpretations, conceptualisations and judgements of the data collected may not always have been the best. Therefore, further validation of the ontology and substantive theory proposed may be advisable in the future.

7.3 Contribution of Findings to the Body of Knowledge

The contributions of this thesis emerge from the presentation of findings in Chapter 5 and the discussion in Chapter 6. The more obvious contributions (T1, T2, P1) emerged as direct result of responding to the research questions. Other contributions emerged from reflections made by informants as discussed in Section 6.3 (T3, P2, P3) and the attempt to position both theory (Figure 7.2) and ontology (Table 6.1) in the current body of knowledge.

Some of these contributions are clearly theoretical and of interest to academics and theoreticians (T1, T2, T3), but probably the more interesting ones (P1, P2, P3), and not entirely foreseen at the start of the study, are actually of a practical nature and of
interest to the SW industry in China, and potentially elsewhere in the World and to other project based industries.

7.3.1 Theoretical Contributions

The following theoretical contributions emerged from chapter 5 and were established in chapter 6:

1. Proposition of an ontology of professional activities that lead to acquisition of experience in the SW Industry Ontology China. This ontology, named the Experience in the Chinese SW Industry (ECSW) Ontology is supported by the findings described in narrative form in Chapter 5, the concept map in Appendix 7 and its synthesis in Figure 7.1.
   - This ontology allows the categorisation of tacit knowledge associated with experience;
   - This ontology will support the creation of descriptive and structural metadata for the purposes of discovery and identification experience as well as defining structures and relationships between the different aspects of that experience;
   - Through the creation of metadata the ontology supports record keeping, retrieval and dissemination of that tacit knowledge within organisations;
   - Therefore, the ontology will assist creation of knowledge management and knowledge sharing models to keep, disseminate and exploit experience in the SW industry.

2. Proposition of the Integrated Theory of Experience Acquisition in the SW Industry (ITEA) Model that explains how experience is acquired in the industry, as discussed in Section 6.2.2 and illustrated in Figure 7.2. Experience of
Working in Projects is presented as the core category, reflecting the project nature of the industry and was clearly identified as the area where experience had a larger and more important role to play. Directly related with Working in Projects are three other significant categories described in Section 6.2.2 as enablers: Communication, Knowledge Sharing and Individual Development. These categories are represented independently as not all aspects of communication, knowledge sharing and individual development are directly related to working in projects. Finally, Understanding the Nature of Experience in the SW Industry and Professional Attitude are seen as drivers for the entire process of reflection, experience acquisition and tacit knowledge construction by the individual practitioners.

This model may at a superficial glance seem very generic, but it is the result of axial coding and selective coding based on codes and categories that emerged from and were discussed as grounded on the Chinese SW industry context in Chapter 5.

3. Proposition of the Experience Bridging between Employability and Competencies in SW Development Practice (EBEC) Model. This model is a valuable and initially not foreseen contribution that places the substantive theory proposed as bridging between theoretical propositions of two well established and very extensive bodies of literature on professional competencies and employability skills. This model is presented in Figure 6.3 and discussed in Section 6.3.3. The model is of use in both theoretical and practical terms and was partially directed by participants own conceptualisations of the practical uses of this research as discussed in the introduction of Section 6.3.

The EBEC model also gives the ontology a broader dimension and places it between Employability Skills frameworks (for newcomers into the profession) and IT/IS Competence Skills frameworks (for the definition of explicit
professional competencies). Therefore, this ontology acquired an even more significant role of filling a complementary gap between these models and defining our entry skills can be developed through experience in professional activities and lead to the development of acquired competencies as well as new ones by learning on the job.

7.3.2 Practical Contributions

As reflected in Chapter 6 and in particular in Section 6.3.3, this study also provides significant contributions to world the real working practice in the SW Industry:

1. The ontology provides the means to classify, meta-tag, store, retrieve and disseminate externalisations (narratives, stories, diaries, interactions in fora, emails, etc.) of tacit knowledge associated with experience. Therefore, the ontology provides SW companies with a framework to help them design, build and implement their knowledge management strategies and systems as well as organisational learning strategies. In addition, the ontology will help SW companies to develop their own tacit knowledge evidence archival and curation strategies. This will assist this externalised tacit knowledge to be preserved and, if possible, data mined in search of behavioural, customer and market patterns. This is particularly important on the SW industry, where companies have some of the highest staff turnovers and lowest company survival rates.

2. The ontology combined with both IMEA and EBEC models provide SW companies and HR departments with a framework that will enable them to recruit suitably experienced individuals. This is a perennial problem associated with employability skills generic frameworks often centred on entry skills.

This unintended contribution was actually first identified by some of the managers and project managers being interviewed, when through reflection and
contextualisation in their own world of practice they very pragmatically appropriated the purpose of the research to their own needs. As pointed out and fully discussed in Section 6.3, the ontology being developed was immediately seen as detailed framework with detailed criteria for experience practitioner recruitment.

3. Ontology combined with both IMEA and EBEC models additionally provides provide SW companies and HR departments with a framework that will help them in staff assessment and development processes aiming not only at competency acquisition and development but also at experience building and tacit knowledge externalisation.

Similarly, the awareness of the potential for this unintended contribution was also first identified by some of the project managers being interviewed, as pointed out and fully discussed in Section 6.3.

7.4 Future work

Despite the theoretical and practical value of the above contributions, it is clear that ontology and theories presented in this thesis are just as a first step in the understanding of identifying and classifying experience related to tacit knowledge in SW industry. The limitations discussed in Section 7.2.3 suggest that there is a need to further validate and generalise these propositions.

There are potential areas that can be further explored by future research:

- Validating and further investigating the suitability of the theory proposed in other types of Chinese SW companies.

The theory generated and ontology proposed in this thesis was built grounded on the
SW sector in China. In order to yield a rich variety of possible contexts in the SW sector, the researcher identified the three main types of SW companies in China, namely private SMEs, large private companies and SOE. Although the study obtained theoretical saturation, it is conceivable to expand the scope of theoretical sampling so as to include other types of companies that operate in the Chinese SW market, such as foreign funded enterprises and Chinese subdivisions of Multi-National companies. These were not included in this study since they were considered as being foreign companies with procedures, processes and cultures that were not Chinese. Nonetheless, these companies do operate in China so it would make sense to expand the ontology and theory to include them.

- Investigating the transferability of the ontology proposed in other National contexts.

The theory proposed in this thesis is strongly grounded in the Chinese context as discussed in Section 5.9 and 6.2.3. However, it is reasonable to expect that, despite obvious cultural differences, processes, procedures and industry standards may create strong similarities in the way professionals act and acquire experience in this industry. Therefore, it is hoped that the findings and theoretical propositions in this type of study may be transferable and used to explain experience in other national contexts elsewhere. Therefore, future work should aim at testing transferability and generalising the propositions of this thesis to the wider SW industry.

- Investigating the applicability of the theory proposed in other industries whose main business activities based on project work.

The core category of the theory proposed and illustrated in Figure 7.2 is “Working in Projects”. This was clearly seen by participants as the core activity in the SW industry and the defining feature in their work. Therefore, it is also reasonable to expect that some of the aspects of the ontology may be generalisable to other
industries whose business activities is specifically characterised by project work. A good source for this type of industry may lie with the Association of Proposal Management Professionals (APMP), who focuses on professionals in industry, arts, sciences, and technologies that are dedicated to the process of doing business through proposals, bids, tenders, and presentations. Through these professionals it may be possible to find many other industrial settings that may benefit from the propositions made in this thesis.

- Testing, validating and further developing the applicability of the ontology in the world of practice.

The propositions in this thesis are of a theoretical nature. As expected in a typical Grounded Theory research project, the aim was to build a context-based ontology and theory grounded on the actual world of practice in the Chinese SW industry. However, the assumption behind this work was that the ontology produced would help organisations in externalising tacit knowledge and meta-tag the product of these externalisations so that they can be processed and managed by electronic records management. So, ultimately it was always expected that the theory developed would have practical use on the world of industry.

Evidence of this potential for practical use emerged during the interviews as discussed in section 6.3. Additional evidence emerged upon receiving feedback on a preliminary report that was sent to all three companies upon completion of this research. In fact, within 4 days of sending this report by email to all participants, the researcher received 9 feedback emails commenting on the value of the ontology proposed. This in itself was a very surprising result as it shows how highly participants were engaged with and valued this research. Significantly, this feedback was received not only from managers, but also software developers and project managers. This provides a clear indication of the potential use in practice of the ontology.
Very positive feedback was received from these participants in relation to the structure and direct use of the ontology:

“I think that this ontology is very interesting. Actually, this categorisation displays and expresses experience in a clear visual and structured framework. It will allow us to communicate, share and exchange knowledge more efficiently, and enhance our team work. Moreover, according to this ontology, we could establish a classification retrieval system for the experience needed in working practice, which will facilitate people search and use tacit knowledge.” (Developer 2)

“In my opinion, firstly, this ontology could help individuals to reflect and summarise their own experience, as well as to develop their own tacit knowledge structures, then it would easier for them to record them as well as retrieve and use it. Secondly, it could help the company and the project teams to build the experience categorisation and classification system, which can support our company and teams to quickly find and use this knowledge. Thirdly, the adoption of this ontology will be the basis to create an organisational learning culture in our company.” (Senior Manager)

Moreover, the ontology was perceived to be of value for individual development as was stated in one of the emails:

“I like this ontology. I could use it as a guide or reference, which could provide me multi-angle and full range of consideration on my personal development. It will help me to have a better, faster, more comprehensive view on my problems.” (Developer 4)

The feedback provided evidence that the ontology immediately facilitated reflection on work practices and enabled some change of professional attitude and understanding:
“I think I like this ontology a lot, especially the category of communication. Real working practice is based on the continuous communications with my team members. Good communication allows me to have an understanding of the overall situation of our project, including the progress and some key milestones. This communication will put pressure on my team members, and promote the completion of the project according to schedule. This communication will also expose the problems earlier that we could correct the problem as soon as we find out. So I would consider this communication is part of process management to control the quality and progress of project, but not the management that only concern about the outcome. This ontology made me reflect on this issue, that I never really considered before, therefore, I will try to understand and use this ontology very carefully.” (Project Manager 2)

Furthermore, this early feedback also proposed the adoption of integrative knowledge management practices bringing together both tacit and explicit knowledge:

“I personally think that the classification of knowledge should be relatively uniform, regardless of tacit and explicit knowledge. They should use the same categorisation and classification. In fact, individuals and teams will accumulate experience during the working processes and also share this knowledge. Although this sharable knowledge is in tacit format, it does not mean it should be separated from the whole knowledge management system. Therefore, in order to use this ontology efficiently and create a sound knowledge management strategy, it is better to consider the explicit knowledge as well into this classification.” (Senior Manager)

Therefore, the natural next step in furthering this research is to validate, explore and expand the ontology in the real world of practice through implementation of knowledge management, electronic records management and organisational learning behaviours.

Finally, the use of research findings for human resources recruitment practices and
performance assessment was immediately recognized by the participants during the interview processes, as reflected in the following quotations, already used above in Chapter 6, but reused here as reinforcement:

“Could you send me a copy of the report or results from this research? I would like to use it for the basis on the future recruitment of our staff. I always have difficulties in knowing what to ask them other than the technical skills.” (I5.14.39.M)

“Yes, yes, very interesting this classification of experience you are studying, do you think I can use it to evaluate my team members? I would like to know who is well experienced and qualified and who I need to improve.” (I28.18.33.PM)

Therefore, future research should include studies on how to use the ontology proposed in areas such as recruitment, individual development or even professional accreditation.

- Validating and further developing the applicability of the ontology in HE and Training.

Interviewees were extremely critical of what they had learnt in formal education, namely in HE courses. According to their statements, these courses seem to concentrate almost exclusively on technical issues and neglect soft skills that seemed to be valued the most in the industry. HE course are seen to provide “basic knowledge for getting started” (I38.10.41.T) that is sometimes “too simple and totally not related with real practical applications” (I35.3.9.D).

Therefore, the ontology proposed could be used by Computer Science, Information Systems and Information departments and course leaders to develop components of their curriculum that are more effective in preparing their graduates for the real world of work.
The propositions in this thesis are but a first step in understanding and defining the quasi-colloquial term of experience in the context of the SW industry. The researcher often felt that everyone talks about experience, but no one defines it. This research is expected to be a first attempt in categorising and classifying experience. The researcher knows it is neither the last nor the ultimate proposition in this area, but hopes it may be the start of a rich and productive strand of investigation.
References


Appendices

Appendix 1: 2007 NAICS Search Results for Software

<table>
<thead>
<tr>
<th>2007 NAICS Code</th>
<th>2007 NAICS Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>334611</td>
<td>CD-ROM, software, mass reproducing</td>
</tr>
<tr>
<td>334611</td>
<td>Compact discs (i.e., CD-ROM), software, mass reproducing</td>
</tr>
<tr>
<td>334611</td>
<td>Game cartridge software, mass reproducing</td>
</tr>
<tr>
<td>334611</td>
<td>Games, computer software, mass reproducing</td>
</tr>
<tr>
<td>334611</td>
<td>Prepackaged software, mass reproducing</td>
</tr>
<tr>
<td>334611</td>
<td>Software, packaged, mass reproducing</td>
</tr>
<tr>
<td>334613</td>
<td>Computer software tapes and disks, blank, rigid and floppy, manufacturing</td>
</tr>
<tr>
<td>423430</td>
<td>Computer software, packaged, merchant wholesalers</td>
</tr>
<tr>
<td>423430</td>
<td>Game software merchant wholesalers</td>
</tr>
<tr>
<td>423430</td>
<td>Software, computer, packaged, merchant wholesalers</td>
</tr>
<tr>
<td>443120</td>
<td>Software stores, computer</td>
</tr>
<tr>
<td>443120</td>
<td>Video game software stores</td>
</tr>
<tr>
<td>454113</td>
<td>Computer software, mail-order houses</td>
</tr>
<tr>
<td>511210</td>
<td>Applications software, computer, packaged</td>
</tr>
<tr>
<td>511210</td>
<td>Computer software publishers, packaged</td>
</tr>
<tr>
<td>511210</td>
<td>Computer software publishing and reproduction</td>
</tr>
<tr>
<td>511210</td>
<td>Games, computer software, publishing</td>
</tr>
<tr>
<td>511210</td>
<td>Operating systems software, computer, packaged</td>
</tr>
<tr>
<td>511210</td>
<td>Packaged computer software publishers</td>
</tr>
<tr>
<td>511210</td>
<td>Programming language and compiler software publishers, packaged</td>
</tr>
<tr>
<td>511210</td>
<td>Publishers, packaged computer software</td>
</tr>
<tr>
<td>511210</td>
<td>Software computer, packaged, publishers</td>
</tr>
<tr>
<td>511210</td>
<td>Software publishers</td>
</tr>
<tr>
<td>511210</td>
<td>Software publishers, packaged</td>
</tr>
<tr>
<td>511210</td>
<td>Utility software, computer, packaged</td>
</tr>
<tr>
<td>541511</td>
<td>Applications software programming services, custom computer</td>
</tr>
<tr>
<td>541511</td>
<td>Computer program or software development, custom</td>
</tr>
<tr>
<td>541511</td>
<td>Computer software analysis and design services, custom</td>
</tr>
<tr>
<td>541511</td>
<td>Computer software programming services, custom</td>
</tr>
<tr>
<td>541511</td>
<td>Computer software support services, custom</td>
</tr>
<tr>
<td>541511</td>
<td>Software analysis and design services, custom computer</td>
</tr>
<tr>
<td>541511</td>
<td>Software programming services, custom computer</td>
</tr>
<tr>
<td>541512</td>
<td>Computer software consulting services or consultants</td>
</tr>
<tr>
<td>541519</td>
<td>Software installation services, computer</td>
</tr>
<tr>
<td>611420</td>
<td>Computer software training</td>
</tr>
<tr>
<td>611420</td>
<td>Software application training</td>
</tr>
</tbody>
</table>
## Appendix 2: KOMPASS Search Results for Software

<table>
<thead>
<tr>
<th>KOMPASS Code</th>
<th>KOMPASS Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>Printing and publishing</td>
</tr>
<tr>
<td>28730</td>
<td>Publishing: Compact discs, records, audio and video cassettes</td>
</tr>
<tr>
<td>2873028</td>
<td>Publishers, software on disk or compact disc (CD)</td>
</tr>
<tr>
<td>44</td>
<td>Pulp, paper and board making machinery and equipment. Printing and office machinery and equipment. Electronic data processing (EDP) equipment</td>
</tr>
<tr>
<td>44880</td>
<td>Operating systems. System and development software</td>
</tr>
<tr>
<td>4488009</td>
<td>Software, programming languages and compilers</td>
</tr>
<tr>
<td>4488010</td>
<td>Software, microprocessor languages</td>
</tr>
<tr>
<td>4488011</td>
<td>Software, programming aid</td>
</tr>
<tr>
<td>4488012</td>
<td>Software, program debuggers</td>
</tr>
<tr>
<td>4488013</td>
<td>Software, programming text editors</td>
</tr>
<tr>
<td>4488014</td>
<td>Software, computer aided software engineering (CASE)</td>
</tr>
<tr>
<td>4488015</td>
<td>Software, computer aided software testing (CAST)</td>
</tr>
<tr>
<td>4488016</td>
<td>Software, graphical user interface (GUI)</td>
</tr>
<tr>
<td>4488017</td>
<td>Software, report program generators</td>
</tr>
<tr>
<td>4488018</td>
<td>Software, application programming</td>
</tr>
<tr>
<td>4488019</td>
<td>Software, online application development</td>
</tr>
<tr>
<td>4488020</td>
<td>Software, touch screen, interactive</td>
</tr>
<tr>
<td>4488021</td>
<td>Software, device drivers</td>
</tr>
<tr>
<td>4488022</td>
<td>Software, utilities</td>
</tr>
<tr>
<td>4488023</td>
<td>Software, disk utilities</td>
</tr>
<tr>
<td>4488024</td>
<td>Software, file utilities (backup, recovery etc.)</td>
</tr>
<tr>
<td>4488025</td>
<td>Software, anti-virus</td>
</tr>
<tr>
<td>4488026</td>
<td>Software, anti-spam</td>
</tr>
<tr>
<td>4488027</td>
<td>Software, data compression</td>
</tr>
<tr>
<td>4488028</td>
<td>Software, computer image compression systems, real time</td>
</tr>
<tr>
<td>4488029</td>
<td>Software, data encryption</td>
</tr>
<tr>
<td>4488030</td>
<td>Software, file or data conversion</td>
</tr>
<tr>
<td>4488031</td>
<td>Software, memory management</td>
</tr>
<tr>
<td>4488032</td>
<td>Software, power management</td>
</tr>
<tr>
<td>4488033</td>
<td>Software, security access control systems, data protection</td>
</tr>
<tr>
<td>4488034</td>
<td>Software, Internet security</td>
</tr>
<tr>
<td>4488035</td>
<td>Software, intrusion detection system (IDS)</td>
</tr>
<tr>
<td>4488036</td>
<td>Software, web server</td>
</tr>
<tr>
<td>4488037</td>
<td>Software, website load distribution</td>
</tr>
<tr>
<td>4488038</td>
<td>Software, speech synthesis</td>
</tr>
<tr>
<td>4488039</td>
<td>Software, computer hardware diagnostics</td>
</tr>
<tr>
<td>4488040</td>
<td>Software, configuration management</td>
</tr>
<tr>
<td>4488041</td>
<td>Software, open source (OSS)</td>
</tr>
<tr>
<td>4488042</td>
<td>Software, remote access</td>
</tr>
<tr>
<td>4488901</td>
<td>Software, server virtualisation</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>4488902</td>
<td>Software, desktop virtualisation</td>
</tr>
<tr>
<td>44890</td>
<td>Software, database management system (DBMS)</td>
</tr>
<tr>
<td>4489001</td>
<td>Software, object orientated database</td>
</tr>
<tr>
<td>4489002</td>
<td>Software, relational database</td>
</tr>
<tr>
<td>4489003</td>
<td>Software, hierarchical database</td>
</tr>
<tr>
<td>4489004</td>
<td>Software, distributed database</td>
</tr>
<tr>
<td>4489005</td>
<td>Software, embedded database</td>
</tr>
<tr>
<td>4489009</td>
<td>Software, CD-ROM database development</td>
</tr>
<tr>
<td>4489010</td>
<td>Software, extraction transfer loading (ETL)</td>
</tr>
<tr>
<td>44900</td>
<td>Application software packages, business, office, professional and financial</td>
</tr>
<tr>
<td>4490001</td>
<td>Integrated software for offices</td>
</tr>
<tr>
<td>4490002</td>
<td>Integrated software, hybrid letter mail</td>
</tr>
<tr>
<td>4490003</td>
<td>Software, desktop publishing (DTP)</td>
</tr>
<tr>
<td>4490004</td>
<td>Software, presentation</td>
</tr>
<tr>
<td>4490005</td>
<td>Software, spreadsheet</td>
</tr>
<tr>
<td>4490006</td>
<td>Software, word processing</td>
</tr>
<tr>
<td>4490007</td>
<td>Software, forms design and management</td>
</tr>
<tr>
<td>4490008</td>
<td>Software, label production</td>
</tr>
<tr>
<td>4490009</td>
<td>Software, address management</td>
</tr>
<tr>
<td>4490010</td>
<td>Software, editorial and publications management</td>
</tr>
<tr>
<td>4490011</td>
<td>Software, cross media publishing (CMP)</td>
</tr>
<tr>
<td>4490012</td>
<td>Software, patents</td>
</tr>
<tr>
<td>4490013</td>
<td>Software, contact management</td>
</tr>
<tr>
<td>4490014</td>
<td>Software, communications</td>
</tr>
<tr>
<td>4490015</td>
<td>Software, facsimile (fax) and telex; Inclusive: - Software, Internet protocol fax (IP fax)</td>
</tr>
<tr>
<td>4490016</td>
<td>Software, electronic mail (E-mail)</td>
</tr>
<tr>
<td>4490017</td>
<td>Software, instant messaging</td>
</tr>
<tr>
<td>4490018</td>
<td>Software, Internet telephony</td>
</tr>
<tr>
<td>4490019</td>
<td>Software, Internet navigation, web browsers</td>
</tr>
<tr>
<td>4490020</td>
<td>Software, intranet</td>
</tr>
<tr>
<td>4490021</td>
<td>Software, extranet</td>
</tr>
<tr>
<td>4490022</td>
<td>Software, virtual private network (VPN)</td>
</tr>
<tr>
<td>4490023</td>
<td>Software, web page design and development</td>
</tr>
<tr>
<td>4490024</td>
<td>Software, electronic commerce (E-commerce)</td>
</tr>
<tr>
<td>4490025</td>
<td>Software, shopping cart/basket (E-commerce)</td>
</tr>
<tr>
<td>4490026</td>
<td>Software, mobile electronic commerce (m-commerce)</td>
</tr>
<tr>
<td>4490027</td>
<td>Software, shopping agents (shopping robots/bots)</td>
</tr>
<tr>
<td>4490028</td>
<td>Software, Internet payment</td>
</tr>
<tr>
<td>4490029</td>
<td>Software, website checking</td>
</tr>
<tr>
<td>4490030</td>
<td>Software, website monitoring</td>
</tr>
<tr>
<td>4490031</td>
<td>Software, website contents management</td>
</tr>
<tr>
<td>4490032</td>
<td>Software, search engine</td>
</tr>
<tr>
<td>4490033</td>
<td>Software, unified messaging system</td>
</tr>
<tr>
<td>4490034</td>
<td>Software, video over Internet protocol (Video over IP)</td>
</tr>
<tr>
<td>4490035</td>
<td>Software, business intelligence</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------------------------------</td>
</tr>
<tr>
<td>4490036</td>
<td>Software, enterprise content management (ECM)</td>
</tr>
<tr>
<td>4490037</td>
<td>Software, customer relationship management (CRM)</td>
</tr>
<tr>
<td>4490038</td>
<td>Software, supplier relationship management (SRM)</td>
</tr>
<tr>
<td>4490039</td>
<td>Software, supply chain management (SCM)</td>
</tr>
<tr>
<td>4490040</td>
<td>Software, e-procurement</td>
</tr>
<tr>
<td>4490041</td>
<td>Software, online transaction processing (OLTP)</td>
</tr>
<tr>
<td>4490042</td>
<td>Software, marketing, commercial and quality research</td>
</tr>
<tr>
<td>4490043</td>
<td>Software, online analytical processing (OLAP)</td>
</tr>
<tr>
<td>4490044</td>
<td>Software, purchasing management</td>
</tr>
<tr>
<td>4490045</td>
<td>Software, sales and marketing</td>
</tr>
<tr>
<td>4490046</td>
<td>Software, telemarketing</td>
</tr>
<tr>
<td>4490047</td>
<td>Software, mail order processing</td>
</tr>
<tr>
<td>4490048</td>
<td>Software, electronic mail (E-mail) marketing</td>
</tr>
<tr>
<td>4490049</td>
<td>Software, direct market merchandising</td>
</tr>
<tr>
<td>4490050</td>
<td>Software, computer aided selling (CAS)</td>
</tr>
<tr>
<td>4490051</td>
<td>Software, auction sales</td>
</tr>
<tr>
<td>4490052</td>
<td>Software, enterprise resource planning (ERP)</td>
</tr>
<tr>
<td>4490053</td>
<td>Software, enterprise asset management (EAM)</td>
</tr>
<tr>
<td>4490054</td>
<td>Software, enterprise application integration (EAI)</td>
</tr>
<tr>
<td>4490055</td>
<td>Software, personnel management/human resources (HR)</td>
</tr>
<tr>
<td>4490101</td>
<td>Software, time and attendance</td>
</tr>
<tr>
<td>4490102</td>
<td>Software, travel expense management</td>
</tr>
<tr>
<td>4490103</td>
<td>Software, electronic catalogue/e-catalogue</td>
</tr>
<tr>
<td>4490104</td>
<td>Software, bulletin board</td>
</tr>
<tr>
<td>4490105</td>
<td>Software, voice board</td>
</tr>
<tr>
<td>4490106</td>
<td>Software, data warehousing</td>
</tr>
<tr>
<td>4490107</td>
<td>Software, archive management</td>
</tr>
<tr>
<td>4490108</td>
<td>Software, library and electronic document management (EDMS)</td>
</tr>
<tr>
<td>4490109</td>
<td>Software, decision support (DSS)</td>
</tr>
<tr>
<td>4490110</td>
<td>Software, business process management (BPM)</td>
</tr>
<tr>
<td>4490111</td>
<td>Software, business activity simulation and modelling</td>
</tr>
<tr>
<td>4490112</td>
<td>Software, company data integration</td>
</tr>
<tr>
<td>4490113</td>
<td>Software, internal company data access</td>
</tr>
<tr>
<td>4490114</td>
<td>Software, geographical optimisation of vehicle fleets</td>
</tr>
<tr>
<td>4490115</td>
<td>Software, transport and logistics</td>
</tr>
<tr>
<td>4490116</td>
<td>Software, public transport management and services</td>
</tr>
<tr>
<td>4490117</td>
<td>Software, logistics process simulation</td>
</tr>
<tr>
<td>4490118</td>
<td>Software, import-export applications</td>
</tr>
<tr>
<td>4490119</td>
<td>Software for wholesale applications</td>
</tr>
<tr>
<td>4490120</td>
<td>Software, warehouse management (inventory) and stock control systems</td>
</tr>
<tr>
<td>4490121</td>
<td>Software for retail chains</td>
</tr>
<tr>
<td>4490122</td>
<td>Software, point of sale (EPOS)</td>
</tr>
<tr>
<td>4490123</td>
<td>Software, bar code</td>
</tr>
<tr>
<td>4490124</td>
<td>Software for credit cards and smart cards, payment authorisation and transaction</td>
</tr>
<tr>
<td>4490125</td>
<td>Software, electronic invoicing</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------</td>
</tr>
<tr>
<td>4490126</td>
<td>Software, automatic invoice processing</td>
</tr>
<tr>
<td>4490127</td>
<td>Software for chemists/pharmacies</td>
</tr>
<tr>
<td>4490128</td>
<td>Software, advertising agencies</td>
</tr>
<tr>
<td>4490129</td>
<td>Software, booking office</td>
</tr>
<tr>
<td>4490130</td>
<td>Software, travel agency, airline, ticketing</td>
</tr>
<tr>
<td>4490131</td>
<td>Software, estate agency and property management</td>
</tr>
<tr>
<td>4490132</td>
<td>Software for lawyers</td>
</tr>
<tr>
<td>4490133</td>
<td>Software, information centre management</td>
</tr>
<tr>
<td>4490134</td>
<td>Software, non-profit making organisations</td>
</tr>
<tr>
<td>4490135</td>
<td>Software, fund raising</td>
</tr>
<tr>
<td>4490136</td>
<td>Software, interactive product configuration</td>
</tr>
<tr>
<td>4490137</td>
<td>Software for personal digital assistants (PDA)</td>
</tr>
<tr>
<td>4490138</td>
<td>Software, business applications</td>
</tr>
<tr>
<td>4490139</td>
<td>Software, business and management performance support</td>
</tr>
<tr>
<td>4490140</td>
<td>Software, budgeting</td>
</tr>
<tr>
<td>4490141</td>
<td>Software, accounting</td>
</tr>
<tr>
<td>4490142</td>
<td>Software, costing</td>
</tr>
<tr>
<td>4490143</td>
<td>Software, payroll</td>
</tr>
<tr>
<td>4490144</td>
<td>Software, factoring and debt recovery/debt collection</td>
</tr>
<tr>
<td>4490145</td>
<td>Software, debt recovery/collection</td>
</tr>
<tr>
<td>4490146</td>
<td>Software, hire purchase, leasing and rental applications</td>
</tr>
<tr>
<td></td>
<td>Inclusive: - Software, plant hire</td>
</tr>
<tr>
<td>4490147</td>
<td>Software, investment analysis</td>
</tr>
<tr>
<td>4490148</td>
<td>Software, financial analysis</td>
</tr>
<tr>
<td>4490149</td>
<td>Software, taxation</td>
</tr>
<tr>
<td>4490150</td>
<td>Software, pension calculation and provision analysis</td>
</tr>
<tr>
<td>4490151</td>
<td>Software, personal tax and finance; Inclusive: - Software, home</td>
</tr>
<tr>
<td></td>
<td>finance, financial planning</td>
</tr>
<tr>
<td>4490152</td>
<td>Software, loan, credit card and mortgage management</td>
</tr>
<tr>
<td>4490153</td>
<td>Software, Interactive Voice Response (IVR)</td>
</tr>
<tr>
<td>4490154</td>
<td>Software, telephone call accounting</td>
</tr>
<tr>
<td>4490155</td>
<td>Software, computer telephony integration (CTI)</td>
</tr>
<tr>
<td>4490201</td>
<td>Software for prepaid services</td>
</tr>
<tr>
<td>4490202</td>
<td>Software, computer telephony applications</td>
</tr>
<tr>
<td>4490203</td>
<td>Software, risk management</td>
</tr>
<tr>
<td>4490204</td>
<td>Software, interactive, for sales representatives</td>
</tr>
<tr>
<td>4490205</td>
<td>Software for social insurance institutions</td>
</tr>
<tr>
<td>4490210</td>
<td>Software, passenger flow simulation/pedestrian flow simulation</td>
</tr>
<tr>
<td>4490901</td>
<td>Software, e-mobility/electromobility</td>
</tr>
<tr>
<td>44920</td>
<td>Application software packages, industrial, technical and scientific</td>
</tr>
<tr>
<td>4492001</td>
<td>Software, project and information management</td>
</tr>
<tr>
<td>4492002</td>
<td>Software, computer aided design (CAD)</td>
</tr>
<tr>
<td>4492003</td>
<td>Software, computer aided manufacturing (CAM)</td>
</tr>
<tr>
<td>4492004</td>
<td>Software, computer aided engineering (CAE)</td>
</tr>
<tr>
<td>4492005</td>
<td>Software, production planning/scheduling</td>
</tr>
<tr>
<td>4492006</td>
<td>Software, works-internal logistics and system integration</td>
</tr>
<tr>
<td>4492007</td>
<td>Software, engineering; Inclusive: - Software, structural analyses</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-------------------------------------------------------</td>
</tr>
<tr>
<td>4492008</td>
<td>Software, reliability engineering</td>
</tr>
<tr>
<td>4492009</td>
<td>Software, dimensional accuracy of gears and gearwheels</td>
</tr>
<tr>
<td>4492010</td>
<td>Software, measurement and control applications</td>
</tr>
<tr>
<td>4492011</td>
<td>Software, optical and photometrical design</td>
</tr>
<tr>
<td>4492012</td>
<td>Software, valve diagnosis and remote maintenance</td>
</tr>
<tr>
<td>4492013</td>
<td>Software, scientific applications</td>
</tr>
<tr>
<td>4492014</td>
<td>Software, casting process simulation</td>
</tr>
<tr>
<td>4492015</td>
<td>Software, plastics injection moulding simulation</td>
</tr>
<tr>
<td>4492016</td>
<td>Software, mathematics and statistics applications</td>
</tr>
<tr>
<td>4492017</td>
<td>Software, telecommunications</td>
</tr>
<tr>
<td>4492018</td>
<td>Software, telematics</td>
</tr>
<tr>
<td>4492019</td>
<td>Software, short message service (SMS)/text messaging service (MMS)</td>
</tr>
<tr>
<td>4492020</td>
<td>Software, wireless communications</td>
</tr>
<tr>
<td>4492021</td>
<td>Software, short range wireless data communication</td>
</tr>
<tr>
<td>4492022</td>
<td>Software, voice message</td>
</tr>
<tr>
<td>4492023</td>
<td>Software, controller area network (CAN)</td>
</tr>
<tr>
<td>4492024</td>
<td>Software, asynchronous transfer mode (ATM) networks</td>
</tr>
<tr>
<td>4492025</td>
<td>Software, radio frequency identification (RFID)</td>
</tr>
<tr>
<td>4492026</td>
<td>Software, medical scanner</td>
</tr>
<tr>
<td>4492027</td>
<td>Software, radiology</td>
</tr>
<tr>
<td>4492028</td>
<td>Software, cephalometric</td>
</tr>
<tr>
<td>4492029</td>
<td>Software, construction industry</td>
</tr>
<tr>
<td>4492030</td>
<td>Software, chemicals for building materials</td>
</tr>
<tr>
<td>4492031</td>
<td>Software, architecture</td>
</tr>
<tr>
<td>4492032</td>
<td>Software, medical analysis laboratories</td>
</tr>
<tr>
<td>4492033</td>
<td>Software, electronic navigational chart</td>
</tr>
<tr>
<td>4492034</td>
<td>Software, dictating machine</td>
</tr>
<tr>
<td>4492035</td>
<td>Software, handwriting recognition</td>
</tr>
<tr>
<td>4492036</td>
<td>Software, voice recognition</td>
</tr>
<tr>
<td>4492037</td>
<td>Software, speech recognition</td>
</tr>
<tr>
<td>4492038</td>
<td>Software, continuous voice recognition, office use</td>
</tr>
<tr>
<td>4492039</td>
<td>Software, biometric recognition</td>
</tr>
<tr>
<td>4492040</td>
<td>Software, computer hardware testing and maintenance</td>
</tr>
<tr>
<td>4492041</td>
<td>Software, online management of computers</td>
</tr>
<tr>
<td>4492042</td>
<td>Software, computer link, design-to-test</td>
</tr>
<tr>
<td>4492043</td>
<td>Software, video surveillance systems</td>
</tr>
<tr>
<td>4492044</td>
<td>Software, communication surveillance (tapping)</td>
</tr>
<tr>
<td>4492045</td>
<td>Software, digital map based distribution systems</td>
</tr>
<tr>
<td>4492046</td>
<td>Software, fuel distribution</td>
</tr>
<tr>
<td>4492047</td>
<td>Software, aviation; Inclusive: - Software, aviation maintenance</td>
</tr>
<tr>
<td>4492048</td>
<td>Software, marine engineering and naval architecture</td>
</tr>
<tr>
<td>4492049</td>
<td>Software, waste management</td>
</tr>
<tr>
<td>4492050</td>
<td>Software, embroidery design, for embroidering machines</td>
</tr>
<tr>
<td>4492051</td>
<td>Software, fault tree analysis (FTA)</td>
</tr>
<tr>
<td>4492053</td>
<td>Software for laser marking</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>------------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>4492904</td>
<td>Software, ship position monitoring and tracking</td>
</tr>
<tr>
<td>4492905</td>
<td>Software, mechatronic system simulation</td>
</tr>
<tr>
<td>4492906</td>
<td>Software, market research</td>
</tr>
<tr>
<td>44930</td>
<td>Software NES</td>
</tr>
<tr>
<td>4493001</td>
<td>Software, interactive</td>
</tr>
<tr>
<td>4493002</td>
<td>Software, multi-user</td>
</tr>
<tr>
<td>4493003</td>
<td>Software, local area networks (LAN)</td>
</tr>
<tr>
<td>4493004</td>
<td>Software, communications network management</td>
</tr>
<tr>
<td>4493005</td>
<td>Software, route planners</td>
</tr>
<tr>
<td>4493006</td>
<td>Software for games</td>
</tr>
<tr>
<td>4493007</td>
<td>Software for domestic applications</td>
</tr>
<tr>
<td>4493008</td>
<td>Software, optical character recognition (OCR) and scanning</td>
</tr>
<tr>
<td>4493010</td>
<td>Software training aids for software packages</td>
</tr>
<tr>
<td>4493011</td>
<td>Software for education and training</td>
</tr>
<tr>
<td></td>
<td>Inclusive: - Software, computer aided musical education system, - Software, computer aided teaching (CAT) systems</td>
</tr>
<tr>
<td>4493012</td>
<td>Software, e-learning</td>
</tr>
<tr>
<td>4493013</td>
<td>Software, interactive distance learning/training</td>
</tr>
<tr>
<td>4493014</td>
<td>Software, language translation</td>
</tr>
<tr>
<td>4493015</td>
<td>Software, language teaching and language laboratory</td>
</tr>
<tr>
<td>4493016</td>
<td>Software, computer aided music composition</td>
</tr>
<tr>
<td>4493017</td>
<td>Software, call centre, helpdesk</td>
</tr>
<tr>
<td>4493019</td>
<td>Software, sports events</td>
</tr>
<tr>
<td>4493022</td>
<td>Software, change management systems</td>
</tr>
<tr>
<td>4493025</td>
<td>Software, three-dimensional visualisation</td>
</tr>
<tr>
<td>4493026</td>
<td>Software, three-dimensional terrain visualisation</td>
</tr>
<tr>
<td>4493027</td>
<td>Software, genealogy</td>
</tr>
<tr>
<td>4493028</td>
<td>Software, network management</td>
</tr>
<tr>
<td>4493029</td>
<td>Software, network traffic monitoring systems</td>
</tr>
<tr>
<td>4493030</td>
<td>Software, network monitoring</td>
</tr>
<tr>
<td>4493031</td>
<td>Software, intelligent agents</td>
</tr>
<tr>
<td>4493032</td>
<td>Software, application generator</td>
</tr>
<tr>
<td>4493033</td>
<td>Software, push technology</td>
</tr>
<tr>
<td>4493034</td>
<td>Software applications for mobile phones (cellular phones) or smartphones</td>
</tr>
<tr>
<td>4493035</td>
<td>Software for application service providers (ASP)</td>
</tr>
<tr>
<td>4493091</td>
<td>Software, game-learning/serious games</td>
</tr>
<tr>
<td>44940</td>
<td>Software, multimedia</td>
</tr>
<tr>
<td>4494001</td>
<td>Software, graphics</td>
</tr>
<tr>
<td></td>
<td>Inclusive: - Software, graphics animation</td>
</tr>
<tr>
<td>4494002</td>
<td>Software, image processing</td>
</tr>
<tr>
<td></td>
<td>Inclusive: - Software, photograph editing</td>
</tr>
<tr>
<td>4494003</td>
<td>Software, image analysis</td>
</tr>
<tr>
<td>4494004</td>
<td>Software, interactive computer graphics</td>
</tr>
<tr>
<td>4494005</td>
<td>Software, multimedia station management</td>
</tr>
<tr>
<td>4494006</td>
<td>Software, business communications, multimedia</td>
</tr>
<tr>
<td>4494007</td>
<td>Software, interactive multimedia</td>
</tr>
<tr>
<td>4494008</td>
<td>Software, interactive television games</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>4494010</td>
<td>Software, video playing or editing</td>
</tr>
<tr>
<td>4494011</td>
<td>Software, music playing or editing</td>
</tr>
<tr>
<td>4494013</td>
<td>Software, virtual reality (VR)</td>
</tr>
<tr>
<td>4494014</td>
<td>Software, augmented reality (AR)</td>
</tr>
<tr>
<td>44950</td>
<td>Software to customer specification, software houses</td>
</tr>
<tr>
<td>4495001</td>
<td>Software, expert systems/artificial intelligence, to customer specification</td>
</tr>
<tr>
<td>4495002</td>
<td>Software, building automation, to customer specification</td>
</tr>
<tr>
<td>4495003</td>
<td>Software, industrial automation, to customer specification</td>
</tr>
<tr>
<td>4495004</td>
<td>Software, robotics, to customer specification</td>
</tr>
<tr>
<td>4495005</td>
<td>Software, safety and prevention of accidents at the workplace, to customer specification</td>
</tr>
<tr>
<td>4495006</td>
<td>Software, process control, to customer specification</td>
</tr>
<tr>
<td>4495007</td>
<td>Software, supervisory control and data acquisition (SCADA), to customer specification</td>
</tr>
<tr>
<td>4495008</td>
<td>Software, factory floor data collection, to customer specification</td>
</tr>
<tr>
<td>4495009</td>
<td>Software, plant and machinery maintenance, to customer specification</td>
</tr>
<tr>
<td></td>
<td>Inclusive: - Software, machinery component replacement, to customer specification</td>
</tr>
<tr>
<td>4495010</td>
<td>Software, material and production management systems (MPMS), to customer specification</td>
</tr>
<tr>
<td></td>
<td>Inclusive: - Software, machinery component replacement, to customer specification</td>
</tr>
<tr>
<td>4495011</td>
<td>Software, plant, machinery and equipment replacement, to customer specification</td>
</tr>
<tr>
<td>4495012</td>
<td>Software, production monitoring and control, to customer specification</td>
</tr>
<tr>
<td>4495013</td>
<td>Software, product lifecycle management (PLM), to customer specification</td>
</tr>
<tr>
<td>4495014</td>
<td>Integrated software, information lifecycle management (ILM), to customer specification</td>
</tr>
<tr>
<td>4495015</td>
<td>Software for process engineering applications to customer specification</td>
</tr>
<tr>
<td>4495016</td>
<td>Software, quality control, to customer specification</td>
</tr>
<tr>
<td>4495018</td>
<td>Software, packaging plant, to customer specification</td>
</tr>
<tr>
<td>4495019</td>
<td>Software, mechanical engineering and metallurgy, to customer specification</td>
</tr>
<tr>
<td></td>
<td>Inclusive: - Software, welding applications, to customer specification</td>
</tr>
<tr>
<td>4495020</td>
<td>Software, numerical control, to customer specification</td>
</tr>
<tr>
<td>4495021</td>
<td>Software for the metal trade to customer specification</td>
</tr>
<tr>
<td>4495022</td>
<td>Software, manufacturing applications, to customer specification</td>
</tr>
<tr>
<td>4495023</td>
<td>Software, material optimisation, manufacturing industries, to customer specification</td>
</tr>
<tr>
<td>4495024</td>
<td>Software, electrical and electronic engineering applications, to customer specification</td>
</tr>
<tr>
<td>4495025</td>
<td>Software, transformer design, to customer specification</td>
</tr>
<tr>
<td>4495026</td>
<td>Software, printed circuit board (PCB) design applications, to customer specification</td>
</tr>
<tr>
<td>4495027</td>
<td>Software for civil defence applications to customer specification</td>
</tr>
<tr>
<td>4495028</td>
<td>Software for electrical installation contractors to customer specification</td>
</tr>
<tr>
<td>4495029</td>
<td>Software, scientific research and laboratory, to customer specification</td>
</tr>
<tr>
<td></td>
<td>Inclusive: - Software, laboratory management, to customer specification</td>
</tr>
<tr>
<td>4495030</td>
<td>Software, measuring instrument calibration, to customer specification</td>
</tr>
<tr>
<td>4495031</td>
<td>Software, meteorology, to customer specification</td>
</tr>
<tr>
<td></td>
<td>Inclusive: - Software, lightning flash location systems, to customer specification</td>
</tr>
<tr>
<td>4495032</td>
<td>Software, marine applications, to customer specification</td>
</tr>
<tr>
<td>4495033</td>
<td>Software, mapping, surveying and geographical information systems (GIS), to customer specification</td>
</tr>
<tr>
<td></td>
<td>Inclusive: - Software, digital mapping, to customer specification</td>
</tr>
<tr>
<td>4495034</td>
<td>Software for civil defence applications to customer specification</td>
</tr>
<tr>
<td>4495035</td>
<td>Software, fluid flow analysis and pipeline design, to customer specification</td>
</tr>
<tr>
<td>4495036</td>
<td>Software for thermal analysis systems to customer specification</td>
</tr>
<tr>
<td>4495037</td>
<td>Software, radiological shielding, to customer specification</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>4495038</td>
<td>Software, vibration measuring, to customer specification</td>
</tr>
<tr>
<td>4495039</td>
<td>Software for digital signal processors to customer specification</td>
</tr>
<tr>
<td>4495040</td>
<td>Software for global positioning systems (GPS) to customer specification</td>
</tr>
<tr>
<td>4495041</td>
<td>Software, online public transport timetable information, to customer specification</td>
</tr>
<tr>
<td>4495042</td>
<td>Software for environmental and ecology applications to customer specification</td>
</tr>
<tr>
<td>4495043</td>
<td>Software, automatic test systems, to customer specification</td>
</tr>
<tr>
<td>4495044</td>
<td>Software, office management, to customer specification</td>
</tr>
<tr>
<td>4495045</td>
<td>Software, knowledge management, to customer specification</td>
</tr>
<tr>
<td>4495046</td>
<td>Software, digital rights management (DRM), to customer specification</td>
</tr>
<tr>
<td>4495047</td>
<td>Software, data analysis, to customer specification</td>
</tr>
<tr>
<td>4495048</td>
<td>Software, oil and gas production applications, to customer specification</td>
</tr>
<tr>
<td>4495049</td>
<td>Software, oil and gas drilling control, to customer specification</td>
</tr>
<tr>
<td>4495050</td>
<td>Software, facilities management, to customer specification</td>
</tr>
<tr>
<td>4495051</td>
<td>Software, space management, retail and trade applications, to customer specification</td>
</tr>
<tr>
<td>4495052</td>
<td>Software for furniture industry applications, to customer specification</td>
</tr>
<tr>
<td>4495053</td>
<td>Software, furniture trade, to customer specification</td>
</tr>
<tr>
<td>4495054</td>
<td>Software, gauge management systems, to customer specification</td>
</tr>
<tr>
<td>4495055</td>
<td>Software, modelling, for urban drainage or sewer systems, to customer specification</td>
</tr>
<tr>
<td>4495101</td>
<td>Software for musical instruments to customer specification</td>
</tr>
<tr>
<td>4495102</td>
<td>Software, lighting management and control, to customer specification</td>
</tr>
<tr>
<td>4495103</td>
<td>Software, pattern recognition technology, to customer specification</td>
</tr>
<tr>
<td>4495104</td>
<td>Software, weighing applications, to customer specification</td>
</tr>
<tr>
<td>4495105</td>
<td>Software, freight handling and transportation, to customer specification</td>
</tr>
<tr>
<td>4495106</td>
<td>Software, pallet management, to customer specification</td>
</tr>
<tr>
<td>4495107</td>
<td>Software, motor trade, to customer specification</td>
</tr>
<tr>
<td>4495108</td>
<td>Software, fleet vehicle management, to customer specification</td>
</tr>
<tr>
<td>4495109</td>
<td>Software, pension fund and investment management, to customer specification</td>
</tr>
<tr>
<td>4495110</td>
<td>Software, stowage planning, to customer specification</td>
</tr>
<tr>
<td>4495111</td>
<td>Software, administration, for public authorities, to customer specification</td>
</tr>
<tr>
<td>4495112</td>
<td>Software, insurance, to customer specification</td>
</tr>
<tr>
<td>4495113</td>
<td>Software for banking and stockbroking applications to customer specification</td>
</tr>
<tr>
<td>4495114</td>
<td>Software, Internet banking/e-banking, to customer specification</td>
</tr>
<tr>
<td>4495115</td>
<td>Software, foreign exchange and stock exchange transactions to customer specification</td>
</tr>
<tr>
<td>4495116</td>
<td>Software, point of sale (EPOS), to customer specification</td>
</tr>
<tr>
<td>4495117</td>
<td>Software, recording studio, to customer specification</td>
</tr>
<tr>
<td>4495118</td>
<td>Software, user surveillance, to customer specification</td>
</tr>
<tr>
<td>4495119</td>
<td>Software, electronic voting, to customer specification</td>
</tr>
<tr>
<td>4495120</td>
<td>Software, vehicle number-plate recognition, to customer specification</td>
</tr>
<tr>
<td>4495121</td>
<td>Software for videotex systems, to customer specification</td>
</tr>
<tr>
<td>4495122</td>
<td>Software for the management of water, gas and electricity supply plant, to customer specification</td>
</tr>
<tr>
<td>4495123</td>
<td>Software, energy network management and service, to customer specification</td>
</tr>
<tr>
<td>4495124</td>
<td>Software, electronic printing, to customer specification</td>
</tr>
<tr>
<td>4495125</td>
<td>Software, typesetting, to customer specification</td>
</tr>
<tr>
<td>4495126</td>
<td>Software, timetabling and scheduling systems, to customer specification</td>
</tr>
<tr>
<td>4495127</td>
<td>Software, travel information indicator board, to customer specification</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>---------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>4495128</td>
<td>Software, electronic data interchange (EDI) systems, to customer specification</td>
</tr>
<tr>
<td>4495129</td>
<td>Software, safety training programs, to customer specification</td>
</tr>
<tr>
<td>4495130</td>
<td>Software, offshore gas and fire emergency training programs, to customer specification</td>
</tr>
<tr>
<td>4495131</td>
<td>Software for cine and video film processing to customer specification</td>
</tr>
<tr>
<td>4495132</td>
<td>Software, medical, hospital and health care applications, to customer specification Inclusive: - Software, medical billing and prescription applications, to customer specification , Software, medicine distribution, for hospitals, to customer specification</td>
</tr>
<tr>
<td>4495133</td>
<td>Software, dental applications, to customer specification</td>
</tr>
<tr>
<td>4495134</td>
<td>Software, bone densitometry, to customer specification</td>
</tr>
<tr>
<td>4495135</td>
<td>Software, hearing care applications, to customer specification</td>
</tr>
<tr>
<td>4495136</td>
<td>Software, programmable logic controller (PLC), to customer specification</td>
</tr>
<tr>
<td>4495137</td>
<td>Software, die design, plastics and rubber industries, to customer specification</td>
</tr>
<tr>
<td>4495139</td>
<td>Software, television broadcasting applications, to customer specification</td>
</tr>
<tr>
<td>4495140</td>
<td>Software, satellite and pay television, to customer specification</td>
</tr>
<tr>
<td>4495141</td>
<td>Software, television road condition reports, to customer specification</td>
</tr>
<tr>
<td>4495142</td>
<td>Software, radio broadcasting applications, to customer specification</td>
</tr>
<tr>
<td>4495143</td>
<td>Software, agricultural applications, to customer specification Inclusive: - Software, irrigation control and analysis, to customer specification , Software, agricultural management, to customer specification</td>
</tr>
<tr>
<td>4495144</td>
<td>Software for horticultural applications to customer specification</td>
</tr>
<tr>
<td>4495145</td>
<td>Software, supply chain traceability for fruit and vegetables, to customer specification</td>
</tr>
<tr>
<td>4495146</td>
<td>Software, forestry management, to customer specification</td>
</tr>
<tr>
<td>4495147</td>
<td>Software, food and catering industries, to customer specification</td>
</tr>
<tr>
<td>4495148</td>
<td>Software, plastics industry applications, to customer specification</td>
</tr>
<tr>
<td>4495149</td>
<td>Software for the pharmaceutical and cosmetic industries to customer specification</td>
</tr>
<tr>
<td>4495150</td>
<td>Software for the paint and varnish industries to customer specification</td>
</tr>
<tr>
<td>4495151</td>
<td>Software, textile industry applications, to customer specification</td>
</tr>
<tr>
<td>4495152</td>
<td>Software, textile trade, to customer specification</td>
</tr>
<tr>
<td>4495153</td>
<td>Software, paper industry applications, to customer specification</td>
</tr>
<tr>
<td>4495154</td>
<td>Software, printing industry, to customer specification</td>
</tr>
<tr>
<td>4495155</td>
<td>Software, cockpit data collection and distribution, to customer specification</td>
</tr>
<tr>
<td>4495201</td>
<td>Software, airport, to customer specification</td>
</tr>
<tr>
<td>4495202</td>
<td>Software, local government, to customer specification</td>
</tr>
<tr>
<td>4495203</td>
<td>Software, low-rental housing allocation management, to customer specification</td>
</tr>
<tr>
<td>4495204</td>
<td>Software, school management systems, to customer specification</td>
</tr>
<tr>
<td>4495205</td>
<td>Software, hotel and leisure industry, to customer specification</td>
</tr>
<tr>
<td>4495206</td>
<td>Software, police force, to customer specification</td>
</tr>
<tr>
<td>4495207</td>
<td>Software to customer specification</td>
</tr>
<tr>
<td>4495208</td>
<td>Software, watermarking, to customer specification</td>
</tr>
<tr>
<td>4495209</td>
<td>Software, satellite communications, to customer specification</td>
</tr>
<tr>
<td>4495210</td>
<td>Software, digital prepress, to customer specification</td>
</tr>
<tr>
<td>4495901</td>
<td>Software, patient education</td>
</tr>
<tr>
<td>44980</td>
<td>Electronic data processing (EDP) and data input services</td>
</tr>
<tr>
<td>4498040</td>
<td>Localisation services for software packages</td>
</tr>
<tr>
<td>4498041</td>
<td>Japanisation of software packages</td>
</tr>
<tr>
<td>4498042</td>
<td>Arabisation of software packages</td>
</tr>
<tr>
<td>44990</td>
<td>Computer and Internet related services NES</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>4499007</td>
<td>Software installation services</td>
</tr>
<tr>
<td>4499008</td>
<td>Software verification, validation and testing services</td>
</tr>
<tr>
<td>4499043</td>
<td>Software maintenance services</td>
</tr>
<tr>
<td>4499044</td>
<td>Open source software (OSS) integration, development and maintenance services</td>
</tr>
<tr>
<td>4499046</td>
<td>Software consultants for defence and aerospace systems</td>
</tr>
<tr>
<td>4499047</td>
<td>Software consultants, insurance and finance</td>
</tr>
<tr>
<td>4499048</td>
<td>Software consultants, transport and logistics</td>
</tr>
<tr>
<td>4499049</td>
<td>Software consultants, data warehousing</td>
</tr>
<tr>
<td>45</td>
<td>Machinery and equipment for mining, quarrying and stoneworking, oil and gas</td>
</tr>
<tr>
<td>45900</td>
<td>Robots, industrial</td>
</tr>
<tr>
<td>4590045</td>
<td>Robots, software selection and application</td>
</tr>
<tr>
<td>61</td>
<td>Importers and exporters, general. General traders and commodity merchants.</td>
</tr>
<tr>
<td>61620</td>
<td>Chain stores and supermarkets</td>
</tr>
<tr>
<td>6162046</td>
<td>Computer, software and computer publications retail chains</td>
</tr>
<tr>
<td>61800</td>
<td>Online sales (E-commerce, Internet marketplaces), Business-to-Consumer</td>
</tr>
<tr>
<td>6180007</td>
<td>Online sales, computers, hardware and software</td>
</tr>
<tr>
<td>67</td>
<td>Wholesalers, distributors, importers and exporters of industrial and</td>
</tr>
<tr>
<td>67900</td>
<td>Computers, software, computer peripherals and auxiliary units (trade)</td>
</tr>
<tr>
<td>6790025</td>
<td>Combined software-hardware equipment (trade)</td>
</tr>
<tr>
<td>6790030</td>
<td>Operating systems, system development and system software (trade)</td>
</tr>
<tr>
<td>6790032</td>
<td>Software, application packages (trade)</td>
</tr>
<tr>
<td>6790033</td>
<td>Software, multimedia (trade)</td>
</tr>
<tr>
<td>80</td>
<td>Administrative, personnel and property services</td>
</tr>
<tr>
<td>80140</td>
<td>Translation services</td>
</tr>
<tr>
<td>8014015</td>
<td>Translation services, software</td>
</tr>
<tr>
<td>80370</td>
<td>Documentation services</td>
</tr>
<tr>
<td>8037054</td>
<td>Computer and software documentation services</td>
</tr>
<tr>
<td>82</td>
<td>Financial and insurance services</td>
</tr>
<tr>
<td>82390</td>
<td>Financial services: Leasing and leaseback</td>
</tr>
<tr>
<td>8239003</td>
<td>Leasing of software</td>
</tr>
<tr>
<td>85</td>
<td>Research and testing</td>
</tr>
<tr>
<td>85100</td>
<td>Research, general</td>
</tr>
<tr>
<td>8510009</td>
<td>Continuous software engineering (CSE), research and development</td>
</tr>
<tr>
<td>85700</td>
<td>Materials testing, assaying, analysing and inspection services</td>
</tr>
<tr>
<td>8570023</td>
<td>Test laboratories, software</td>
</tr>
<tr>
<td>85780</td>
<td>Quality control services</td>
</tr>
<tr>
<td>8578010</td>
<td>Software quality assurance services</td>
</tr>
<tr>
<td>86</td>
<td>Education and training</td>
</tr>
<tr>
<td>86230</td>
<td>Training and re-training courses, computing and information technology (IT)</td>
</tr>
<tr>
<td>8623004</td>
<td>Training courses, software packages</td>
</tr>
</tbody>
</table>
Appendix 3: Research Information Sheet

Dear participant,

You are being invited to take part in the research project entitled:

Identification and Classification of Shareable Tacit Knowledge Associated to Experience in the Software/IT Industry Sector: A Case-Study in China.

Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

1 – What is the research project’s purpose?

This research aims at investigating and classifying the very ill-defined concept of tacit knowledge (non-technical knowledge) associated with experience within the context of Chinese Software/IT organisations. The research is grounded in the process of software development and will provide an classification and theory that will enable a structured approach to transference of tacit into explicit knowledge, which can then be systematically managed.

2 – Why have I been chosen?

You are being invited to participate in this research as an IT professional directly engaged in the development of software. Your knowledge and expertise as a practitioner is very welcome to help us identify tacit knowledge in software development, from an academic perspective.

3 – Do I have to take part?

It is entirely up to you to decide whether or not to take part in this research. If you do decide to take part you will be given this information sheet to keep (and be asked to sign a consent form) and you can still withdraw at any time without fear or prejudice and without it affecting any benefits that you are entitled to in any way. You do not have to give a reason for withdrawing.
4 – What will happen to me if I take part?

您怎样参与这项研究

Your participation in this study entails engaging in a semi-structured, open-ended interview with the purpose of understanding your personal experience of development of software. The interview may last between 30 to 60 minutes, during which you will be asked to speak openly about your experience of daily working processes and activities. Your interview will be digitally recorded with your permission. After the interview, the recording will be transcribed into Word documents and fully anonymised, as any reference to participants’ identity will be eliminated. Additionally, all information disclosed in the interview process will remain strictly confidential.

这项研究采用半结构化的，开放式的访谈，用以了解和挖掘您在软件开发过程的个人经验。采访可能会持续30至60分钟，在此期间，您将被要求谈论您在的日常工作流程和活动的经验。在您的许可之下，您的访谈内容会被以数字化的形式记录下来。采访结束后，记录内容将被转化成 Word 文档。访谈完全匿名，任何可能识别参与者身份的标记将被抹掉。此外，在采访过程中披露的所有信息将被严格保密。

5 – What do I have to do?

您需要做什么

To avoid disruption, interviews will be scheduled to your best convenience, in a quiet room in your workplace.

为避免您的尴尬和不安，访谈会根据您的时间要求，尽力安排在您认为轻松、安静的工作房间中。

6 – What are the possible disadvantages and risks of taking part?

参与此项研究有什么风险

Your participation in this study does not imply any identifiable risks or disadvantages. As the identity and affiliation of participants will not be recorded, there is minimal risk that the study will constitute an invasion of your privacy. Questions were designed as not to cause harm, anguish or discomfort. If you feel uncomfortable answering any of the questions, feel free to express your concerns. You are, of course, free to decline to answer such questions. You are moreover encouraged to refrain from disclosing any information that you may consider defamatory, incriminating, or otherwise sensitive. You participate this study do not exist any risk. Due to the identity of participants will not be recorded, this will not constitute an invasion of your personal privacy. Interview questions were designed to cause no harm, no discomfort. If you feel uncomfortable answering any of the questions, you are free to express your concerns. You are, of course, free to decline to answer such questions. You are moreover encouraged to refrain from disclosing any information that you may consider defamatory, incriminating, or otherwise sensitive.

您参与这项研究并不存在任何风险。由于参加者的身份和标识将不被记录，这就不会侵犯到您的个人隐私。访谈问题设计以无伤害、无不适为主。如果在回答问题时，您有任何不适，请表达出来。当然，如果您认识问题涉及敏感性话题、或诽谤性内容，您也可以拒绝回答此类问题。

7 – What are the possible benefits of taking part?

此项研究您能得到什么

Your participation in this research will contribute to identify and explore tacit knowledge from individuals in the development of software in China and improve the competitive capability of that Chinese Industry both in China and abroad.

从管理的角度来看，分析结果可以帮助公司挖掘实践应用中的潜在资产，帮助企业发展战略和模式，建立知识管理在公司体系。

8 – Will my taking part in this project be kept confidential?

您的参与信息会被保密吗

All the information that is collected about you, as well as any information that you give during the course of the research will be kept strictly confidential, as ensured to all participants in the consent form. You will not be able to be identified in any reports or publications. During analysis, you will be assigned a number allowing complete anonymity. Your interview but not your name will be recorded and transcribed, with all records being kept for a period of 5 years with the researcher or the project.
supervisor in a secure place. After this period all transcripts will be destroyed.
在采访进行时，你会被分配到一个数字，完全是匿名的。你的采访（但不是你的名字）将被记录
和转录为文本格式。所有的记录会被保存 5 年，并被放置在一个安全的地方。在此期间之后，所
有记录将被销毁。

9 - What type of information will be sought from me and why is the collection of this information relevant for achieving the research project's objectives?
什么样的信息是研究所需要的
The objective of this research is to offer qualitative descriptions and analysis about the identification
and classification of personal and professional experience in a Software Company by academics as an
unfolding process. The contribution of your genuine experiences and viewpoints is essential to
studying the concepts and categories of the tacit knowledge in the process of software development,
and the relationship between them.
本研究的目的是根据定性的描述，分析软件企业中个人的专业经验。您的实践经验和真实想法对于
研究软件开发过程中的隐性知识，以及它们之间的关系起着至关重要的作用。

10 - What will happen to the results of the research project?
结果如何运用
The results of this research will be published in a doctoral thesis. Information gained during the
research project may additionally be published in academic journals and conference papers; and used
for subsequent research. In all of the aforementioned circumstances, the participant's name,
affiliation and position title will never be used in relation to any of the information provided.
Participants will be notified upon publication of results in the doctoral thesis, and copies will be
forwarded upon request.
这项研究的成果将以博士论文形式呈现。此外，在研究项目中部分成果可能会被发表在学术期刊
和会议论文中，可能也会用于后续的研究。在上述情况下，所有参与者的姓名和工作单位，将永
久不被显示。另外，发表的博士论文、期刊文章和会议论文，可根据要求提供给研究参与者。

11 - Who is organising and funding the research?
此研究的成员
This research is self-funded, supervised by Loughborough University.
此研究是自费项目，由英国拉夫堡大学（Loughborough University）指导进行。

12 - Who has ethically reviewed the project?
谁审核此项目
This research operates under the rigorous research ethics protocols of Loughborough University.
本研究通过了英国拉夫堡大学（Loughborough University）严格的伦理审核协议。

Contact for further information:
联系方式
If you have a question about any aspect of this project, please speak to the researcher concerned or
the supervisors, who will do their best to answer your query. Contact details are listed at the end of
the document.
如果你有任何疑问，请随时联系有关研究人员，他们会尽量回答您的查询。

Thank you for your help with this research.
谢谢您的帮助

Contact Details:
Hui Chen
Information Science
Loughborough University
Leicestershire LE11 3TU
E-mail: H.chen3@lboro.ac.uk
TELE: 158-1127-9244

Hui Chen
信息科学学院
拉夫堡大学
邮编：LE11 3TU
邮箱：H.chen3@lboro.ac.uk
国内手机：158-1127-9244
# Appendix 4: Consent Form

## Participant Consent Form

<table>
<thead>
<tr>
<th>Title of Research Project: Identification and Classification of Shareable Tacit Knowledge Associated to Experience in the Software/IT Industry Sector: A Case-Study in China</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of Researcher: Hui Chen</td>
</tr>
</tbody>
</table>

### Participant Identification Number for this project: Please initial box

1. I confirm that I have read and understand the information sheet, given to me prior to this interview, explaining the above research project and I have had the opportunity to ask questions about the project.

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question or questions, I am free to decline.

3. I understand that my responses will be kept strictly confidential. I give permission for members of the research team to have access to my anonymised responses, and to publish anonymised excerpts of my interview. I understand that my name will not be linked with the research materials, and I will not be identified or identifiable in the report or reports that result from the research.

4. I agree for the data collected from me to be used in future research.

5. I agree to take part in the above research project.

### Name of Participant (or legal representative)  Date  Signature

### Name of the Researcher  Date  Signature


Copies: 

Once this has been signed by all parties the participant should receive a copy of the signed and dated participant consent form, the letter/pre-written script/information sheet and any other written information provided to the participants. A copy of the signed and dated consent form should be placed in the project’s main record (e.g. a site file), which must be kept in a secure location.
Appendix 5: Interview Script

A. General Questions:

1. What kind of work do you do in the company? What daily actions does it involve?

   您在公司里担任什么样的工作？您的日常工作具体涉及什么内容？

   Use the following activities that listed below, as triggering questions
   - Planning and managing project
   - Capturing requirements for SW
   - Designing SW
   - Programming
   - Testing SW
   - Installing and delivering SW
   - Maintaining system
   - Evaluating and improving products, processes, and resources
   - Others __________________

   可以任选以下几个不同的工作内容，并加以详细描述：
   - 项目计划与管理
   - 客户需求调研
   - 软件设计
   - 编程
   - 软件测试
   - 软件实施
   - 软件维护
   - 项目总结
   - 其他________________

2. How long have you been a practitioner in this field?

   您从事于软件行业有多久？

   in the current company?

   ____________________________

   ____________________________

   ____________________________

   ____________________________
3. Can you give a description of the project (or task) you are working on now? And what experience is required to do that other than technical skills?

您能详细地描述您正在执行的项目/任务吗？您认为什么经验对于完成这次项目/任务是必须的（除技术能力以外的）?
4. In general, what kind of experience is important in your job?

总体而言，您觉得什么样的经验和技能在工作中最为重要?

why you think it's important?
为什么您觉得很重要？
how do you think these help you in practice?
您觉得这些技能经验在实际运用中怎么能帮助到您？
in relation to which of the SW development activities?
这些经验技能具体与软件开发中哪个/哪些过程有联系？

5. Are you aware of the importance of this experience in your practice?

您意识到这些经验技能的重要性了吗？

how do you think it works?
您觉得这些经验技能是如何起到作用的？
6. Did you ever share or attempt to share this experience in your work?

您曾经有过或试图与人分享你的经验之谈吗？

does the company set any strategies or tools to share your personal experience?
公司是否有建设一些制度或者管理工具来帮助你分享你的个人经验？
do you think your contribution has been used by others?
您觉得你曾经贡献的经验有被他们使用过吗？
have you taken the benefits from others’ contribution?
您有曾从别人贡献的经验之中受益吗？
how do you think it works? or should work?
您觉得公司设计的策略有助于分享经验吗？或者应该怎样？

7. Did you ever record (store/save) or attempt to record this experience in your work?

您曾经保存过或者试图保存您工作中的经验吗？

does the company set any strategies or tools to encourage employees to record personal experiences?
公司有建设一些制度或者管理工具来帮助你保存您的个人经验吗？
how do you think it works? or should work?
您觉得这些策略或工具有用吗？或者他们应该怎么运作？
B. Specific Software Developing Phase Questions

8. Now being more specific, I would like to ask your opinion about the experience that is needed to engage each of the main stages of SW development.

现在，我会问一些更加详细具体的问题，涉及到软件开发过程中具体的需要的技能和经验。

a) Planning and Managing Phase?

计划和管理?

Before obtaining the project, what kind of knowledge do you think could help you to get a project from the markets? (Source of customers, negotiation with customers, proposal writing for customers, etc.)

在拿到项目之前，您认为什么知识可以帮助您争取到项目？（客户来源，与客户的沟通，项目计划书的撰写等）

The planning and managing stage consists of proposal writing, project planning and scheduling, project cost, project monitoring and reviews, personal selection and evaluation, risk management, report writing and presentation. Which part of these activities are you involved with? What kind of experience can you summarize from your daily work that you think is important?

项目计划与安排阶段包含多种任务，计划书的撰写，项目规划与安排，项目预算，项目监管和审查，人员安排和评估，风险预测，文档说明书和演示等。您参与到了其中哪一部分？
总体而言，您认为什么样的经验对于您的日常工作很重要?

What kind of experience and knowledge do you think could help to manage and monitor the procedure of project?

您认为什么样经验和知识可以帮助您管理和监察整个项目的进展?

When you work with others, do you think there are any skills involved which can challenge or affect the efficiency of your working? (good communication channels, efficient work division and good leadership)

当您与他人共事时，您认为什么样的技能可能会影响或帮助您的工作效能？（好的沟通渠道，有效的工作分工，好的领导才能）

What type of knowledge from the projects you are on now would you like to transfer to new projects?

您现在这个项目中所运用的什么样知识，会积累运用到下一个项目中？

What type of knowledge has been suitable for reuse from the projects you have been working on earlier?

您现在这个项目中运用的那些知识，是来自于上一个项目的积累？
b) Capturing Requirements Phase

客户需求调研

What kind of experience and knowledge do you think could help you to specify and express customers’ needs, and definite in terms of system’s interface?
您认为什么样经验和知识能够帮助您捕捉和表述客户的需求，并转化为专业技术语言记录下来？

What kind of knowledge do you think it could help you to understand and analysis the customers’ requirements?
您认为什么样经验和知识能够帮助您理解和分析客户的需求？

What kind of knowledge do you think it could help you to present the customers’ needs in term of both business and technical level?
您认为什么样经验和知识能够帮助您从业务和技术应用的角度表达出客户的需求？

When you work with others, do you think there are any skills involved which can challenge or affect the efficiency of your working? (good communication channels, efficient work division and good leadership)
当您与他人共事时，您认为什么样的技能可能会影响或帮助您的工作效能？（好的沟通渠道，有效的工作分工，好的领导才能）

What type of knowledge from the projects you are on now would you like to transfer to new projects?
您现在这个项目中所运用的什么样知识，会积累运用到下个项目中？

What type of knowledge has been suitable for reuse from the projects you have been working on earlier?
您现在这个项目中运用的那些知识，是来自于上一个项目的积累？
c) Designing Phase

系统设计

The designing stage requires the technical experience in defining and designing software modules, components and source libraries. Except of the technical issues, what kind of skills do you think could help you to get a better understanding of technical language from requirement specification? What kind of skills do you think to help to choose the strategy and pattern for building the system from the high-level architectural design?

系统设计阶段要求技术经验包括定义和设计软件模型。除了以上这些技术型经验，您认为什么技能能够帮助您很好的理解需求说明书中的技术语言?

When you work with others, do you think there are any skills involved which can challenge or affect the efficiency of your working? (good communication channels, efficient work division and good leadership)

当您与他人共事时，您认为什么样的技能可能会影响或帮助您的工作效能？（好的沟通渠道，有效的工作分工，好的领导才能）

What type of knowledge from the projects you are on now would you like to transfer to new projects?

您现在这个项目中所运用的什么样知识，会积累运用下一个项目中？

What type of knowledge has been suitable for reuse from the projects you have been working on earlier?

您现在这个项目中运用的那些知识，是来自于上一个项目的积累？
d) Programming Phase

What kind of skills and experience make you think that you are suitable for your job? (use of information and experience, constructed patterns of programming techniques and strategy, etc.)

What kind of experience do you think can promote the efficiency of your work? (the working style of reusing the code)

When you work with others, do you think there are any skills involved which can challenge or affect the efficiency of your working? (good communication channels, efficient work division and good leadership)

What type of knowledge from the projects you are on now would you like to transfer to new projects?

What type of knowledge has been suitable for reuse from the projects you have been working on earlier?
e) Testing Phase

软件测试

Have you been former analysts, programmers, or designers before? Do you think the experience from previous position is helpful? And what are they?
您以前承担过系统分析、编程、系统设计等任务吗？您认为之前的工作经验对现在的测试有帮助吗？那这些经验是什么？
What kind of knowledge do you think is helpful for better understanding of the specification?
您认为什么知识对于理解客户需求说明书有帮助？
What kind of skill is needed to let you be familiar with the testing methods and tools?
您认为什么技能对于您熟悉测试方法和工具是必须的？
When you work with others, do you think there are any skills involved which can challenge or affect the efficiency of your working? (good communication channels, efficient work division and good leadership)
当您与他人共事时，您认为什么样的技能可能会影响或帮助您的工作效能？（好的沟通渠道，有效的工作分工，好的领导才能）
What type of knowledge from the projects you are on now would you like to transfer to new projects?
您现在这个项目中所运用的什么样知识，会积累运用下一个项目中？
What type of knowledge has been suitable for reuse from the projects you have been working on earlier?
您现在这个项目中运用的那些知识，是来自于上一个项目的积累？
f) Installing and Delivering Phase

软件实施

What kind of knowledge do you think is important to implement the system in customer’s needs? 
您认为什么知识对于您按照客户要求去实施软件非常重要？
What kind of skills do you think it can enable the satisfaction of customer in the customers’ site? 
当您处在客户公司，您认为什么技能能够保障您达到客户满意？
Have you ever had any challenge in the process of installing systems or presenting the training and documentations? How can you solve the trouble? 
在安装系统的过程中，在向客户提供培训服务和文档说明时，您有过任何问题出现吗？你是怎么解决的？
When you work with others, do you think there are any skills involved which can challenge or affect the efficiency of your working? (good communication channels, efficient work division and good leadership) 
当您与他人共事时，您认为什么样的技能可能会影响或帮助您的工作效率？（好的沟通渠道，有效的工作分工，好的领导才能）
What type of knowledge from the projects you are on now would you like to transfer to new projects? 
您现在这个项目中所运用的什么样知识，会积累运用下一个项目中？
What type of knowledge has been suitable for reuse from the projects you have been working on earlier? 
您现在这个项目中运用的那些知识，是来自于上一个项目的积累？
g) Maintenance Phase

系统维护

Maintaining requires all the SW development team (e.g. analysts, programmers, and designers). Please describe which part do you participate in?

系统维护阶段需要软件开发所有成员的参与，如：系统分析员、编程人员、系统设计员。请描述您参与了哪一部分的工作？（针对 bug 和新需求的出现）

What kind of knowledge do you think is important when you adjust the change?

在应对需求调整时，您认为什么知识很重要？

What kind of knowledge do you think is helpful to enhance the satisfaction of customer?

您认为什么样的知识对于提高客户满意度很有帮助？

What kind of knowledge do you think is helpful to balance satisfaction of customer and the company’s benefits?

您认为什么样的知识对于处理平衡客户满意度和企业利益时很有帮助？

When you work with others, do you think there are any skills involved which can challenge or affect the efficiency of your working? (good communication channels, efficient work division and good leadership)

当您与他人共事时，您认为什么样的技能可能会影响或帮助您的工作效能？（好的沟通渠道，有效的工作分工，好的领导才能）

What type of knowledge from the projects you are on now would you like to transfer to new projects?

您现在这个项目中所运用的什么样知识，会积累运用下一个项目中？

What type of knowledge has been suitable for reuse from the projects you have been working on earlier?

您现在这个项目中运用的那些知识，是来自于上一个项目的积累？
h) Evaluating and Improving Products, Processes and Resources

项目总结

Have you ever evaluated the techniques and strategies from the previous project, and acquired the advisable experience from the activities among working practice?
您曾经评估过之前项目的技巧和策略（从软件本身、开发过程、资源利用）吗？以及总结一些在工作实践中的可取的经验？

If yes, what kind of knowledge have you been identified, managed and shared?
如果有，什么样知识你曾经意识出、管理到、并且分享过？

If not, why?
如果没有，为什么？

If possible, what kind of knowledge from the on-going project will you record, and convert into explicit?
如果可能，什么样的知识您会从现在正在进行的项目中识别出，并且转化为显性可保存的？
C. Closing Questions

9. Do you think experience-based knowledge is important in your work? Why?
   您认为基于经验的知识重要吗？为什么？

10. Do you think there is a need to identify, define, classify and share your experience? Why?
    您认为有必要去鉴别、获取、分类和共享你的经验吗？为什么？
### Appendix 6: Presentation of Findings from the Pilot Study

<table>
<thead>
<tr>
<th>Categories</th>
<th>Sub-Categories</th>
<th>Codes (Activities where experience determines use or acquisition of knowledge)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>Management of Teams</td>
<td>Understanding the Role of Colleagues in the Project; Understanding the Nature of the Project; Understanding the Nature of Teamwork; Understanding the Nature of Testing</td>
</tr>
<tr>
<td></td>
<td>Learning from Previous Leaders</td>
<td>Learning from Leaders while being a Team Member</td>
</tr>
<tr>
<td></td>
<td>Management Styles</td>
<td>Appropriate Delegation of Authority; Respect for Team Members; Sense of Growing Together as a Team; Explanation of Assigned Duties; Providing Positive Feedback to Team Members; Valuing of the Individual; Individual’s Emotion Management; Ability to Listen to Others; Encouraging Employees</td>
</tr>
<tr>
<td>Individual Development</td>
<td>Working in Project Team</td>
<td>Self Estimation of Time; Self Estimation of Ability and Interests; Keeping Up with Estimated Deadlines; Identification and Reporting of Technical Difficult; Reporting Problems in Time; Discussing Problems; Documenting Own Work; Taking Responsibility over Assigned Duties; Interpersonal Skills; Helping Others; Ability of Work with Other’s Code</td>
</tr>
<tr>
<td></td>
<td>Recording and Reflecting on Activities</td>
<td>Recording and Reflecting through Written Notes; Recording and Reflecting in through Diagrams and Abstractions</td>
</tr>
<tr>
<td></td>
<td>Knowledge Sharing Habits</td>
<td>Using Personal Knowledge Sharing Media</td>
</tr>
<tr>
<td></td>
<td>Professional Attitude</td>
<td>Good Self Stress Management Skills; Professional Execution of Duties; Self-Respect; Self-Motivation</td>
</tr>
<tr>
<td></td>
<td>Self - Confidence</td>
<td>Confidence in Acquired Professional Experience; Confidence in Technical Tools and Frameworks;</td>
</tr>
<tr>
<td></td>
<td>Reuse of Information and Resources</td>
<td>Reuse of Own Code Libraries; Reuse of Public Code Libraries; Reuse of Algorithms and Reasoning</td>
</tr>
<tr>
<td>Categories</td>
<td>Sub-Categories</td>
<td>Codes (Activities where experience determines use or acquisition of knowledge)</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>--------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Specific Professional Ability</td>
<td>Ability of Representing Abstract Concepts into Diagrammatic Form</td>
</tr>
<tr>
<td></td>
<td>Motivation for Continuous Professional Development</td>
<td>Self Learning; Continuous Learning; Just-in-time Learning; Learning from Doing; Professional Training; Training beyond Academic Learning</td>
</tr>
<tr>
<td></td>
<td>Building and Maintaining Professional Social Networks</td>
<td>Awareness of the Importance of Interpersonal Relations</td>
</tr>
<tr>
<td></td>
<td>Project Management</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Task Assignment</td>
<td>Estimation of Individuals’ Abilities; Estimation of Time for Others; Division of Labour; Fair Treatment of Team Members; Task Scheduling;</td>
</tr>
<tr>
<td></td>
<td>Project Acceptance</td>
<td>Evaluation of Team’s Technical Ability</td>
</tr>
<tr>
<td></td>
<td>Summative Evaluation of Completed Project</td>
<td>Encouraging Team Member Recording of Experiences Habits; Learning Lessons</td>
</tr>
<tr>
<td></td>
<td>Documentation of Project Activities</td>
<td>Encouraging Team Member Recording of Activities Habits; Documenting New or Innovative Procedures; Documenting New Resources</td>
</tr>
<tr>
<td></td>
<td>Project Monitoring and Control</td>
<td>Control of Developing Process According to Plan; Monitor Individual’s Progress; Holistic Understanding of Project; Resolving the Technical Difficulties; Resolving the Identified Problems; Resolving Drifts from Plan; Testing and Verification; Monitoring Quality of Team Members’ Work; Multi-Tasking</td>
</tr>
<tr>
<td></td>
<td>Understanding Requirements</td>
<td>Resolving Ambiguities and Technical Difficulties; Negotiating Requirements with the Customer; Monitoring Change of Requirements; Teamwork; Using Previous Experience to Understand Requirements; Preparing to Development according to Requirements;</td>
</tr>
<tr>
<td></td>
<td>Managing Team</td>
<td>Adapting Language to Team’s Level;</td>
</tr>
</tbody>
</table>

472
<table>
<thead>
<tr>
<th>Categories</th>
<th>Sub-Categories</th>
<th>Codes (Activities where experience determines use or acquisition of knowledge)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Members as Valuable Human Resources</td>
<td></td>
<td>Explanation of Requirements; Balancing different Aspect of the Project;</td>
</tr>
<tr>
<td>Quality Assurance of Internal Processes</td>
<td></td>
<td>Backup; Monitoring Quality of Coding; Meeting Market Quality Standards</td>
</tr>
<tr>
<td>Risk Assessment and Management</td>
<td></td>
<td>Control Risk in Development; Control Risk from Outsourcing Group; Control Risk by Using of Prototyping; Control Risk by Keeping Closely Inline with Contract</td>
</tr>
<tr>
<td>Enabling Efficient Communication</td>
<td></td>
<td>Using Chat Facilities; Using Face-to-Face Communication</td>
</tr>
<tr>
<td>Project Management Abilities</td>
<td></td>
<td>Awareness of Suitable Support SW</td>
</tr>
<tr>
<td>Customer Relationship Management</td>
<td>Understanding of Customer Characteristics</td>
<td>Differentiated Response to Customers' Characteristics; Providing to the Customer what the Customer Wants;</td>
</tr>
<tr>
<td></td>
<td>Negotiating with Customers</td>
<td>Using Diagrams or Abstractions; Using Appropriate Questioning and Interviewing Techniques; Selecting Adequate Discourse for each Customer; Selecting Adequate Profile of Team Members who Negotiate the Customer; Differentiated Explanation of Requirements and Project to Different Elements in Customer Company;</td>
</tr>
<tr>
<td></td>
<td>Build and Maintain Customer Trust</td>
<td>Build Customer Trust; Maintaining Trust through Carefully Crafted Communication; Maintaining Trust through Sustained Communication; Maintaining Trust through Transparency; Including Customer as a Member of the Team; Using Professional Social Networks to Gain Trust</td>
</tr>
<tr>
<td></td>
<td>Using Professional Social Networks to Gain Trust and Business</td>
<td>Traditional Social Networks; Internet Based Social Networks;</td>
</tr>
<tr>
<td>Knowledge Sharing</td>
<td>Knowledge Sharing with External Colleagues</td>
<td>Mutual Trust Based on Similarity of Experiences</td>
</tr>
</tbody>
</table>
|                                              | Knowledge Sharing                    | Sharing Based on Activity within the</table>
<table>
<thead>
<tr>
<th>Categories</th>
<th>Sub-Categories</th>
<th>Codes (Activities where experience determines use or acquisition of knowledge)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>with University Classmates</td>
<td>same Industry (SW); Advising Others as an SW Industry Expert; Supporting Others in Specific Areas of Acquired Expertise in the SW Industry</td>
</tr>
<tr>
<td></td>
<td>Knowledge Sharing with Communities of Practice (CoP)</td>
<td>Participating in Web Communities of Practice (CoP); Interaction between People through CoP; Participating in Bulletin Board System (BBS) Forae</td>
</tr>
<tr>
<td></td>
<td>Awareness of Benefits of Knowledge Sharing</td>
<td>Creation of New Knowledge; Mutual Learning; Learning from CoPs; Learning Using Search Engines</td>
</tr>
<tr>
<td>Communication</td>
<td>Communication with Leader</td>
<td>Presenting the Clear Ideas</td>
</tr>
<tr>
<td></td>
<td>Communication with Customers</td>
<td>Understand the Customer’s Intentions</td>
</tr>
<tr>
<td></td>
<td>Communication with Colleagues</td>
<td>Seeking advice</td>
</tr>
<tr>
<td></td>
<td>Communication Modes</td>
<td>Face-to-Face; Formal Documents; Instant Messaging; Telephone; Email; Personal Preferences</td>
</tr>
</tbody>
</table>
Appendix 7: Concept Map with Main Categories and Sub-Categories
Appendix 8: Presentation of Findings from the Main Study

**Legend:** New codes and new sub-categories emerged from main study are marked with “◎”.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Sub-Categories (Level 2)</th>
<th>Sub-Categories (Level 3)</th>
<th>Sub-Categories (Level 4/5)</th>
<th>Codes (Activities where experience determines use or acquisition of knowledge)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding the Nature of Experience ◎</td>
<td></td>
<td></td>
<td></td>
<td>Experience as Asset for Turnover ◎</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Important Influence from Experience ◎</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Practice Experience Beyond Textbook ◎</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Importance of Transferring Tacit Knowledge into Explicit Knowledge ◎</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Importance of Classifying Knowledge Domains ◎</td>
</tr>
<tr>
<td>Communication</td>
<td>Understanding the Importance of Communication ◎</td>
<td></td>
<td></td>
<td>Communicating Efficiently ◎</td>
</tr>
<tr>
<td></td>
<td>Communication with Different Agents in the Development Process ◎</td>
<td></td>
<td></td>
<td>Communication is more Important than Technology Skills ◎</td>
</tr>
<tr>
<td>Communication with Colleagues</td>
<td>Communication with Colleagues</td>
<td></td>
<td></td>
<td>Knowing how to Seek Advice</td>
</tr>
<tr>
<td></td>
<td>Communication with Leader</td>
<td></td>
<td></td>
<td>Adapting Language to Different Agents ◎</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Building Communication Bridge with Leader ◎</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Building the Cooperative Relationships ◎</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Communicating with Team Members ◎</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Negotiating with Colleagues ◎</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sharing Responsibility of Tasks ◎</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Being Respectful ◎</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Be Straightforward ◎</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Being Cautiously ◎</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Presenting Clear Ideas</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reporting Progress ◎</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Solving Problems ◎</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Take the Initiative to Communicate ◎</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Understanding the Characteristics of Communication with Leaders ◎</td>
</tr>
<tr>
<td>Individual Development</td>
<td>Motivation for Continuous Professional Development</td>
<td>Ability to Use Different Communication Modes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>---------------------------------------------------</td>
<td>----------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication with Business Partners and Competitors ◎</td>
<td>Being Considerate ◎</td>
<td>Keeping Communication Professional ◎</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication with Customers</td>
<td>Understanding the Characteristics of Communication with Business Partners and Competitors ◎</td>
<td>See Working in Projects/ Interacting with Customers/ Negotiating with Customers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to Use Different Communication Modes</td>
<td>Formal Documentation</td>
<td>Email</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Face-to-Face</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Instant Messaging</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Telephone</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Personal Preferences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual Development</td>
<td>Motivation for Continuous Professional Development</td>
<td>Modes of Learning for Continuous Professional Development ◎</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual Learning ◎</td>
<td>Continuous Learning</td>
<td>Individual Learning ◎</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Just-in-time Learning</td>
<td>Continuous Learning</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Learning by Doing</td>
<td>Just-in-time Learning</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Self-Learning</td>
<td>Learning by Doing</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Self-Selective Learning based on Current Work ◎</td>
<td>Self-Learning</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Learning from External Case-Studies ◎</td>
<td>Self-Selective Learning based on Current Work ◎</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning from Others ◎</td>
<td>Learning from Online Training System ◎</td>
<td>Learning from External Case-Studies ◎</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Learning from Company Tutoring Schemes ◎</td>
<td>Learning from External Case-Studies ◎</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Learning from Team Members ◎</td>
<td>Learning from External Professional Training</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Learning from Internal Training Initiatives ◎</td>
<td>Learning from Invited Experts ◎</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Learning by Training Others as Instructors ◎</td>
<td>Learning from Invited Experts ◎</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Learning from Invited Experts ◎</td>
<td>Learning from Invited Experts ◎</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Learning from External Case-Studies ◎</td>
<td>Learning from External Case-Studies ◎</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Learning from External Professional Training</td>
<td>Learning from External Professional Training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taking Notes and Memoing ◎</td>
<td>Annotating Different Types of Knowledge ◎</td>
<td>Documenting Innovative Procedures ◎</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Documenting Reusable Resources ◎</td>
<td>Documenting Reusable Resources ◎</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Documenting SW Problems and Solutions ◎</td>
<td>Documenting SW Problems and Solutions ◎</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Documenting Technical Knowledge from Own Experience</td>
<td>Documenting Technical Knowledge from Own Experience</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ability to Use Different</td>
<td>Ability to Use Different</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recording and Reflecting through Computer Application Software</td>
<td>Recording and Reflecting through Computer Application Software</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific Learning Resources</td>
<td>Annotation Tools</td>
<td>Recording and Reflecting through Diagrams and Abstractions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------</td>
<td>----------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recording and Reflecting through Mobile Apps</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recording and Reflecting through Written Notes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge Sharing</td>
<td>Motivation for Sharing Knowledge</td>
<td>Extrinsic Motivation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intrinsic Motivation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awareness of Benefits of Knowledge Sharing</td>
<td></td>
<td>Value-added of Developing Sharing Habits</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Value-added of Help to Solve Technical Issues</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Value-added of Knowledge Sharing in General</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Value-added of Sharing Different Working Practices</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Value-added of Sharing in Internet Message Boards (IMBs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Value-added of Sharing with Communities of Practice (CoP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge Sharing with Different Agents</td>
<td>Knowledge Sharing with Internal Colleagues</td>
<td>Sharing through Annual Seminars</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Knowledge Sharing with External Parties</td>
<td>Sharing through Annual Work Summary</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Knowledge Sharing through Formal Mechanisms</td>
<td>Sharing through Routine Meetings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Informal Knowledge Sharing</td>
<td></td>
<td>Sharing through Tutoring Schemes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sharing within Internal Workshops</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sharing through Chatting Facilities</td>
<td>Sharing through Company Information System</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sharing through Company Mobile Phone</td>
<td>Sharing through Company Mobile Phone</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Advising Others as an Expert</td>
<td>Building the Social Circle through Continuing Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gaining Benefits from Others</td>
<td>Sharing Based on Activity within the Same Industry (SW)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Supporting Others in Specific Areas of Acquired Expertise in the SW Industry</td>
<td>Support Knowledge Sharing with Special Circles</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mutual Trust Based on Similarity of Experiences</td>
<td>Knowledge Sharing with University Classmates</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Participating in Internet Message Boards (IMBs)</td>
<td>Participating in Web Communities of Practice (CoP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Participating in Web Communities of Practice (CoP)</td>
<td>Knowledge Sharing with Friends</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sharing Based on Good Personal Relationship</td>
<td>Knowledge Sharing with Web Based Communities of Practice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working in Projects</td>
<td>Management of Projects</td>
<td>Project Creation</td>
<td>Business Competitors</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------</td>
<td>------------------</td>
<td>----------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ability to Apply Theory into Practice</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ability to Clearly Express the Value and Usefulness in the Proposal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ability to Conceptualize the Whole Project</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ability to Gain Ideas from Customers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ability to Seek Ideas from External Case-studies</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ability to Seek New Ideas from Other Disciplines</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Capability of Appraising a Project</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Discovering Projects through Conference Attendance and Presentation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exploring New Trend for SW Development</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Keeping High Quality of Writing Business Tenders</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Comprehensive Consideration for Business Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Evaluation of Team's Technical Ability</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Understanding of the Internal Standards from Customers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ability of Dividing Labour</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ability of Estimating Individuals</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>From Company Salesmen</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>From Customers' Feedback</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>From Direct Communication with Team Members</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>From Internal Seminar Initiatives</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>From Performance Evaluation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>From Previous Leaders</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>From Previous Working Shared Working Experience</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Estimation of Time for Others</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Task Estimation and Scheduling</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Task Scheduling</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Understanding of Suitable Project Management SW</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Project Monitoring and Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Controlling the Development Process According to the Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Holistic Understanding of Project</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monitoring Individual's Progress</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monitoring Quality of Team Members' Work</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resolving Drifts from Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resolving the Technical Difficulties</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Quality Assurance | Designing with Maintenance and Expansion in Mind
| Meeting National Standards
| Standardizing the Process of Project Management
| Testing and Verification | Testing from Customers' Operation Practice
| Understanding of Difference Testing Objects
| Understanding Testing for Exceptions and Limitations
| Understanding the Nature of Testing
| Understanding the Need to Test Logically Connected Modules
| Reuse of Information and Resources | Reuse of Algorithms and Reasoning Frameworks
| Reuse of Own Code Libraries
| Reuse of Public Code Libraries
| Reuse of Working Methods
| Risk Assessment and Management | Control Risk by Adhering to Contract
| Control Risk by Understanding Information Security
| Control Risk by Using Prototyping
| Control Risk from External Parties
| Control Risk from Human Resources
| Risk Identification and Assessment
| Summative Evaluation of Completed Project | Evaluating the SW Produced
| Reflecting of Work Done
| Management of Project Teams | Leadership | Scheduling and Monitoring | Ability to Clearly Explain Assigned Duties
| Ability to Facilitate Meetings
| Ability to Provide Positive Feedback
| Adapting Language to Team's Level
| Appropriate Delegation of Authority
| Individual's Emotional Management
| Listening to Others
| Understanding the Nature of Leadership
| Valuing of the Individual
| Enabling Individual Development | Encouraging Team Member Recording Activity Habits
| Inviting Experts for Training
| Providing Further Development for Everyone
| Providing Online Training System
| Providing Training by Using Company Tutoring Schemes
| Providing Training by Using Internal Training Initiatives
| Management of Teams | Fostering a Sense of Growing Together
| Fostering Awareness of Teamwork
<p>| Holistic Understanding of the Technical Nature of SW |</p>
<table>
<thead>
<tr>
<th>Working in Project Teams</th>
<th>Enabling Efficient Communication and Knowledge Sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team Bonding</td>
<td>Communication within Project Team</td>
</tr>
<tr>
<td></td>
<td>Knowledge Sharing within Project Team</td>
</tr>
<tr>
<td>Being a Responsible Team Member</td>
<td>See Communication/Communication within Project Teams</td>
</tr>
<tr>
<td></td>
<td>See Knowledge Sharing/Knowledge Sharing within Project Teams</td>
</tr>
<tr>
<td>Interpersonal Skills</td>
<td>Understanding the Nature of Teamwork</td>
</tr>
<tr>
<td></td>
<td>Understanding the Nature of the Project</td>
</tr>
<tr>
<td></td>
<td>Understanding the Role of Colleagues in the Project</td>
</tr>
<tr>
<td></td>
<td>Using Commonly Agreed Coding Norms</td>
</tr>
<tr>
<td></td>
<td>Willingness to Help Others</td>
</tr>
<tr>
<td></td>
<td>Willingness to Work with Other’s Code</td>
</tr>
<tr>
<td></td>
<td>Ability to Logically Organise Own Work</td>
</tr>
<tr>
<td></td>
<td>Be Active to Ask</td>
</tr>
<tr>
<td></td>
<td>Be Brave to Ask</td>
</tr>
<tr>
<td></td>
<td>Identification and Reporting of Technical Difficulties</td>
</tr>
<tr>
<td></td>
<td>Self-Estimation of Ability and Interests</td>
</tr>
<tr>
<td></td>
<td>Time Management</td>
</tr>
<tr>
<td>Understanding the Business</td>
<td>Understanding the Business Flow</td>
</tr>
<tr>
<td></td>
<td>Understanding the Jargon of Business</td>
</tr>
<tr>
<td></td>
<td>Understanding the Knowledge of Business</td>
</tr>
<tr>
<td>Understanding the Organisation</td>
<td>Being Familiar with Customers’ IT Infrastructure</td>
</tr>
<tr>
<td></td>
<td>Understanding the Culture of Customers’ Company</td>
</tr>
<tr>
<td></td>
<td>Understanding the Customers’ Working Environment</td>
</tr>
<tr>
<td>Understanding the Individuals</td>
<td>Differentiated Attention to Customers’ Characteristics</td>
</tr>
<tr>
<td></td>
<td>Understanding Customers’ Background</td>
</tr>
<tr>
<td>Understanding Requirements</td>
<td>Enhancing Understanding Ability through Practice</td>
</tr>
<tr>
<td></td>
<td>Fully Preparing before Collecting Requirements</td>
</tr>
<tr>
<td></td>
<td>Representing Abstract Concepts into Diagrammatic Form</td>
</tr>
<tr>
<td></td>
<td>Resolving Ambiguities and Technical Difficulties</td>
</tr>
<tr>
<td></td>
<td>Understanding the Context and Reason of Requirements</td>
</tr>
<tr>
<td></td>
<td>Using Appropriate Questioning and Interviewing Techniques</td>
</tr>
<tr>
<td>Negotiating with Customers</td>
<td>Collaborating with Colleagues</td>
</tr>
<tr>
<td></td>
<td>Listening Patiently to Customers</td>
</tr>
<tr>
<td></td>
<td>Selecting Adequate Discourse for each Customer</td>
</tr>
<tr>
<td></td>
<td>Selecting Adequate Profile of Team Members who Negotiate the Customer</td>
</tr>
<tr>
<td></td>
<td>Using Diagrams or Abstractions</td>
</tr>
<tr>
<td>Building and Maintaining Customers' Trust</td>
<td>Using Flexible Solutions ☑</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Building Trust with Sincere Attitude</td>
<td>Using Previous Experience to Guide Customers ☑</td>
</tr>
<tr>
<td>Having a Good Awareness of Providing Service ☑</td>
<td>Including Customer as a Member of the Team</td>
</tr>
<tr>
<td>Maintaining Trust beyond Own Work Responsibilities ☑</td>
<td>Maintaining Trust through Sustained Communication</td>
</tr>
<tr>
<td>Maintaining Trust through Transparency</td>
<td>Satisfying the Extra Demands from Customers ☑</td>
</tr>
<tr>
<td>Socially Connecting with Customers ☑</td>
<td>Staying Away from Customers’ Internal Conflicts ☑</td>
</tr>
<tr>
<td>Providing Training to Customers ☑</td>
<td>Having a Good Awareness of Providing Service ☑</td>
</tr>
<tr>
<td>Written Operation Guidelines ☑</td>
<td>Being Objective when Writing Training Materials ☑</td>
</tr>
<tr>
<td>Face-to-face Demonstration ☑</td>
<td>Drawing Flow Diagram for Training Handbooks ☑</td>
</tr>
<tr>
<td>Adopt Differentiated Training Strategies according to Different Customers’ Characteristics ☑</td>
<td>Producing Inclusive Training Materials According to Different Types of Users ☑</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Professional Attitude</th>
<th>Enjoymen of Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Motivation ☑</td>
<td>Professional Execution of Duties</td>
</tr>
<tr>
<td>Self-Reflection ☑</td>
<td>Self-Reflection</td>
</tr>
<tr>
<td>Self-Respect</td>
<td>Self-Respect</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Self-Adjustment ☑</th>
<th>Adapting to Changing Situations ☑</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adapting to Large Work ☑</td>
<td>Adapting to New Roles ☑</td>
</tr>
<tr>
<td>Adapting to New Working Environments ☑</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Self-Stress Management</th>
<th>Self-Stress Management</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Self-Confidence</th>
<th>Confidence in Language Capability ☑</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confidence in Presentation Skills and Oral Language ☑</td>
<td>Confidence in Reporting Skills and Written Language ☑</td>
</tr>
<tr>
<td>Confidence in Maintenance from SW Coding Experience</td>
<td>Confidence in Technical Tools and Frameworks</td>
</tr>
<tr>
<td>Confidence in Using Different Coding Languages</td>
<td></td>
</tr>
</tbody>
</table>