THE IMPACT OF KNOWLEDGE MANAGEMENT ON PROJECT SUCCESS

EMHEMED ABOU BAKER ARAFA

SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTORATE IN BUSINESS ADMINISTRATION

UNIVERSITY OF PORTSMOUTH

BUSINESS SCHOOL

SUPERVISORS: PROFESSOR ASHRAF LABIB
DR. ANDREW LEE

OCTOBER, 2015
Declaration

I declare that this thesis has not been submitted in whole or in part to any university as part of degree. I further declare that, except where reference is made in the text, the contents are entirely my own work. The author agrees that the library may lend or copy the thesis upon request for study purposes, subject to the normal conditions of acknowledgement.

Emhemed Arafa
October, 2015
ABSTRACT

The loss of experienced employees in project organisation leads to the loss of valuable knowledge and experience gained over many years. Knowledge management (KM) has the ability to challenge this situation.

This research study is focused on the field of knowledge management in Engineering, Procurement and Construction (EPC) type contracts in Libyan oil and gas industry projects. The research study aims to put forward guidance on how KM should be implemented in practice as a convincing case for the oil and gas construction industry. Adopting a practical «in project environment» KM scheme is a means of becoming more efficient, with greater ability to continuously learn and adapt in a dynamic mode.

In Libya’s oil and gas industry, and in particular, in project development, there has been very little guidance on how KM should be implemented in practice. The existing available KM mostly takes the form of tacit knowledge and almost none was identified as explicit knowledge.

Emergent in nature, the research work is comprised of three phases: initial interviews, case study «A», and case study «B». Each of the phases was combined with a review of relevant literature, primary research (including interviews, questionnaires, case studies and action research) and grounded theory in analytical processes.

Phase (1) - Initial interviews were conducted with project managers and senior managers from three different oil and gas companies; many gaps were identified by investigating issues related to KM. It was evident that KM within the projects organisation was kept in tacit format by individuals.

Phase (2) - Case study (A): Review and analysis of a KM implementation initiative made by a Project Manager (PM) with his team between 2006-2008, was found to be not successful and non-contributory in real-world terms, but in academic terms it gives an opportunity to identify and evaluate challenges to be faced in adopting a KM model in organisations. The role of the Projects Department emerged as essential in the articulation of KM between project and organisation.
Phase (3) - Case study B: The researcher was involved through a live EPC project, making observations and organising interviews when necessary and analyse the created knowledge life cycle during the project.

The research gives much attention to the phenomena of knowledge development during an EPC project; the knowledge created in any of the project phases will take a different shape due to the technical development of the project work from one phase to the next; as such, if the project is not tracked during its development, it will lose its context and dramatically decrease the effectiveness of its re-usability in subsequent project phases and new projects within the organisation.

The added value of this research is the development of a practical organisational model for managing effectively the knowledge created during projects execution, based on an integrated, optimised, and suitable lessons learned tracking system.
Acknowledgements

It would have been impossible to complete this research work without the support of my family, my mother, my wife and my children who gave me all their encouragement and a peaceful environment in which to do my research, as well as their patience for the six years of the study. This would simply not have been possible without the support of my family.

In this regard, I would like to sincerely thank my supervisors, Professor Ashraf Labib and Dr Andrew Lee, who provided me with tremendous support and guidance throughout this learning experience; the opportunities afforded to me over the past six years are greatly appreciated.

I would also like to express my gratitude to the numerous organisations and individuals within the Libyan oil and gas sector who participated in the research and gave their time willingly to share their knowledge and experiences, particularly those who opened doors and provided access to information about their projects.

To each and every one who has influenced in my life … I’m sincerely grateful.
List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSF</td>
<td>Critical Success Factors</td>
</tr>
<tr>
<td>EPC</td>
<td>Engineering Procurement Construction</td>
</tr>
<tr>
<td>EPIC</td>
<td>Engineering, Procurement, Installation and Commissioning</td>
</tr>
<tr>
<td>GIL</td>
<td>Global Information Link</td>
</tr>
<tr>
<td>HR</td>
<td>Human Resources</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communication Technology</td>
</tr>
<tr>
<td>K</td>
<td>Knowledge</td>
</tr>
<tr>
<td>KCI</td>
<td>K creation initiative</td>
</tr>
<tr>
<td>KCIC</td>
<td>K creation initiative captured</td>
</tr>
<tr>
<td>KCINT</td>
<td>K creation initiative not tracked</td>
</tr>
<tr>
<td>KCIL</td>
<td>K creation initiative lost</td>
</tr>
<tr>
<td>KDD</td>
<td>Knowledge Discovery in Data</td>
</tr>
<tr>
<td>KM</td>
<td>Knowledge Management</td>
</tr>
<tr>
<td>LL</td>
<td>Lessons Learned</td>
</tr>
<tr>
<td>LPE</td>
<td>Lead Project Engineer</td>
</tr>
<tr>
<td>NOC</td>
<td>National Oil Company</td>
</tr>
<tr>
<td>PM</td>
<td>Project Manager</td>
</tr>
<tr>
<td>PMAJ</td>
<td>Project Management Association of Japan</td>
</tr>
<tr>
<td>PMBOK</td>
<td>Project Management Body of Knowledge Guide</td>
</tr>
<tr>
<td>PMI</td>
<td>Project Management Institute</td>
</tr>
<tr>
<td>SPI</td>
<td>Society for Petroleum Engineers</td>
</tr>
<tr>
<td>TKCI</td>
<td>Total K creation initiative</td>
</tr>
</tbody>
</table>
## CONTENTS

Acknowledgements ........................................................................................................... iv

**Chapter 1** ........................................................................................................................ 10

1.1 Motivation for focusing this study on the oil and gas industry, in particular, in Libya 13

1.2 Motivation for focusing this study on project development, in particular, the EPC project type .......................................................... 14

1.3 Personal motivation for this study ....................................................................... 15

1.4 Objectives and structure of the thesis ................................................................ 16

1.5 Research questions ......................................................................................... 17

1.6 Research scope and limitations ...................................................................... 19

1.7 Structure of the thesis ...................................................................................... 20

1.8 Summary ........................................................................................................... 25

**Chapter 2** ...................................................................................................................... 26

2.1 Literature review ................................................................................................. 27

2.1.1 KM in international oil and gas companies .................................................. 27

2.1.2 KM in Libyan oil and gas companies ............................................................ 28

2.2 History of Knowledge Management .................................................................. 29

2.3 Knowledge definition ....................................................................................... 30

2.4 Knowledge dimensions .................................................................................... 31

2.5 Knowledge management process (Add K conversion of Nonaka) .................... 35

2.6 KM implementation in the construction and oil sectors .................................. 39

2.6.1 Critical success factors of KM implementation: ........................................... 41

2.6.2 K implementation barriers ........................................................................... 45

2.6.3 Role of HRM .................................................................................................. 47

2.6.4 Role of ICT ................................................................................................... 49

2.7 KM in project organisation ................................................................................. 50

2.7.1 Projects and project management .................................................................. 50

2.7.2 EPC projects .................................................................................................. 53

2.7.3 Project success ............................................................................................... 55

2.7.4 Project Knowledge Management .................................................................. 57

2.7.5 Temporary and permanent organisations» knowledge management ................. 58

2.7.6 KM and PM .................................................................................................... 59

2.7.7 Project knowledge management models ......................................................... 62

2.7.7.1 Lessons learned (LL)................................................................................ 65

2.7.7.2 LL process ................................................................................................ 65

2.7.7.3 Effective lessons learned .......................................................................... 68
2.7.7.4 LL in EPC projects ................................................................. 68
2.7.8 Limitations in the current knowledge management theories .................. 69

**Chapter 3** .................................................................................. 71
  3 Research methodology ................................................................. 72
  3.1 Research emerging phases ......................................................... 72
  3.2 Justification of research methodology ....................................... 76
  3.2.1 Selection of research philosophy ............................................ 77
  3.2.1.1 The Interpretivist philosophical paradigm .......................... 77
  3.2.2 Selecting research approach and strategies ............................... 80
  3.2.2.1 Grounded theory ............................................................. 82
  3.2.2.2 Case study ..................................................................... 90
  3.2.2.3 Action research ............................................................... 90
  3.2.3 Selecting research methods .................................................... 92
  3.2.3.1 Mixed methods ............................................................... 92
  3.2.4 Selection of data collection techniques and procedures ............. 94
  3.2.5 Data recording and validation procedures ................................ 97
  3.2.6 Sampling and ethical considerations ...................................... 98
  3.2.7 Selection of data analysis technique and procedures .................. 100
  3.2.7.1 Open coding .................................................................. 100
  3.2.7.2 Axial coding .................................................................... 101
  3.2.7.3 Selective coding ............................................................... 102
  3.3 Data collection/analysis and the iterative process until theoretical saturation 102

**Chapter 4** .................................................................................. 105
  4 Initial interviews ......................................................................... 106
  4.1 Introduction ............................................................................. 106
  4.2 Sampling .................................................................................. 106
  4.3 Data collection .......................................................................... 109
  4.4 Data analysis and findings ......................................................... 111
  4.5 Discussion ............................................................................... 112
  4.5.1 Knowledge definition ........................................................... 113
  4.5.2 Category 1: Knowledge .......................................................... 113
  4.5.3 Category 2: Knowledge management process .......................... 117
  4.5.4 Category 3: Existing learning activities .................................... 119
  4.5.5 Category 4: Role of organisation .......................................... 123
  4.5.6 Individual initiative ............................................................... 124
  4.6 Conclusion .............................................................................. 125
  4.6.1 Responses to research questions .......................................... 125
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.6.2 Framework</td>
<td>128</td>
</tr>
<tr>
<td>4.6.3 Next phase</td>
<td>129</td>
</tr>
<tr>
<td>Chapter 5</td>
<td>131</td>
</tr>
<tr>
<td>5.1 Introduction</td>
<td>132</td>
</tr>
<tr>
<td>5.2 Step 1</td>
<td>136</td>
</tr>
<tr>
<td>5.2.1 Sampling</td>
<td>136</td>
</tr>
<tr>
<td>5.2.2 Data collection</td>
<td>137</td>
</tr>
<tr>
<td>5.2.3 Data analysis and findings</td>
<td>137</td>
</tr>
<tr>
<td>5.2.4 Discussion</td>
<td>139</td>
</tr>
<tr>
<td>5.3 Step 2</td>
<td>141</td>
</tr>
<tr>
<td>5.3.1 Data collection</td>
<td>141</td>
</tr>
<tr>
<td>5.3.2 Sampling</td>
<td>142</td>
</tr>
<tr>
<td>5.3.3 Data analysis and findings</td>
<td>143</td>
</tr>
<tr>
<td>5.4 Step 3</td>
<td>145</td>
</tr>
<tr>
<td>5.4.1 Data collection</td>
<td>145</td>
</tr>
<tr>
<td>5.4.2 Sampling</td>
<td>146</td>
</tr>
<tr>
<td>5.4.3 Data analysis</td>
<td>148</td>
</tr>
<tr>
<td>5.4.4 Discussion</td>
<td>148</td>
</tr>
<tr>
<td>5.5 Conclusion</td>
<td>151</td>
</tr>
<tr>
<td>5.5.1 Responses to research questions</td>
<td>151</td>
</tr>
<tr>
<td>5.5.2 Framework</td>
<td>152</td>
</tr>
<tr>
<td>5.5.3 Next step</td>
<td>155</td>
</tr>
<tr>
<td>Chapter 6</td>
<td>156</td>
</tr>
<tr>
<td>6.1 Introduction</td>
<td>157</td>
</tr>
<tr>
<td>6.2 First cycle:</td>
<td>161</td>
</tr>
<tr>
<td>6.2.1 Data collection: (Focus group)</td>
<td>161</td>
</tr>
<tr>
<td>6.2.2 Sampling: (Lead project engineers and project managers)</td>
<td>162</td>
</tr>
<tr>
<td>6.2.3 Findings</td>
<td>162</td>
</tr>
<tr>
<td>6.2.4 Discussion</td>
<td>167</td>
</tr>
<tr>
<td>6.2.5 Next step</td>
<td>169</td>
</tr>
<tr>
<td>6.3 Second cycle</td>
<td>170</td>
</tr>
<tr>
<td>6.3.1 Data collection: (Interviews, observation)</td>
<td>170</td>
</tr>
<tr>
<td>6.3.2 Findings</td>
<td>172</td>
</tr>
<tr>
<td>6.3.2.1 Discussion</td>
<td>172</td>
</tr>
<tr>
<td>6.4 Conclusion</td>
<td>175</td>
</tr>
<tr>
<td>6.4.1 Responses to research questions</td>
<td>175</td>
</tr>
</tbody>
</table>
## List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>Kinds of thesis structure (adapted from Paltridge (2002))</td>
<td>20</td>
</tr>
<tr>
<td>Figure 2</td>
<td>An overview of the research process (source: author)</td>
<td>22</td>
</tr>
<tr>
<td>Figure 3</td>
<td>Knowledge dimensions (Nonaka &amp; Takeuchi, 1995)</td>
<td>33</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Iceberg metaphor of Michael Polanyi</td>
<td>34</td>
</tr>
<tr>
<td>Figure 5</td>
<td>Different authors’ use of the terms with regards to their level on an individual-industry scale and the publication year (Paulin &amp; Suneson, 2012)</td>
<td>39</td>
</tr>
<tr>
<td>Figure 6</td>
<td>CSF chart of Ehsan Borousan et al. (2012)</td>
<td>42</td>
</tr>
<tr>
<td>Figure 7</td>
<td>Summary of Literature Review that identifies CSFs affecting KM adoption (adapted from Salah, 2013)</td>
<td>44</td>
</tr>
<tr>
<td>Figure 8</td>
<td>Common project life cycle sequences</td>
<td>44</td>
</tr>
<tr>
<td>Figure 9</td>
<td>Knowledge management in temporary organisations. (Lindner &amp; Wald, 2010)</td>
<td>53</td>
</tr>
<tr>
<td>Figure 10</td>
<td>Temporary and permanent organisation knowledge management (Disterer, 2002)</td>
<td>59</td>
</tr>
<tr>
<td>Figure 11</td>
<td>Proposed theoretical framework for project knowledge sharing - contribution to project adapted from (Ismail &amp; Marjani, 2009).</td>
<td>62</td>
</tr>
<tr>
<td>Figure 12</td>
<td>The evolution path of general contract knowledge system (Zhu et al 2014)</td>
<td>63</td>
</tr>
<tr>
<td>Figure 13</td>
<td>Modified hybrid KDD model (Hammad and AbouRizk 2014)</td>
<td>64</td>
</tr>
<tr>
<td>Figure 14</td>
<td>Research road map (Source: Author)</td>
<td>75</td>
</tr>
<tr>
<td>Figure 15</td>
<td>Framework of research methodology based on Saunder’s Onion (Source: Author)</td>
<td>77</td>
</tr>
<tr>
<td>Figure 16</td>
<td>The research process-interpretive approach (Adapted from Sekaran, 2000, p. 54; Galliers, 1992, p. 61; and Finegan, 2001)</td>
<td>80</td>
</tr>
<tr>
<td>Figure 17</td>
<td>Glaser (1978, 1992) place of induction, deduction and verification in grounded theory analysis (Source: Heath &amp; Cowley, 2004)</td>
<td>85</td>
</tr>
<tr>
<td>Figure 18</td>
<td>Strauss (1987) and Strauss and Corbin’s (1990) place of induction, deduction and verification in grounded theory analysis</td>
<td>85</td>
</tr>
<tr>
<td>Figure 19</td>
<td>The mixed-methods research structure (Source: Author)</td>
<td>94</td>
</tr>
<tr>
<td>Figure 20</td>
<td>Research iterative data collection-analysis process (Source: Author)</td>
<td>103</td>
</tr>
<tr>
<td>Figure 21</td>
<td>First research phase design</td>
<td>107</td>
</tr>
<tr>
<td>Figure 22</td>
<td>first phase framework (source: author)</td>
<td>130</td>
</tr>
<tr>
<td>Figure 23</td>
<td>Third research phase design</td>
<td>134</td>
</tr>
<tr>
<td>Figure 24</td>
<td>Respondent distribution.</td>
<td>147</td>
</tr>
<tr>
<td>Figure 25</td>
<td>second phase framework (source: author)</td>
<td>154</td>
</tr>
<tr>
<td>Figure 26</td>
<td>Third research phase design</td>
<td>158</td>
</tr>
</tbody>
</table>
### List of Tables

Table 1 Most popular KM literature contribution ................................................................. 30
Table 2 The classifications of Organisation Knowledge .......................................................... 33
Table 4 Literature review identified K sharing barriers ......................................................... 46
Table 6 Straussian vs Glaserian approaches of GT .............................................................. 88
Table 8 Grounded theory paradigms .................................................................................... 101
Table 9 Respondent distribution ......................................................................................... 143
Table 10 Respondent distribution ....................................................................................... 146
Table 11 Organisational factor ranking .............................................................................. 149
Table 12 Project management factor ranking ..................................................................... 149
Table 13 Professional factor ranking .................................................................................. 150
Table 14 ICT factor ranking ............................................................................................... 150
Table 15 LL session participation ....................................................................................... 163
Table 17 LL session participation ....................................................................................... 168
Table 18 Elements of the Axial Coding Paradigm (Adapted from Strauss & Corbin) ....... 179
Chapter 1

INTRODUCTION
Chapter 1

Introduction

The past 15 years have seen a significant flow of interest in the role of knowledge within organisations and a rapid growth in the use of knowledge management techniques by companies across a broad range of sectors. Thus knowledge management is one of the management techniques most widely used by many large companies and institutions in the world. Interest in knowledge management is becoming more attractive and important due to several factors:

- Accelerating rates of technological and market change mean that learning is increasingly important for sustaining business success.

- Organisations are becoming larger and more complex. This means that there are greater opportunities for learning from the experiences of businesses, divisions, groups and people from different parts of the same organisation.

- Information technology permits the gathering, transfer, organisation and sharing of data, facts and information within organisations to an extent that wasn’t imaginable just 20 years ago.

- Knowledge management can be an important tool in achieving an advantage through cost and schedule leadership leading to greater success within the organisation.

In this context, Offsey, S (1997) identifies four direct benefits of KM for organizations:

- Awareness: everyone knows where to go to find the organization’s knowledge.

- Accessibility: all individuals can access it.

- Availability: knowledge is usable wherever it is needed.

- Timeliness: knowledge is available whenever it is needed.

According to Palmer and Platt (2005), if properly implemented, KM can offer firms the following benefits:

- A major competitive advantage.
Chapter 1

Introduction

- Avoiding repeating mistakes and reinventing the wheel.
- Reducing the time taken to find information.
- Allowing faster decision-making.
- Improving client satisfaction.
- Improving employee morale and teamwork.

Even if the field is still young, knowledge management techniques have begun to be widely applied across industries. According to a survey of 200 IT managers by InformationWeek Research, 94% of companies consider knowledge management strategic to their business processes. Many of these companies are in the early stages of their knowledge management efforts. According to the survey, companies estimate that they capture only about 45% of their intellectual capital, on average. Also, only 36% of companies have formal policies for sharing knowledge assets and even fewer have formal policies for capturing such assets.

Achieving success in the industry is dependent upon how its knowledge is managed, including knowledge generated by academic contributing circles and collaborative research centres together with existing knowledge that organisations hold in the form of intellectual capital.

Knowledge management (KM) is therefore being recognised as a means through which improved business performance is possible (Kamara, Augenbroe, Anumba, & Carrillo, 2002). The success of various KM initiatives in other industries was reported in the literature such as pharmaceuticals industry (Normann & Ramirez, 1993).

KM allows organisations to devise mechanisms that could bring them closer to knowledge communities, thereby generating new knowledge and producing continuous improvement. This interaction can allow a flow of knowledge between internal and external knowledge communities instead of an organisation responding reactively to a knowledge push, the principle of KM can pull that knowledge into itself. It establishes the mechanisms by which these intangible organisation assets are best exploited to the benefit of the organisation that manages and operates a sensitive business by adopting KM principle and effectively use it in consistent and simultaneous manner.
1.1 Motivation for focusing this study on the oil and gas industry, in particular, in Libya

Oil reserves in Libya are the largest in Africa and among the ten largest globally with 46.4 billion barrels as of 2010. Oil production was 1.65 million barrels per day as of 2010, giving Libya 77 years of reserves at current production rates if no new reserves were to be found.

Libya is considered as a highly attractive oil area due to its low cost of oil production (as low as $1 per barrel at some fields), and proximity to European markets. Libya’s challenge is maintaining production at mature fields, while finding and developing new oil fields. Most of Libya remains unexplored as a result of past sanctions and disagreements with foreign oil companies.

The oil and gas industry is a knowledge-based business. Exploration, production, development and management of oil and gas reserves are knowledge oriented; it is a very expensive business subject to big technical and financial risks. Therefore, the competitive advantages are depending on company’s ability to exploit knowledge more effectively for its continuity and expansion.

Conditions specific to the oil and gas industry further suggest the potential of knowledge management to provide solutions to some of the most critical problems faced by the industry. For instance, the Society for Petroleum Engineers (SPE) estimates that between 1980 and 1998 the number of people working in the oil and gas industry fell from 700,000 to 300,000. The median age of today’s SPE members is 47. The industry will experience a 44% attrition rate among petroleum engineers by 2010, and 231,000 years of cumulative experience and knowledge will be lost to the industry in the next 10 years due to retirement. Almost half of the workforce will be new.

In terms of joint researcher experience and knowledge, oil and gas companies are losing a remarkable percentage of their employees. This continuous knowledge loss, which is due to retirement and the movement of expertise for several reasons, can potentially be compensated through the adoption of appropriate knowledge management systems, and archiving most of the tacit knowledge in the form of explicit knowledge that can be easily reused through a software system.
As a result, influences or effects are implied, KM has become one of the most powerful forces for changing management systems and management thinking among the major oil and gas companies.

In the developed countries, oil and gas companies have begun to build their long-term strategies upon effective knowledge management, as knowledge has become the strategically most important resource for firms. Chevron, for example, has designed a Best Practice Knowledge Sharing Database to promote the sharing of practices, knowledge, know-how and lessons learned all over the company. Chevron also developed the Global Information Link (GIL) to manage knowledge; this is a software system, creating a single desktop and operating environment worldwide (O’Brien, D. & Rounce, J., 2001).

However, in developing countries, including Libya, KM is relatively new. Few studies of its implications have been embraced, and there has been insufficient examination in Libya, in particular in the oil and gas industry, which is a substantial part of the Libyan national economy as a producer and operator.

The literature available in this area discusses the importance of knowledge management (KM) as a means of improving productivity in general. The focus is mostly still on the organisational level; the question of how knowledge integration can be applied in the oil and gas industry remains, to a great extent, unanswered. Nothing was found in the literature related to its application in the oil and gas sector in Libya.

It is vital to challenge this situation because knowledge management is a beneficial innovation in Libya in general and in its oil and gas industry in particular.

1.2 Motivation for focusing this study on project development, in particular, the EPC project type

The subject research study focuses on managing knowledge within Libyan oil and gas project development.

The practice of Engineering Procurement Construction (EPC) projects is the largest management practice of large-scale oil and gas projects in Libya and in the world. It emphasis on EPC covers the extended scope of project development in the oil and gas industry. It presents the most complex forms of projects as it involves a wide range of project
development processes and study results based on EPC projects, and can be generally applied to most other forms of project development. «An EPC project can be a complex one, broader in scope and professional field, made up of a large number of interconnected subsystems and components, requiring considerable human efforts and financial commitment» (Yeo & Ning, 2002).

«As EPC projects are diversified in knowledge which covers different professional fields, life cycle periods and stakeholders, the knowledge integration not only helps solve the problems of management inside the current projects, but it also supports the accumulation of knowledge of the forthcoming projects» (Zhu, Sun, Xu, & Haider, 2014).

Having highlighted the importance of the oil and gas potential in Libya and the plans for future big development projects, why is KM in relation to execution of EPC projects important?

According to the development plans a large part of the future oil and gas production is coming from the employment of new EPC projects, planned to take place during the coming years, and as the EPC type (famous contracting strategy adopted and used in Libyan projects) projects is the most tested and used within the Libyan oil and gas sector.

As stated above, the increased demand for oil and gas will subsequently encourage the increase of development projects, which will require capital investments in the billions of dollars.

Due to the large amount of capital required, owners and shareholders of such projects will expect greater efficiencies from the engineering, procurement and construction of the projects than current practices provide; improvements are always an added value, such as avoiding redoing the work (maximising benefit of using project knowledge, making sure all project team members are aware of it on time, etc.), and such improvements can reduce time to market, which will create additional revenue, and avoid delays that generate additional cost and delay time to market (production of direct losses, possible commercial penalties.....etc.).

1.3 Personal motivation for this study

Having worked in the oil and gas industry for over 29 years, currently holding a position of senior project manager in one of the major Libyan oil and gas operating companies, the
researcher wishes to expand his experience in knowledge management systems in the execution of EPC projects. Holding a DBA degree in Knowledge Management Systems will enhance his skills and professional career; it will provide the opportunity to transfer what has been learned and experienced throughout the research work undertaken in the form of results and recommendations.

The researcher has used the opportunities afforded through meetings, interviews, participation in meetings with a number of project staff and management of several oil and gas companies, in addition to a consistent follow-up of some projects undertaken by the operator.

1.4 Objectives and structure of the thesis

This research is descriptive and qualitative in nature. It attempts to provide enough evidence of the concept that may eventually help project teams in the oil and gas construction industry in Libya to adopt and practise KM in their development of future EPC projects.

The main objective of the research is to develop a KM process framework, with activities aimed at improving the business performance of organisations. It also assists senior management involved in oil and gas project development functions to better understand the importance and potential of KM, and in its promise to deliver both a learning and business performance within the organisation.

The rationale developed in the above section leads to the following set of objectives to be tackled during the research work:

1) To investigate the issues related to managing the knowledge derived in Libyan oil and gas organisations.

2) To identify practices and activities for managing knowledge within the leading oil and gas organisations for EPC projects execution, that can represent a basis for building and implementing an effective knowledge management system.

3) To suggest a conceptual knowledge management model based upon the emerging issues that can be used in the oil and gas industry in Libya for the development of EPC projects, Simple, less complicated and suitable considering the low spread of knowledge in the overall organisation that can encourage management, project management teams and their
sub-teams to use and implement KM model, to facilitate knowledge creation and sharing activities in their project’s environment.

The thesis also introduces a dual emergent case study investigation, whose aims were to study the factors that affect the knowledge management activities in the project environment in one major Libyan oil and gas industry organisation, and how business performance can be affected (i.e. the extent to which a KM system can support and contribute to a project’s success).

1.5 Research questions

The research questions in a grounded theory study are very different to the hypotheses or null hypotheses generated at the beginning of an experimental design quantitative study. Furthermore, the questions must be flexible and open-ended to allow the theory to develop. They should be sufficiently broad to enable a systematic inquiry to be conducted of all the aspects of a phenomenon in depth (Strauss & Corbin, 1990) and to give researchers the flexibility and freedom to explore the phenomenon in depth; thus, the researcher cannot know beforehand what the essential matters are (Glaser, 1978).

Stock (2001) also argued that really precise research questions cannot be posed before beginning any grounded theory study.

Research questions are «statements that identify the phenomenon to be studied» (Backman & Kyngas, 1999) and are «always broad» (McCallin, 2003).

Based upon the above arguments, the research objectives can be translated into the following research questions:

**Phase 1 questions:**

- Q1.1: What issues should be addressed in relation to KM adoption within Libyan oil and gas EPC organisations?

- Q1.2: What measures should organisations take to resolve effectively these knowledge management issues?
Chapter 1

Q1.3: How can these measures be suitably implemented and accepted in EPC Libyan oil and gas companies?

The research questions may even change during data collection (Glaser, 1978). Moreover, it is those interacting in the field that define their problems or concerns (McCallin, 2003). The research problem should not be pre-empted by the researcher, but should be defined by the research participants themselves (McCallin, 2003). The way that the research problem and questions are formulated in grounded theory studies reflects its methodological objective that «grounded theory explains what is actually happening in practical life, rather than describing what should be going on» (McCallin, 2003, p. 203).

Based upon these arguments, researchers, therefore, should expect that the question will evolve» over the course of the study.

Thus, in the second and third phases of the research, there is a need to change and develop the questions towards a new focused area, as demonstrated in the following:

Phase 2 questions:

KM issues that emerged during the first phase were valuable and answered the first research question, but the matter is still broad and relatively generic.

For this, the first research question investigating KM issues was narrowed by the researcher to focus essentially on the critical influencing factors of «implementing a KM system» as shown below

Q2.1: What critical factors can influence the adoption of KM in the Libyan oil and gas EPC project environment within the oil and gas companies?

And as a consequence, the second and third questions asking for what and how measures should be taken by organisations were integrated into the following question.

Q2.2: Building upon the existing practices, how can these factors be addressed and how can roles and duties be distributed within the company to implement an effective K management.
Chapter 1  Introduction

Phase 3 questions:

With regard to the issues that emerged during the first phase and the critical adoption factors during the second phase of the research, developing LL practices, and the improvement of knowledge sharing and transfer within a project and from one project to another.

The research question related to this phase was formulated as follows:

Q3.1: How can the LL process be improved to manage effectively the EPC project K and enhance its transfer between projects?

1.6 Research scope and limitations

This research is a qualitative study and has relied on an in-depth investigation of a medium sample size (i.e. it started with three major Libyan oil and gas companies). The main research objective is to demonstrate the effect of knowledge management (KM) on EPC projects environment, and the learning, sharing and then reuse of knowledge. It can only be practical fulfilled by focusing on a small to medium size sample of case study examples and studying these in more detail, bearing in mind that no research has been carried out in the past investigating knowledge management (KM) in the project environment in the Libyan oil and gas sector.

knowledge management is relatively new in the oil and gas industry in general and in particular in the oil and gas industry in Libya, for this reason a sole quantitative study approach was deemed not appropriate thus not many organisations (or people) in Libya are familiar with its underlying philosophy; in general, they often confuse knowledge management with an IT initiative and software applications.

It is for this reason that the first two objectives of this study were fulfilled through a comprehensive literature review and not through empirical means. The results obtained in this research are specific and more toned to the organisations studied but also have general implications for understanding the role of knowledge management in enhancing the learning and sharing of knowledge, and for how to reuse it in any other organisations of a similar business and nature that function and operate in Libya.
1.7 Structure of the thesis

Paltridge (2002) identified four main kinds of thesis: «traditional: simple», «traditional: complex», «topic-based» and «compilation of research articles». The «traditional: simple» type, which is generally the most popular, follows the format of an introduction, literature review, materials and methods, results, discussion and conclusions.

<table>
<thead>
<tr>
<th>Traditional Simple</th>
<th>Topic Based</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction</td>
<td>1. Introduction</td>
</tr>
<tr>
<td>2. Literature Review</td>
<td>2. Topic 1</td>
</tr>
<tr>
<td>3. Materials and Methods</td>
<td>3. Topic 2</td>
</tr>
<tr>
<td>4. Results</td>
<td>4. Topic 3</td>
</tr>
<tr>
<td>5. Discussion</td>
<td>5. Conclusions</td>
</tr>
<tr>
<td>6. Conclusions</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Traditional Complex</th>
<th>Compilation Based</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction</td>
<td>1. Introduction</td>
</tr>
<tr>
<td>2. Literature Review</td>
<td>2. Background to the Study</td>
</tr>
<tr>
<td>3. (Background Theory)</td>
<td>3. Research Article 1</td>
</tr>
<tr>
<td>4. (General Methods)</td>
<td></td>
</tr>
<tr>
<td>• Introduction</td>
<td>• Introduction</td>
</tr>
<tr>
<td>• Methods</td>
<td>• Results</td>
</tr>
<tr>
<td>• Results</td>
<td>• Discussion</td>
</tr>
<tr>
<td>• Discussion</td>
<td>• Conclusions</td>
</tr>
<tr>
<td>6. Study 2</td>
<td>4. Research Article 2</td>
</tr>
<tr>
<td>• Introduction</td>
<td>• Introduction</td>
</tr>
<tr>
<td>• Methods</td>
<td>• Literature Review</td>
</tr>
<tr>
<td>• Results</td>
<td>• Materials and Methods</td>
</tr>
<tr>
<td>• Discussion</td>
<td>• Results</td>
</tr>
<tr>
<td>7. Study 3</td>
<td>• Discussion</td>
</tr>
<tr>
<td>• Introduction</td>
<td>• Conclusions</td>
</tr>
<tr>
<td>• Methods</td>
<td>5. Research Article 3</td>
</tr>
<tr>
<td>• Results</td>
<td>• Introduction</td>
</tr>
<tr>
<td>• Discussion</td>
<td>• Literature Review</td>
</tr>
<tr>
<td>8. Discussion</td>
<td>• Materials and Methods</td>
</tr>
<tr>
<td>9. Conclusions</td>
<td>• Results</td>
</tr>
<tr>
<td></td>
<td>• Discussion</td>
</tr>
<tr>
<td></td>
<td>• Conclusions</td>
</tr>
<tr>
<td></td>
<td>6. Conclusions</td>
</tr>
</tbody>
</table>

Figure 1 Kinds of thesis structure (adapted from Paltridge (2002)).
Chapter 1

Introduction

In the case of this thesis, the «traditional complex» type has been adopted as a structure; it typically reports on a sequence of studies, and consists of an introduction and background to the research study, literature review, reflection of general methods, a sequence of sections on each of the individual studies considered, and a conclusions and recommendations section.

Due to the iterative nature of the grounded theory methodology, this form fits in quite well with the variety of different studies that have been undertaken during the period from 2011 to 2014.

Figure 2 provides an overview of the process or workflow adopted for this research study. The following subsections provide the structure of this thesis by giving a brief description of the layout and the content of the chapters.
<table>
<thead>
<tr>
<th>Chapter 1</th>
<th>Introduction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Formulation of research problem, objectives and general research question</strong></td>
<td>![Question Mark]</td>
</tr>
<tr>
<td><strong>Research methodology and sample selection</strong></td>
<td>![Person Thinking]</td>
</tr>
<tr>
<td><strong>Initial data collection and analysis</strong></td>
<td>![Data Collection Diagram]</td>
</tr>
<tr>
<td><strong>Research questions and methods evolving, theoretical sampling</strong></td>
<td>![Question Mark and Golf Ball]</td>
</tr>
<tr>
<td><strong>Case study A</strong></td>
<td><strong>Case study B</strong></td>
</tr>
<tr>
<td><strong>Discussion, framework development and conceptual model proposition</strong></td>
<td>![Folder with Documents]</td>
</tr>
<tr>
<td><strong>Conclusions and recommendations</strong></td>
<td>![Person Crossing Finish Line]</td>
</tr>
</tbody>
</table>

**Figure 2:** An overview of the research process (source: author).
Chapter 1

Bearing in mind the above, this thesis was structured to comprise seven chapters:

Chapter 1: INTRODUCTION
It provides an overview of this research. It addresses the research background, research rationale, research objectives, research questions, research propositions, research methods and scope and limitations of the research.

Chapter 2: LITERATURE REVIEW
It presents a review of literature relevant to the study, which was dictated by the emergent nature of the research and undertaken throughout the course of the study. The chapter commences by providing an initial review of literature in diverse fields such as: knowledge, knowledge management, project management, organisational planning and development, organisational learning, innovation etc. It discusses the construction industry and its culture and develops a case for the deployment of KM in the construction industry and in particular in oil and gas. It then explains terms as they are currently being understood in the literature (such as KM, knowledge, and PM).

The chapter ends by providing emerging directions of research in the field of KM in the project environment context.

Chapter 3: RESEARCH METHODOLOGY
Considers the research methodology adopted, including the constructivist philosophy, the grounded theory methodology and the various data gathering and collection methods utilised during the research investigation, namely interviews and surveys. The selection of participants through theoretical sampling is dealt with in the context of an emergent research design, which also incorporates a case study.

Chapter 4: INITIAL INTERVIEWS
This chapter presents, elaborates and discusses the outcome findings from the initial 20 interviews conducted with senior managers (SM) and project managers (PM) from three major oil and gas companies in Libya.
Chapter 1

Introduction

These findings focus on the existing approaches that are currently used, if any, to manage knowledge and the current knowledge management activities within the three major Libyan oil and gas organisations.

Open coding was the predominant coding process used during this phase. The analysis and discussions of the initial findings had led to the development of an emerging preliminary framework upon which the basis for further empirical research will progress.

This initial phase was conducted during the period from 2010 to 2011.

Chapter 5: RESEARCH PHASE 2 (CASE STUDY A)

This chapter presents the case study findings based on an existing KM initiative in major Libyan oil and gas organisations (companies), including online questionnaires from the project team involved in this initiative and interviews with lead engineers (or middle project managers).

Specific attention is given to further developing the categories by axial coding the feedback from this case study’s findings, which are included to provide further refinement of the emerging issues and their conditions.

This case study was conducted during the years 2011 and 2012.

Chapter 6: RESEARCH PHASE 3 (CASE STUDY B)

This chapter presents the results generated from the performed in-depth case study of EPC projects in one leading Libyan oil and gas organisation, which concentrates on the improvement of LL practices through an action research strategy over five projects.

Through further axial coding, the relationships between categories were elaborated and three consistent paradigms emerged. Theoretical saturation was reached during this phase.

These case studies were undertaken between 2012 and 2014.

Chapter 7: DISCUSSION AND MODEL DEVELOPMENT

This chapter discusses all the findings that were obtained from the three previous chapters.
Chapter 1

Introduction

It describes how the emerged categories were integrated and the core category was fixed through selective coding. The model developed was presented to the management of participant companies to collect preliminary comments before the practical evaluation.

This phase was conducted in 2014.

Chapter 8: CONCLUSIONS AND RECOMMENDATIONS

This chapter outlines the major conclusions, limitations and recommendations drawn from the study.

1.8 Summary

Chapter (1) has introduced the research presented within this thesis, the following being a summary of the main points discussed:

With KM being recognised as important to the oil and gas industry, there is a need for further empirical research in this area.

The first aim of this research work is to map out the current situation (EPC project working environment) of the leading Libyan oil and gas organisations (leading companies) regarding the use of knowledge in a project environment and the associated issues related to it.

The second aim is to demonstrate with a grounded theory framework how issues that emerged during the investigation work can be treated effectively.

The third aim deals with the practical demonstration of the role of KM in improving the weaknesses identified in the first aim.

The structure of the thesis reflects the emergent nature of the research design, which is guided by theoretical sampling as part of the grounded theory process. In this regard, the next chapter specifically deals with the grounded theory methodology and issues relating to philosophy, research methods and research design.
Chapter 2
LITERATURE REVIEW
2 Literature review

Literature review is an ongoing process during grounded theory. In the initial phases of research, literature is reviewed to identify preliminary concepts and categories. Then, as the research progresses, it becomes more focused in order to support the emergent theory.

2.1 KM in oil and gas industry

2.1.1 KM in international oil and gas companies

The oil and gas industry originated in the United States of America and then extended worldwide. American exploration and production companies had initiated and developed several management systems to support their production and development plans; they were, and still are, pioneers in exploration, production, management, and technology. They were followed by UK companies and then, recently, most oil and gas leaders are international companies existing worldwide, through joint venture agreements with national companies. According to Sangeeta Shah Bharadwaj, Sumedha Chauhan, and Aparna Raman (Oct. 2015) in today’s globally competitive environment, knowledge-intensive organizations gain knowledge and wisdom through their business activities.

BP

BP’s knowledge management approach is fitted by a structure, which identifies a learning cycle – before, during and following any function – which can be reinforced by simple process tools. Collison and Parcell (2001) mentioned that BP encourages workers to locate the Intranet or Web to discover who has been doing the related function before beginning a job, therefore saving time and accomplishing that work better than before by knowing the mistakes.

BP also presented a tool to assess efficiency, named the After Activity Review (AAR), a brief group conference to capture operational knowledge, while doing the task. BP has been following an activity to analyse efficiency once a task is finished, which can be named «Retrospect & Rquo». BP management also made some «fellow functions» to enable cross-business sharing. By encouraging behaviours like asking for help, active listening, establishing associations and creating confidence, BP made a knowledge sharing culture in the organisation. There are more than 250 sites in BP. Some are conventional and have distinct objectives; others are informal (Collison & Parcell, 2001).
Chevron

Chevron is rolling out «The Chevron Way», which is really a guiding group of objectives, maxims and values that define the functions of workers, the targets of the company, and the marketing procedures, to interact and function together to achieve the target (Derr, 1999). Chevron has a few communities; probably the most successful areas are the best practices refining networks. These sites have explained organisation targets, apparent sponsorship from senior management, and a passionate coordinator (OBrien & Rounce, 2001). Chevron is rolling out the «method owners» programme because of their network of US gas refineries.

Shell

People in Shell’s Layer organisation work in distributed virtual teams, and produce and adapt knowledge worldwide of most readily useful training to regional situations (Skyrme & Wyllie, 1997). Lesley Chipperfield, Supervisor, Layer International Exploration & Production (E&P) states that within E&P, Layer gives attention to people and people-to-people connections. They developed a slogan that says, «Knowing who is as good as knowing how».

2.1.2 KM in Libyan oil and gas companies

Knowledge management in the (Libyan) oil and gas industry is still lacking, «despite the tremendous effort companies worldwide have devoted to the implementation of knowledge management systems, organisations in Libya are still suffering from the failure of Knowledge Management (KM) implementation» (Saleh, 2013).

According to S. Abouen, V. Ahmed, G. Aouad (2014), it was first, developed in America and Europe, provoking the existence of a number of well-established Project Management approaches in the form of Bodies of Knowledge. In Libya however there are problems relating to the development of project managers, particularly within the Libyan Oil Industry, which acts as the main contributor to the Libyan economy. The importance of project management development in the Libyan oil industry can be attributed to a number of reasons, which make this study unique. Agnaia (1997) states that the problems in the Libyan oil sector were caused by the inability of technical and educational institutions to provide much needed qualified personnel.

«KMS is modern technology in the business world, and because the oil industry relies heavily on modern technologies, the Libyan oil sector must adopt and apply it» (Saleh, 2013).
Chapter 2

Al-Busaidi (2005; 2007) reveals that in the Arab world, and in Libya in particular, the application of Information Systems (IS) and KM systems (KMS) is still at an early stage.

The literature available in this area discusses the importance of knowledge management as a means of improving productivity in general, but it does not sufficiently describe mechanisms through which KM can be embedded into the industry operating culture of oil and gas, and provides almost nothing about the Libyan oil and gas industry.

2.2 History of Knowledge Management

Grant (2007) considered that the beginning of knowledge management was with Polanyi’s early publications on individual knowledge in the direction of a post-critical philosophy during 1958 and the tacit domain in 1966, which then became the foundation and reference for the majority of works on knowledge management during the 1990s.

One more important development in knowledge management theory was introduced by Nonaka through his work on «knowledge-creating companies» in 1991 and soon after in 1995.

Nonaka had used and further extended Polanyi’s work on individual knowledge through real case studies from knowledge creating companies in Japan. Furthermore, Nonaka had built up the «knowledge creation model», by which he declared that successful innovations initiate the conversion of organisational tacit knowledge into explicit knowledge and back to tacit knowledge, continuing in the same manner to present the process of knowledge development within the organisation.

Within the above contexts, there were also other consistent and recognised developments in KM elaborated by other authors such as Davenport and Prusak (1998). They supported the apparent difference between data, information and knowledge in their publications on working knowledge. They argued for a more holistic analysis of knowledge management from the socio-technical theory, elaborating that their school of thought tended to be too prescriptive because it ignores the local environment in which the organisation operates (Grant, 1999).

The development of KM categorisation by Mikel Earl (2001) was one of the more important achievements in the KM field. Earl acknowledged three main KM schools: the technocratic
school, economic school, and the behavioural school. The technocratic school is based on information and management technologies which support knowledge employees in their daily work. The economic school essentially creates profits for the firm through utilisation of explicit knowledge, and other obscure assets similar to patents and copyrights. The behavioural school is more oriented in the direction of the behavioural aspects of management which requires organisations to be positive in creating, sharing and using knowledge.

Gherardi (2006) distinguished two KM bodies of knowledge: the sociology of knowledge, which teaches that «the conception of knowledge should be analysed in terms of social construction of reality»; and history of science, which argues that «normal science does not become institutionalized by means of a process of accumulation and reflection on the knowledge produced, but through the mobilization of power resources in support of claims for its legitimacy and validity» (Gherardi, 2006). Table 1 summarises the key and well-known development areas of KM.

<table>
<thead>
<tr>
<th>Period</th>
<th>KM Contribution Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>Susan Gherardi (KM Bodies of Knowledge)</td>
</tr>
<tr>
<td>2001</td>
<td>Michael Earl (KM Taxonomy)</td>
</tr>
<tr>
<td>1998</td>
<td>Davenport &amp; Prusak (Working Knowledge Socio-technical Theory)</td>
</tr>
<tr>
<td>1996</td>
<td>Robert Grant (Knowledge-Based Theory of the Firm)</td>
</tr>
<tr>
<td>1991, 1995</td>
<td>Ikujiro Nonaka (Knowledge Creating Companies)</td>
</tr>
<tr>
<td>1958, 1966</td>
<td>Michael Polanyi (Personal Knowledge)</td>
</tr>
</tbody>
</table>

**Table 1 Most popular KM literature contribution**

**2.3 Knowledge definition**

Before describing KM in further detail, it is essential to investigate the issues associated with knowledge. Knowledge was the subject of philosophical discussion for thousands of years (Boyd, Egbu, Chinyo, Xiao, & Lee, 2004). Significant interest is given to the philosophical perspectives on knowledge by Jashapara (2004), from Plato and Aristotle, through to those espoused in modern KM literature such as in Nonaka (1994) and Davenport and Prusak (1998) who defined Knowledge as «Knowledge is a fluid mix of framed experience, values,
contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information». Schwandt (1994) recognised that people «do not find or discover knowledge so much as construct or make it. We invent concepts, models and schemes to make sense of experience and, further, we continually test and modify these constructions in light of new experience», and experience is a recurring theme in these definitions, as the entry in the Oxford English dictionary OED (2008) confirms:

1. Information and skills acquired through experience or education.
2. The sum of what is known.
3. Awareness or familiarity gained by experience of a fact or situation.

According to Davenport and Prusak (1998), knowledge naturally contains both a meaning and judgement. A judgement is a conclusion based on a person’s experience and beliefs.

Knowledge is a powerful resource that enables individuals and organizations to achieve several benefits such as improved learning and decision-making - Kamla Ali Al-Busaidi1, L. Olfman, Terry Ryan, and Gondy Leroy (2010) and according to Sangeeta Shah Bharadwaj, Sumedha Chauhan, and Aparna Raman (2015) in order to compete effectively, firms must leverage their existing knowledge and create new knowledge that favourably positions them in their chosen markets. In order to accomplish this, firms must develop an ‘absorptive capacity’—the ability to use prior knowledge to recognize the value of new information, assimilate it, and apply it to create new knowledge and capabilities.

Nonaka and Takeuchi recognised that knowledge and information are different in beliefs and commitment, action, and meaning (Nonaka & Takeuchi, 1995).

2.4 Knowledge dimensions

It can be concluded that knowledge is experientially based and is always altered in the light of new experiences. Moreover, as Sousa and Hendriks (2006) have argued, knowledge is socially constructed in nature, a view shared by many authors (Styhre & Josephson, 2006).

This idea is shared by Quintas (2005) who recognises three key issues concerning the nature of knowledge: the tacit nature, the social nature, and the stickiness of knowledge. Tacit
knowledge is acquired through experience and internal reflection and cannot be simply shared with others who have not been through comparable experiences.

Regarding the «social dimension – it may be created and held collectively» (Quintas, 2005). The stickiness of knowledge refers to its context and the complexity with which this type of knowledge can be shared to other situations or contexts, «what has value or meaning in one context may have little or no meaning in another context» (Quintas, 2005). Also Fong (2005) identified context as important and reflects the constructivist perspective in discussing the concept of knowledge sharing, which «relies on reaching a shared understanding of the underlying knowledge, not just the content but also the context of the knowledge» (Fong, 2005).

Nonaka and Takeuchi (1995) provided in their theory of organisational knowledge creation, the most famous definitions of knowledge in literature on this subject and introduced two dimensions of knowledge.

The ontological dimension considers the levels of knowledge creating entities as individual, group, organisation, and inter-organisation levels.

In the same direction, Egbu and Robinson (2005) identified three key types requiring consideration in managing knowledge within organisations: product (technical knowledge), process (procedural and regulatory knowledge), and people (identifying people with specific skills and experiences).

The epistemological dimension comprises two types of human knowledge: explicit and tacit:

- Explicit – can be readily codified into words and numbers, easily shared, easy to distribute, and can be managed as information

- Tacit – not easily visible or expressible, highly individualised and context specific, difficult to share and manage, and more valuable than explicit knowledge. This is a theme continued by Caddy (2001) who provides examples of both explicit and tacit knowledge in an organisational context, in relation to both individuals and collectively within groups (see Table 2).
Michael Polanyi (1966) mentioned that, «We can know more than we can tell». According to him, knowledge that can be *expressed in words and numbers* only represents the tip of the iceberg of the entire body of possible knowledge.

Polanyi identified two categories human knowledge: tacit and explicit.

Polanyi argued that «Tacit Knowledge is highly personal and hard to formalize, making it difficult to communicate or share with others. Subjective insights, intuitions and hunches fall into this category of knowledge. It is deeply rooted in an individual’s actions and experience as well as in the ideals, values, or emotions he or she embraces; it is a personal quality which makes it hard to formalize and communicate». 
There are (3) three aspects of tacit knowledge:

1. Technical aspect, which covers the kind of informal personal talent skills and abilities often referred to as «know-how».

2. Cognitive dimension. It consists of a mental model, beliefs, principles, ideas, and values, which are deeply embedded within individuals (personal) and which we as individuals take for granted.

3. Explicit Knowledge is codified knowledge that can be transmitted in a prescribed and recognised manner using a systematic language. It is confined in records of the past such as hard and/or soft documentation, databases, and is considered on a chronological basis to perfectly present the particular knowledge extent.

It can be articulated in different ways; such as words and numbers and shared between a community in the form of general data, scientific data, equations and formulas, specifications, operating manuals and guidelines. This type of knowledge can be voluntarily transmitted in an easy way between individuals in an official and systematic manner.

![Figure 4 Iceberg metaphor of Michael Polanyi](image)

It can be summarised that the appropriate definition of knowledge to adopt in this research is the following: «Knowledge is a combination that includes both individual experience and understanding in the organisation and the organisation’s archived information that exists, such as documents and reports, available within the organisation and in the world outside». 
2.5 **Knowledge management process (Add K conversion of Nonaka)**

Significant importance is placed on processes for managing knowledge by the British Standards Institute (BSI) (2003) which defines KM as: «the creation and subsequent management of an environment which encourages knowledge to be created, shared, learnt, enhanced, organised and utilised for the benefit of the organisation and its customers».


Suresh (2006) placed comparable importance upon processes following an extensive literature review and defines KM as «a process by which knowledge is identified, captured, codified, stored, disseminated (shared/transferred), implemented (adapted, transformed, synthesised) and its impact measured for the benefit of the organisation». In connection with such processes, Suresh contends that KM «consists of distinct but interrelated processes that are not linear but can be cyclical and iterative» (Suresh, 2006).

Guido Schryen, Gerit Wagner, Alexander Benlian (2015) research has discovered that having defined our understanding of knowledge, we draw on the theory of (organizational) knowledge creation (Nonaka 1994) to develop a two-dimensional model of knowledge which is based on two constituent dimensions: codification and abstraction of knowledge.

Our empirical analysis also reveals how often the corresponding review types can be found in the IS literature over the past 15 years. Gap spotting reviews amount to almost one third of all IS literature reviews, thereby contributing to the externalization of domain metaknowledge. Perspectival reviews occur rarely; one reason might be that it requires knowledge in other, related disciplines, such as psychology or computer science, and that this combination of knowledge from multiple disciplines is rare.
Egbu and Robinson (2005) identify and go into more detail on a number of these KM sub-processes including:

- **Identification**: identifying people with specific skills, abilities of suppliers and subcontractors, and knowing who to contact when there is a problem are key challenges of KM. Communities of Practice (CoP) can aid the identification of such knowledge, while skills databases can also prove useful.

- **Capture**: where tacit knowledge is transformed into explicit form, including mechanisms such as minutes of meetings, a database for project reviews, and staff reports on external training events they have attended.

- **Storage**: involves recording valuable experience in electronic form to avoid repeating mistakes; train new staff and retain knowledge of staff who leave the organisation.

- **Mapping**: utilises lists and visual representations of the organisation’s knowledge including pointers to people, documents, and databases.

- **Dissemination**: comprising the sharing and transfer of knowledge, there are a variety of techniques and technologies which support the dissemination of tacit and explicit knowledge: telephone communications, storytelling, mentoring, and job shadowing can all contribute to sharing tacit knowledge, while a company newsletter can expedite the transfer of events, best practices, and lessons learned.

- **Creation**: concerned with adding value to previous knowledge through innovation, particularly in developing new skills and competencies of employees. Hussain and Lucas (2004) discuss KM as a process that helps organisations identify, select, organise, disseminate and transfer knowledge. The main focus for creating knowledge was related to researching new ideas and products from external sources. In terms of creating knowledge, it may be created in a purposeful manner, such as through R&D or much more serendipitously through the problem-solving process on a construction project as noted by Kazi, Koivuniemi and Moksøen (2005).

In this regard, they refer to a number of organisational knowledge initiatives:

- Sharing knowledge and best practices
• Instilling responsibility for sharing knowledge
• Capturing and re-using best practices
• Embedding knowledge in products, services, and processes
• Producing knowledge as a product
• Driving knowledge generation for innovation
• Mapping networks of experts
• Building and mining customer knowledge bases
• Understanding and measuring the value of knowledge
• Leveraging intellectual assets

**Difference between knowledge transfer and knowledge sharing process**

In the context of knowledge management process, the author was faced with three different terms that seemed to be synonymous but is related to three different concepts: knowledge transfer, knowledge sharing, and knowledge dissemination. They are considered to have overlapping content. Sometimes they use more than one term when discussing the same concept. After conducting an in-depth literature review, the author selected and adopted the definition that made sharing as a process more related to the interaction between individuals, and transfer to exchange between groups (projects teams, sub-teams), while dissemination terminology comprised both sharing and transfer of knowledge, besides, the development of a high quality of the system storage function is crucial for the knowledge contributors to have an easy and quick sharing process Kamla Ali Al-Busaidi1, Lorne Olfman2, Terry Ryan2, and Gondy Leroy (2010).

For example, one author identifies over three dozen knowledge-sharing barriers in one article (Riege, 2005); in another article the same author uses knowledge transfer as a term when suggesting actions to overcome the same and similar barriers (Riege, 2007). He even refers to his own research in the following way: «Indeed, organisations wishing to make their knowledge management strategy a success need to pay attention to potentially more than three dozen human, organisational and technological obstacles to transferring knowledge». 
A number of authors have attempted to clarify the differences and define terms in order to avoid this confusion and find a dividing line between Knowledge Transfer (KT) and Knowledge Sharing (KS).

The most common differentiation is related to the levels of analysis, in that KS is used habitually by authors focusing on the individual level, while KT is used more when groups, departments, organisations, or even businesses are in focus (Argote & Ingram, 2000).

KM is viewed as a process, where many activities are formed to carry out key elements of an organisation’s KM strategy and operations as Funmilola Olubunmi Omotayo (2015).

Argote and Ingram (2000) describe knowledge transfer as «the process through which one unit (e.g., group, department, or division) is affected by the experience of another».

Saif Al Muzahmi (March 2015) found that Knowledge management is a practice of discovering, capturing, and applying the collective knowledge in an organization to help the organization compete (Meihami & Meihami, 2014).

It is most common during the project execution phase, that the project team (key members in particular) is maintained in a coherent and consistent manner during the project’s life; however, it will be demonstrated later in this research that changes and modifications within the project team can occur from phase to phase. Changes in the project team (if not minor) will impact greatly the maintenance of project knowledge and this will generate negative consequences on the project’s success.

Funmilola Olubunmi Omotayo (2015) says that KM as a discipline has been a focal point of discussion over the past decades. In recent years, the importance of KM has been widely recognized as the foundations of industrialized economies shifted from natural resources to intellectual assets. Saif Al Muzahmi (March 2015) stressed that must be kept in minds in order to ensure absolute success of the tenets of knowledge management that the management of the organization continuously brings a change in its organizational culture. The incumbent corporate culture does not always support sharing practices in the organization (Staroňová, 2014). There is a list of complex tasks that Oil and Gas companies have to deal with, which are considered as knowledge intensive work in the company (Skalle, Aamodt, & Laumann, 2014).
As the above issue related to project team continuity and availability is very important from one project phase to the next, the author of this research study considers that knowledge flow from any project phase to the subsequent phase will be defined and treated as knowledge transfer between independent units.

Figure 5 Different authors’ use of the terms with regards to their level on an individual-industry scale and the type of knowledge over time to indicate the important periods in KM. The publication year (Paulin & Suneson, 2012)

2.6 KM implementation in the construction and oil sectors

In the literature, when developing a formal KM initiative, there are a number of issues to consider. According to both Robinson et al. (2005) and Egbu (2004), the following points should be considered:

- Develop a KM strategy with management and financial support
- Identify the type and nature of knowledge that needs to be managed
- Understand the characteristics of knowledge
Chapter 2  

Literature review

• Develop a knowledge-sharing culture

• Link KM to existing incentives and performance measures

• Provide support from both IT and non-IT tools

• Utilise a KM maturity scale in order to objectively standard KM implementation efforts

The above points are made at a generic level and this research investigates how they can be applied in the oil and gas sector in Libya. That is why the first case study investigated the specific influencing factors of KM implementation in the oil and gas industry in Libya.

John Girard, JoAnn Girard (2015) defined KM as:

• Knowledge Management is the identification and analysis of available and required knowledge assets, knowledge asset related processes, or the subsequent planning and control of actions to develop both the assets and the processes ("Knowledge Management, IBM Glossary."). USA

• Knowledge management is an integrated, systematic process for identifying, collecting, storing, retrieving, and transforming Information and Knowledge assets into Knowledge that is readily accessible in order to improve the performance of the organization (Prior, 2010).

• Knowledge management involves activities related to the capture, use and sharing of knowledge by the organisation. It involves the management both of external linkages and of knowledge flows within the enterprise, including methods and procedures for seeking external knowledge and for establishing closer relationships with other enterprises (suppliers, competitors), customers or research institutions.

In addition to above, Sangeeta Shah Bharadwaj, Sumedha Chauhan, and Aparna Raman (Oct. 2015) said that Measuring KM effectiveness and its contribution to the organizational performance is a key concern of many organizations. As knowledge is an intangible strategic asset of an organization, measuring it is a challenge.
The implementation of a KM programme involves the creation, acceptance, and adoption of processes, values, and systems that are either company-wide or in the very least span across functions, departments, and communities. The implementation and long term success of such far reaching changes require top and central management backing, both from the perspective of resource and political support but also to ensure day-to-day acceptance of such measures Alan Frost M.Sc. (2014).

2.6.1 Critical success factors of KM implementation:

The lack of KM implementation found during the initial interviews led to an investigation of critical success factors (CSFs) to help organisations to understand the context of KM implementation and to develop effective strategies or policies to maximise the probability of success in KM implementation.

The second phase of this research is a case specific study which emerged as necessary to identify the real causes of KM implementation initiative failure and directly reflects to the critical areas or influencing factors of KM implementation (see section 5.1).

In this context, many authors studied the CSFs of KM implementation at a general and specific level.

Borousan, E., Hajiabolhasani, A., & Hojabri, R. (2012) work was reviewed as a study of CSFs relating to oil and gas in Iran. They studied factors that cause problems in implementation of knowledge management oriented to major Iranian oil and gas companies, mostly under the National Iranian Oil Company (NIOC). Borousan et al (2012) considered three major factors can be mined. Culture, information technology, and KM strategy are the three basic factors of KM implementation. The culture factor was considered by them as a broad concept which can be divided into two categories including management and organisational culture, which are both critical in KM implementation. Their research «wanted to find out the main factors that influence KM implementation in Iranian oil and gas companies and can potentially cause problems and make these companies face challenges implementing knowledge management it seems that Iran’s oil and gas industry should be careful about two major factors».

On the study of Mohammad J. Arif and Mohammed Hassan Bin Shalhoub (2014) he found that the author (Chong et al. 2006) confirms that the failure in identifying the critical success
factors and the lack of reference to measure the impact of knowledge management and taking advantage of existing knowledge in development leads to failure of those institutions to maintain competitive advantage and inability to catch up with their peers, considered a freeze or eat their knowledge and which may lead to damage to either the short term or long term.

Compared to management culture and KM strategy, organisational culture and IT infrastructure have more importance in implementation of KM: «Culture and IT infrastructure are two important factors that a lack of them can cause problems implementing knowledge management».

They considered that the management culture factor has a «moderate impact», while the importance of KM strategy is a factor in the first step of KM implementation, which is less than the other major factors.

Laith Ali Yousif AL-Hakim and Shahizan Hassan (February 2012, Vol. 4) said that In short, successful KM implementation requires preparation to create an organisational environment to get the best possible use of knowledge, and a conducive environment of effective KM implementation. Previous studies have identified a broad range of factors that could have an effect on the success of KM implementation.

On a national scale, the work of Khalifa, ZA, & Jamaluddin, MY (2012) relating to the construction industry, and the work of Saleh (2013) related to oil and gas, were reviewed.
Khalifa, ZA, & Jamaluddin, MY. (2012) identified 10 predictors of KM factors in their investigation, classified into four categories: organisation factors, individual factors, technological factors, and KM factors, as illustrated in Figure 6.

The data analysis made by Khalifa et al. (2012), shows that seven out of the 10 predictors of KM found has «a major effect on the decision of successful KM implementation in the construction industry in Libya». In line with previous KM literature, top management support, training and education, knowledge sharing culture, ease of KM use and all KM related factors were found to be positive predictors of KM implementation. Organisational culture does not have a statistically significant effect on the successful KM».

They consider that «organisational culture factors have no significant relationship with the use of KM tools in the construction industry in Libya», and reflected that this was because «this industry is very bureaucratic». They added that «it is hard to motivate employees to share knowledge as indicated by the negative relationship between the independent variable motivation to share knowledge and the dependent variable KM implementation» and that «KM web-based system is highly recommended to solve the problem of lack of motivation of knowledge sharing, lack of knowledge infrastructure in construction industry in Libya».

While according to Laith Ali Yousif AL-Hakim and Shahizan Hassan (February 2012, Vol. 4) is that using quantitative survey research involving 220 mid-level managers, present study empirically tested a proposed theoretical framework that examines the above relationships based on structural equation model. The results show that critical success factors of knowledge management had a statistically significant and direct positive effect on innovation and OP. Most importantly, the findings indicate that critical success factors of knowledge management had a positive and statistically significant effect on organizational performance through the partial mediation effect of innovation. The present study shows the significance of the critical success factors of knowledge management in relation to enhanced innovation and improved organizational performance.

Saleh (2013), in his PhD research, focused exclusively on the identification of critical factors that influence acceptance and adoption of KM systems for the Libyan Public Oil Sector. Based on the works of many scholars from around the world who had undertaken studies on the CSFs that affect knowledge management initiatives in both developed and developing countries e.g., (Alavi, 2001; Al-Mabrouk, 2006; Conley, 2011; Davenport, De Long, & Beers,
Chapter 2  

Literature review

1998; Jennex, Smolnik, & Croasdell, 2008; Kankanhalli, Tanudidjaja, Sutanto, & Tan, 2003; Liebowitz 1999; Liebowitz & Megbolugbe, 2003; Mas-Machuca & Costa, 2012; Saleh 2013) summarised the CSFs in 12 groups as shown in Figure 7.

<table>
<thead>
<tr>
<th>Authors</th>
<th>General Factors</th>
<th>Management Leadership</th>
<th>Information Technology</th>
<th>Organizational Strategy</th>
<th>Measurement</th>
<th>Organizational Infrastructure</th>
<th>Process &amp; Activities</th>
<th>Motivation Aids</th>
<th>Resources</th>
<th>Training &amp; Education</th>
<th>Human Resources</th>
<th>Marketing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skyrme &amp; Amidon (1997)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Davenport et al. (1998)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liebowitz (1999)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>APQC (1999)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zack (1999)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Holsapple &amp; Joshi (2000)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choi (2000)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>McDermott &amp; O «Dell (2001)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alavi &amp; Leidner (2001)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hauschild (2001)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horak (2001)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hasanali (2002)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yahiya and Goh (2002)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chourides (2003)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wong Aspinwall (2004)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hung et al (2005)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wong (2005)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Al-Mabrouk (2006)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conley and Zheng (2009)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machuca &amp; Costa (2012)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 7 Summary of Literature Review that identifies CSFs affecting KM adoption (adopted from Salah, 2013)
Chapter 2  

Literature review

From the above factors that influence the successful adoption of KM systems, Salah investigated just three key elements that, according to him, influence organisational change particularly in Libya. He demonstrated that these play a vital role in KM acceptance and adoption in the Libyan oil sector. The first concerns organisational culture. The second dimension is concerned with training and education, while the third relates to the information technology infrastructure.

Table 3 Categories of Critical Success Factors of KM acceptance and adoption in the Libyan oil sector particularly according to Salah (2013)

<table>
<thead>
<tr>
<th>Category</th>
<th>Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Information technology infrastructure: IT equipment; availability of KMS technologies in the oil sector</td>
</tr>
<tr>
<td>2</td>
<td>Organisational culture: top management role; organisational profile</td>
</tr>
<tr>
<td>3</td>
<td>Education and training: training programme efficiency; education level</td>
</tr>
</tbody>
</table>

2.6.2 K implementation barriers

Some authors consider that the relationship between a barrier and success factor is counterbalanced in such a way that overcoming a barrier means a success, and success factors can be derived from barriers. Potential barriers to K management, therefore, reflect CSFs in KM implementation.

That is why a literature survey of knowledge sharing barriers was conducted, as it is considered the key process of knowledge management implementation.

Many barriers cited in the literature, can inhibit persons from sharing their knowledge, such as the lack of time needed to put it into a form appropriate for sharing, ignorance of what knowledge needs to be shared (Levy, Hadar, Greenspan, & Hadar, 2010), fear of publishing something secret (Paroutis & Saleh, 2009), and the lack of an organisational culture and/or structure that fosters knowledge sharing (Ling, 2011).
A summary of the potential of some barriers to successful KM implementation cited by these authors are identified in Table 4.

<table>
<thead>
<tr>
<th>Barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of time and money</td>
</tr>
<tr>
<td>Temporary, project-based and dispersed</td>
</tr>
<tr>
<td>Employee resistance</td>
</tr>
<tr>
<td>Poor organisational culture and structure</td>
</tr>
<tr>
<td>Piecemeal, ad hoc adoption</td>
</tr>
<tr>
<td>Problems of measurability and validation</td>
</tr>
<tr>
<td>Lack of understanding of the benefits of KM</td>
</tr>
<tr>
<td>Conflicting orientations to change and lack of sensitivity to context</td>
</tr>
</tbody>
</table>

However, four barriers not listed in the initial literature survey emerged from data collection in Phase 2: lack of trust, fear of losing power, job security, and fear of being judged as failing.

Thus, a more in-depth literature investigation relating to these three discovered barriers was done in retrospect.

- **Lack of trust**

Trust is one of the significant factors which have strongly influenced individuals to share knowledge (Al-Alawi, Al-Marzooqi, & Mohammed, 2007; Fathi et al., 2011; King, 2006; & Szulanski, 1996) Reciprocated and communal trust improves the communication between employees and produces more knowledge sharing. Employees normally fear sharing knowledge due to competition existing among them and this may result in losing power in the firm. However, when trust exists between individuals, it is not seen as a threat by individuals who want to share this knowledge with colleagues (Fathi et al., 2011).
According to Goh (2002), trust in a firm happens when information is available to employees and the organisation has a system of rewards and recognition for those who share their knowledge. «In a climate of low trust, employees will not share their knowledge well» (Goh, 2002).

Riege (2005) believed that when people fear that their knowledge will be altered or are not sure about the strength of the source of knowledge, they will not share their knowledge. Riege also mentioned that trust will have consequences on the communication process and, in the end, the quantity of knowledge that will be shared.

Levin, Cross, Abrams, and Lesser (2002) argued that knowledge sharing occurs more in fragile ties when intensity of trust is constant, because people desire to learn more and join more with people with diverse information, but where ties are strong, people may have similar knowledge. It was supposed by Levin et al. (2002) that the nature of knowledge has an effect on the importance of trust. It is also argued that when the knowledge is mostly tacit and mainly gained by experience, trust in competence is more important.

- **Fear of losing power and job security**

Fear of losing power and job security are other important factors that may influence knowledge sharing in the organisation.

According to Szulanski (1996), fear of losing power/influence in the organisation is an important knowledge sharing barrier. When individuals think that they will lose ownership, or a position of privilege and superiority, if they share their knowledge, then they will not share it.

- **Fear of being judged a failure**

Fear of being judged a failure is another important barrier. «We assume that everyone did the best job that they could, given what they knew at the time. We are not here to pass judgment on what happened but to learn and grow from our collective experience» (Kerth, 2008).

**2.6.3 Role of HRM**

Human Resource Management (HRM) emerged as playing a role in KM implementation during the second phase of research.
A number of authors have identified different areas where KM and HRM overlap.

Gloet (2006) posits that «Interest in the relationship between KM and HRM has increased over recent years as both KM and HRM have grown more sophisticated and complex». While Theriou and Chatzoglou (2007) recognise this relationship, they argue that human issues are ignored in many KM initiatives, and that the KM literature has made only inequitable and limited use of HRM concepts and frameworks. Edvardsson (2008) thought that «knowledge is dependent on people and that HRM issues, such as recruitment and selection, education and development, performance management, pay and reward, as well as the creation of a learning culture, are vital for managing knowledge within firms».

Storey (2005) identified HR-linked interventions that can be related to knowledge work, such as employment, work and organisation design, development (including training, learning, personal development and career management), and performance management.

Jashapara (2004) identified a number of HR interventions that can aid the successful implementation of a KM initiative, including: employee involvement, employee communication, training and development, appraisals, reward and recognition, and performance, while Koch (2003) identified two important means of developing organisational knowledge resources: recruitment and training. Appraisals and reward systems, job design, organisational culture, job security, internal promotion, and career opportunities, are areas recognised as requiring further consideration in terms of the role of HRM in KM (Hislop, 2002).

According to Olomolaiye and Egbu (2004), «if KM is to succeed in organisations, HR practices and policies should be designed to facilitate a mechanism that brings people together, either formally or informally».

Training can provide HR with an opportunity «to mix together employees from different parts of the company who do not normally interact with one another» (Lengnick-Hall & Lengnick-Hall, 2005).
Chapter 2

Lengnick-Hall and Lengnick-Hall (2005) suppose that HR plays a role in promoting informal networks, where «people know each other and help each other regardless of rank, function or job title».

Meetings, conferences, social events, employee round tables and internal electronic communication networks, are other areas where HR can become involved.

Svetlik and Stavrou-Costea (2007) identify common «activities and goals when creating work units, teams, cross-functional cooperation, as well as communication flows and networks inside the organisation and across its borders».

2.6.4 Role of ICT

Technology plays a significant supportive role in KM initiatives. Several authors, such as Payne and Sheehan (2004), Tiwana (2000), and Walker, Wilson, and Srikantan (2004) claim it is evident that technology has a great contribution to make as it has a central role in knowledge management in any organisation; it supports the right to use soft access systems, sharing, and the use of knowledge in a flexible manner, as appropriate to the concerned project concerned.

However, in this respect Carrillo, Robinson, Al-Ghassani, and Anumba (2004) dispute that IT facilitates the identification and sharing of knowledge, as several earlier attempts to capture personal experiences had proved ineffective. Within this context, Prusak (2006) declared «IT systems do not manage knowledge, they manage data and information». Having said that, surely there is a need to integrate technologies that enhance existing work practices; with the development of an IT system and strategy within the organisation, it is important in improving knowledge effectiveness (Egbu & Botterill, 2002).

Moreover, according to the BSI (2003), «KM does not necessarily need complex and expensive technologies». Intranets, according to Payne and Sheehan (2004) «are widely used as the single point of access to an organisation’s knowledge». They are mainly practical, as Al-Ghassani, Kamara and Anumba (2004) indicate «in large construction organisations that are often geographically dispersed». Dainty, Qin and Carrillo (2005), in their KM study pertaining to the importance of the intranet, focused particularly on the role of Human Resource activities as being a very important resource. In this regard, it is important to point out that technology operates not only to support people to access the desired information, but
also it facilitates people’s contacts with other people (individuals and groups), «to encourage the sharing of tacit knowledge and the generation of new ideas» (Payne & Sheehan, 2004).

2.7 KM in project organisation

In oil and gas projects, new daily problems are encountered and solutions emerge that are rarely recorded and documented, according to Kazi, Koivuniemi and Moksen (2005). The lessons learned reside only with those individuals directly involved in the problem-solving process.

According to Graham and Thomas (2008), «by capturing and sharing project knowledge, the amount of reinventing the wheel and waste can be reduced, whilst improving project performance».

According to Saif Al Muzahmi (March 2015) that Knowledge management is considered important in business organizations since business exists. Firms need to create and manage knowledge to compete in the market and to take more market share though innovation and creativity which come with knowledge management. Knowledge management let the management to bring creativity and innovation in its operations and products.

In a case study of a Finnish construction organisation, Kazi et al. (2005) recognised a number of social processes for sharing project knowledge, for example, site visits, audits, and meetings.

2.7.1 Projects and project management

Project management definition and practices in Libyan oil and gas companies do not exist under the umbrella of the three major international project management standards: PMI, PMJ and PRINCE 2.

Project management is defined by the British Standard in Project Management (BS 6079) as the planning, monitoring, and controlling of all aspects of a project, and the motivations of all those concerned by it, to achieve the project objectives on time and to the specified cost, quality, and performance (Management, 1996).

The Project Management Institute’s Body of Knowledge guide (PMBOK) defines a project as «a temporary endeavour undertaken to create a unique product, service, or result» and project
management is defined as the application of knowledge, skills, tools, and techniques to project activities to meet the project requirement» (PMI, 2008).

In addition, project management is used to illustrate the organisational approach to the management of in-progress operations (PMI, 2000).

In project environments the main objective of utilising Project Management tools is mostly to assist in facilitating the work process related to the overall management and control of the project, and to accomplish its objectives in terms of safety, quality, time and cost, as per its approved development plan.

In this respect, the use of project management includes planning, scheduling, monitoring, and controlling of all project activities, in order to guarantee that a project is executed according to the plan originally put in place to complete the project successfully (Project Development Plan) with minimum acceptable deviations in accordance with the organisation’s procedures.

According to the various definitions, it is evident that the key factor that distinguishes a project from other forms of management is the life cycle, as well as the management skills and actions involved in going through that life cycle.

A project is, by nature, a temporary work environment, where the cited rules between a company and its contractors and sub-contractors to manage this temporary relationship in commercial and contractual terms terminate when the project scope is concluded and handed over to the company.

It is common that each project differs in its main scope and characteristics, such as size, type, location, objectives, contractor, price, etc. For this reason, every project is considered unique and also complex in terms of the technical, commercial, authority interfaces and community factors involved.

Sandhu (2005) argues that project management includes the application of knowledge, skills, tools, and techniques to project actions and processes in order to meet stakeholders» requirements and hopes with respect to that project.
Chapter 2  

Project management has also been seen as the discipline of managing projects so that their principal objectives can be met; objectives normally being defined in terms of time, cost, technical performance, and scope (Morris, 2001).

According to S. Abouen, V. Ahmed, G. Aouad (2014), Project management can be applied to any project regardless of size, budget or timeline. Project management helps organisations meet their customers’ need by standardizing routine tasks and reducing the number of tasks that could potentially be forgotten. It ensures that available resources are used in the most effective and efficient manner.

Other popular definitions of projects and project management are offered in other guides or frameworks such as Managing Successful Projects with the PRINCE2 guide.

A project is defined in the PRINCE2 guide as «a temporary organization that is created for the purpose of delivering one or more business products according to an agreed business case» (OGC, 2009, p. 16). In other words, according to PRINCE2, a project is «the planning, delegating, monitoring and control of all aspects of the project, and the motivation of Knowledge Management in Projects of those involved, to achieve the project objectives within the expected performance targets for time, cost, quality, scope, benefits and risks» (OGC, 2009, p. 17).

PRINCE2 is a framework used mostly in Europe and Australia in project management; it has recently become more widely used internationally.

Alternative definitions for projects and project management are manifested by the Project Management Association of Japan (PMAJ).

PMAJ and the Project and Program Management guide are very highly regarded by the project management professionals in Japan.

According to PMAJ’s Project and Program Management guide (P2M), a «project refers to a value creation undertaking, which is completed in a given or agreed time frame and under constraints, including resources and external circumstances» (PMAJ, 2005, p. 15).

The PMAJ considers project management as «the professional capability to deliver, with due diligence, a project product that fulfils a given mission, by organizing a dedicated project
team, effectively combining the most appropriate technical and managerial methods and techniques and devising the most efficient and effective work breakdown and implementation routes» (PMAJ, 2005, p. 16).

After going through the three definitions of project and project management, it can be noted that all have similarities and complement each other.

In conclusion, it is certain that the key objective of project management is to make sure that a project is completed within the necessary scope required by the stakeholders, within project budget, on time, and with the desired quality of product or service.

### 2.7.2 EPC projects

The usual international and Libyan development sequence of projects for the oil and gas industry starts from the Evaluation Phase, progressing through Concept Selection, Concept Definition, Execution or Construction, Start-up and Handover Phase. In the literature there are a number of slightly different development styles, such as those of the Project Management Institute and British Standards Institute (Dixon, 2000). All those and others have accurately distinguished a project’s work environment from the non-project environment. The more common project life cycle sequence is as shown in Figure 8 (Evaluation – Concept Selection – Concept Definition – Execution – Start-up and Handover)

![Figure 8 Common project life cycle sequences](image)

G1: Gate 1  
G2: Gate 2  
G3: Gate 3  
HO: Hand Over  

The Engineering, Procurement, Installation and Commissioning (EPIC) type of Projects contracting scope (contract strategy) is an important area of Project Management applications, since this specific, unique, complex and discontinuous environment has its own particular
nature; in the oil and gas industry it involves big to huge investments and high exposure to risks that can be generated during the work development span.

Projects are categorised by their differences in the scope or the product that they will deliver at the end date (completion date), technical and contractual responsibility and schedule. Scope is the total deliverables to be developed through the project life process. The varieties in the scope classify projects into different types. Cova (2002) referred to sub-contracting, partial projects, package agreement, turnkey projects, and turnkey plus projects. In many studies (e.g., Artto et al., 1998; Bergen, 1990; Hirschman, 1967; Holstius, 1989; Luostarinen & Welch, 1990; Owusu, 2003; Vanhoucke, 2001; Wikstrom, 2005) project business is organised in one of the following common ways: partial projects, sub-contracting projects, package agreements, turnkey projects, and turnkey plus projects.

The terminology used to describe various projects differs among the scope and specialists participating. In project based organisations, six common types of projects can be recognised.

- In the case where the company/contractor supplies (delivers) only equipment to a client this is known as equipment delivery (ED). The purchase order for these equipment deliveries includes general management, procurement, manufacturing, and delivery. Such deliveries can be with or without supervision of installation (it depends on warranty extent and requirements), however, in most cases support for the commissioning, and start-up of machinery in a project is included within the delivery scope.

- In the case where the company (owner)/contractor supplies equipment along with design and engineering activities of a project, this is known as equipment with engineering delivery (EEQ).

- In the case where the company /contractor supplies engineering, procurement, and construction, these are known as engineering, procurement, and construction (EPC) projects. For instance, an EPC project can be with or without civil work. The client/buyer (Company) is not involved in the detailed day to day activity management and coordination activities belonging to the various technical and managerial aspects. However, this concept is not rigid. It depends on the Company and to what extent it needs to be involved; Company involvement is generally linked to the project complexity and scope.
• In the case where the project is executed offshore (no matter if in shallow or deep water) the company (owner)/contractor supplies engineering, procurement, installation and construction, these are known as engineering, procurement, installation and construction (EPIC) projects. The client/buyer is not involved in the detailed day to day management and coordination activities belonging to the various technical and managerial aspects of the project. However, this concept is not rigid as it depends on the Company and to what extent it needs to be involved, Company involvement is generally linked to the project complexity and scope.

• In the case where the seller/contractor is further involved, with extended responsibilities to operate and maintain a project for a defined period of time, this setup is recognised as EPC or EPIC with operation and maintenance (O&M). This work frame is more common in offshore projects, where the client usually takes more time to prepare their operational and maintenance team to take full responsibility.

• In the case where clients (Company/stakeholders) develop or construct by themselves, this arrangement is named Develop, Construct and Own (DCO).

• The above illustrated definitions are based on the more common setups used by industry and exposure and experience of the researcher, having being in industry for over 25 years.

2.7.3 Project success

After going through the three different project and project management definitions of PMI, PMJ, and PRINCE2, the same associations were consulted for the investigation of project success.

The PMBOK stated that project success is certainly influenced by the increase in project management indicators, the application of appropriate knowledge, process, skills, tools, and techniques (PMI, 2008).

According to PRINCE2, there is a set of principles, themes, and processes to deliver a successful project according to the business case. The company event, based on the guide, presents the maximum mix of data applied to judge whether the challenge is attractive, remains attractive throughout the challenge lifecycle, and is feasible and possible and, thus, worthwhile purchasing from the stakeholders» perception (OGC, 2009). PRINCE2 claims that
a critical accomplishment component of any challenge is that it produces what an individual needs and sees as acceptable (OGC, 2009).

The P2M adds extra dimensions for the criteria of project success. It states that, to be able to complete a task successfully, it is necessary to formulate a well-integrated plan that takes into account budget, and time, along with health, security, and environment (HSE) aspects of the project (PMAJ, 2005).

Belqais Allali, Kaushal Keraminiyage, Udayangani Kulatunga (2014), Practices can involve capturing, organizing, sharing, and using knowledge. They argued that if firms did not think about allocating SK as part of the business strategy, then the business can become subject to stagnation. Hovorka & Larsen, (2006) stated that staff knowledge and skills are fundamental elements in agility. Firms adopting this strategy pay more attention to managing and leveraging knowledge. Agility is likely to be associated with an firm's ability to integrate, use and share knowledge. Jones et al., (2006) argued that organizational strategic level mechanisms are essential to facilitating knowledge sharing and usage.

Generally speaking, project success could be judged as the project being completed within time, cost, and quality. However, Turner (2009) argues that this definition is simplistic and even dangerous. He gives a typical example of a task that was finished on cost and in time, but five years later was judged a failure. Turner states that different stakeholders, for example, sponsors, users and project managers, determine project success in various ways and it is very important to reach a harmony of those different requirements, to join up the requirements of the different stakeholders (Turner, 2009). Kerzner (2009) believes that it is one of the hardest tasks to predict whether a project will be successful. Jobs shipped punctually, within charge and conference efficiency demands, may contribute to profits, but we might not be able to recognise whether the project itself was managed correctly (Kerzner, 2009).

In addition to the traditional meanings of project success from different courses or frameworks, Turner (2009) provides seven requirements for evaluating project success:

- The project escalates the shareholder price of the parent organisation.
- The project produces a profit.
- The project offers the specified efficiency improvement.
Chapter 2

- The newest advantage operates as expected.
- The newest advantage generates an item or offers something that people want to buy.
- The newest advantage is simple to operate.
- The project is completed punctually, to budget, and with the specified quality.
- The project staffs have a satisfactory knowledge and the project achieved their needs.
- The companies produced a profit.

Turner stresses that project success must harmonise the requirements of everyone in the organisation. The project success requirements pay attention to success as a whole. The most effective three factors relate to genuinely higher-level strategic goals. The middle three factors relate to the project’s outcome on whether the project shipped the thing that was expected. The final three factors measure the operations of the project as well as the outputs of the project (Turner, 2009).

2.7.4 Project Knowledge Management

Few studies have attempted to fully capture the use of information management in project conditions (Disterer, 2002; Jagadeesan & Ramasubramanian 2002; Kotnour, 1999; Kasvi, Vartiainen, & Hailikari, 2003) and none have attempted to separate tasks into categories.

Disterer (2002) showed responsibility for transferring information and experience generated from a temporary project business environment to a permanent business was assigned to project management. The data transfer illustrates the transfer of both the project outcome and about the roles and instructions made throughout the project. The transfer of the information about the project results or outcome might be documentation-based (e.g., archives, paperwork, images, etc.) or process-based (e.g., training).

In addition, Disterer (2002) also claims that the instructions made out during the project cannot be moved in the same manner as the information pertaining to project results. Thus, two types of information management techniques should really be utilised in a project task, one to fully capture information about the project outcome, and one to fully capture information and experience about procedures and functions in the project. To capture the
information and experience about procedures and functions, Disterer (2002) suggested that in the project management organisation there should be jobs designated to determining and acquiring knowledge. The challenge is that these management approaches provide new and dynamic ways of managing information requiring the constant improvement of knowledge management approaches. Moreover, the industry faces challenges in coordinating the geographically dispersed workforce in offering support to knowledge management development and knowledge capturing Saif Al Muzahmi (March 2015).

Gholamreza Jandaghi, Hamid Reza Irani., Zeinab Sadat Mousavi, Maryam Davoodavabi (2014) study, Knowledge management enablers in an organization encourage knowledge development, knowledge generation inside the organization as well as sharing and protecting it (Yeh et al, 2006). Applying such process improves knowledge processes and enhances organizational knowledge by linking knowledge management with organizational strategies. Also, it provides proper guidelines to compensate current deficiencies and helps organization to keep its competitive advantage. In present study and after brief study of knowledge management concepts by identifying and considering affecting factors on management success and knowledge management enablers, research hypotheses were revealed to evaluate organizational readiness to execute knowledge management in both individual and organizational sections.

2.7.5 Temporary and permanent organisations» knowledge management

Several reports consider mechanisms of learning and knowledge-sharing in short-term organisations (project environment in the subject study). Prencipe and Tell (2001) created a first concept of learning mechanisms in project-based firms. Giving a scientific basis for learning practices during job execution, Keegan and Turner (2001) investigated 19 organisations across Europe to recognise essential facets influencing learning from and through projects.
KM in short-term companies involves different kinds of knowledge linked to specific knowledge transfers involving the short-term company along with the permanent company. Disterer (2002) further argues that, for a company as well as a task manager to have the ability to control complicated tasks, it has to handle and use knowledge from the permanent company and from other projects. This is illustrated in Figure 10 below.

2.7.6 KM and PM

A strong relationship between KM and PM emerged in the first phase of research, was proved in the second phase and developed during the third phase. This relationship can be summarised as follows:
Knowledge derived from a project is an essential part of created K in the organisation (phase 1)

KM activities can be aligned with project management activities (phase 1)

PM factors are the major influencing factors of KM implementation in a project environment (phase 2)

KM contributes to project execution success (phase 3)

KM should be aligned with PM from the beginning to the end of a project (phase 3).

In the literature, the link between KM and PM is often represented as KM in project environments. Lytras and Pouloudi (2003) explained the meeting of both areas as cognitive repetition of knowledge function in different configurations.

Timur Narbaev (2015) stated that the PM methods and techniques have been successfully applied to managing complex activities in different industries (Narbaev and De Marco, 2011; Narbaev and De Marco, 2014; Tsekhovoy, Nekrassova and Karmazina, 2014) turning it into multi-disciplinary field of knowledge and application.

Leseure and Brookes (2004) mentioned that the essential part of knowledge is knowledge drawn from projects. Therefore, from the point of view of project management, kernel knowledge management is essential in order to transfer knowledge within project teams or across them. They affirm that flaws in knowledge management are produced in inadequate actions within an organisation and low project performance. According to their empirical analysis, the main issue in knowledge management in projects is the building of collective knowledge.

Tacit knowledge management possessed by experts is also a critical challenge for effective project management. Furthermore, Reich (2007) identified 10 main knowledge-based risks that might affect project management considerably, such as flaws in learning from past project lessons, problems in integrating and transferring knowledge, lack of a knowledge map, and volatility in governance. To manage those risks, Reich set five knowledge-related initiatives: establish a learning climate, establish and maintain knowledge levels, create channels for knowledge flow, develop team memory, and use the risk register.
Moreover, Lierni and Ribière (2008) examined precise KM practices that are mainly helpful for the development of project management. They emphasised the need for organisations to have the «right knowledge» to the «right person(s)» at the «right time» in order to reduce project schedule and cost, and to augment project quality. The authors assured that «knowledge management enables a project team to reduce doing rework and compresses the time that it takes to plan projects» (Lierni & Ribière, 2008).

Knowledge management enhances communication within project teams, ensuring a more thoughtful sharing of project objectives. It provides best practice consciousness, lessons learned, project management methodologies, and techniques (Liebowitz & Mgbologbe, 2003). Leseure and Brookes (2004) also argued that «KM and PM can only go hand in hand».

Furthermore, projects, «whether or not we choose to think of them as temporary organisations, involve considerable knowledge processing» (Reich, 2007). Reich also conducted extensive research on knowledge-based risks in IT projects. She planned to follow a project from a knowledge view. From that perspective, a project was meant to be a ground for knowledge creation, utilisation, and sharing, where learning is important for project performance and success. Initially, KM was studied in academic literature mainly in organisational contexts, emphasising permanent organisational learning (Reich, 2007).

As the author attests, there is a wide space between extremely theoretical KM literature and more practical and non-conceptual PM literature. Thus, Reich attempted to incorporate all the main ideas from academic and practitioner literature on KM and PM and create a model. Knowledge is more and more important and almost all aspects within the organisation can be explained in knowledge–based terms using knowledge management concept and models (Reich, 2007). Reich constructed a model adopting as a base, the three domains suggested by Rosemann and Chan (2000) for KM investigation in projects.

«KM in the context of a project is the application of principles and processes designed to make relevant knowledge available to the project team. Effective KM facilitates the creation and integration of knowledge, minimises knowledge losses, and fills knowledge gaps throughout the duration of the project» (Reich, 2007).
2.7.7 Project knowledge management models

In accordance with Ismail and Marjani (2009), regardless of the considerable literature on knowledge sharing, little is known about how people share knowledge, particularly in a project environment. The authors have proposed a theoretical K framework that specifies that given suitable motivators and inhibitors to sharing knowledge, and effective sharing of knowledge in tasks, this enhances the chance of project success. Their model proposes major links between effective project knowledge sharing practice and project success.

The model was based on Nonaka’s Knowledge Conversion Model (called the SECI model) and targets the socialisation of tacit knowledge that is presently a difference in most project environments. The authors concluded that ensuring when and how tacit and explicit knowledge is provided is essential for enhancing project success (Ismail & Marjani, 2009).

\[
\text{Figure: 11 Proposed theoretical framework for project knowledge sharing - contribution to project adapted from (Ismail & Marjani, 2009).}
\]


According to the above mentioned author, “the process of EPC project management is also the process of knowledge management”. When the knowledge is converted into concept, the relationship between concepts and its attribute becomes easier and clearer to integrate.
Their framework is based on the alignment between the project knowledge management and project management as «there is no established system between EPC project management and service standards at present in the developing countries» the case of China is not so far from the case of Libya that’s why the alignment property between K and project management was equally used in the research of the framework to guarantee the suitability of framework. However, contrasting to the research framework focused on the oil and gas sector, Zhu et al. framework was not directed to any specific sector adopting the EPC type of project management, the research framework should be more specific and based on the specific intervening conditions, knowledge development and projects practices of oil and gas sector.

![Figure 12: The evolution path of general contract knowledge system (Zhu et al. 2014)](image)

In order to transfer existing multidimensional historical data from completed projects into useful knowledge for future projects, Hammad & AbouRizk (2014), proposed a modified hybrid Knowledge Discovery in Data (KDD) model, based on data mining techniques to extract useful knowledge from project data sets.

Data mining according their definition is «the analysis of observational datasets to find unsuspected relationships and to summarize the data in novel ways that are both understandable and useful to the data owners». 
It comes after the problem resolving process and data reporting steps and before the evaluation of discovered Knowledge as shown in the Figure 13.

Even if the KDD model is not specific to EPC project types, the data and Knowledge management steps outlined by this model are similar to the knowledge creation initiatives management steps described by the developed LL tracking system in chapter 7.

The proposed LL tracking system during this research is more developed and depends of the EPC project phases but it is based on the following similar steps: collection of K creation initiatives issued from problem resolving process, validation of the initiatives and then reusing of the created and validated knowledge.

In addition, data mining was used by the researcher in the current research, during the second case study to capture the K creation initiatives from projects documents as it will be described in chapter 6.

As the KDD model was applied to three different case studies to test its ability and it leads to extract useful knowledge from datasets, it can triangulate the results of the current research and support the developed LL tracking system.

![Figure 13 Modified hybrid KDD model (Hammad and AbouRizk 2014)](image-url)
2.7.7.1 Lessons learned (LL)

The importance of managing lessons learned within knowledge management is proven in the literature.

Senge (1994, p.49) defined learning in an organisation as «the continuous testing of experience, and the transformation of that experience into knowledge – accessible to the whole organisation, and relevant to its core purpose».

In a first step, a broad and general literature review of LL was done. Then, after specific facts related to LL in an EPC project emerged, a second step of the literature review was conducted concerning managing the LL.

According to Secchi, Ciaschi and Spence (1999), a lesson learned is «a knowledge or understanding gained by experience. The experience may be positive, as in a successful test or mission, or negative, as in a mishap or failure. Successes are also considered sources of Lessons Learned. A lesson must be significant in that it has a real or assumed impact on operations, valid in that it is factually and technically correct, and applicable in that it identifies a specific design, process, or decision that reduces or eliminates the potential for failures and mishaps, or reinforces a positive result.

A lesson learned can make reference to an optimistic experience, in case of successful effects, or even to a negative experience, in case of deteriorating processes, flaws or undesirable influences, (ILO Global Labour Firm, 2014). Lessons learned can be based equally upon good experiences that obtain organisational targets, and on negative experiences that result in undesirable outcomes.

2.7.7.2 LL process

- **Collection (identifying and capture)**

«Identifying and presenting lessons learned is an exercise to recognise and document the richest and most meaningful lessons gained from project events» (ILO, 2014).

The identification and recording of a lesson is a very difficult method, (Kartam, 1996). Two approaches have already been discovered for collecting LL; a «sought input» type collection method, in which a custodian of the LL obtains insight from different agencies (Fisher et al., 1998) and a necessity for people to submit LL themselves (Kartam, 1996).
There are numerous strategies and processes regarding project reviews but the main concentration is that the lessons learned should be incorporated right back into the knowledge base of the organisation in order for learning to take place.

«There are various methods and processes regarding project reviews but the main focus is that the lessons learned should be incorporated back into the knowledge base of the organisation in order for learning to take place» (Maluleke & Marnewick, 2012).

Disterer (2002) identified LL collection tools, such as post project reviews and debriefings.

**Documentation**

The usual way to deal with LL is through documentation. However, in practice it has been proved that these studies are usually imprecise, hard to locate, or tough to comprehend. An alternative way is the use of requirements, but the presence of a huge level of requirements that are not technically consistent or applicable is a problem (Andrade et al., 2007). The key reason to document LL, as Carrillo (2005) claimed, is when project teams separate to work on other projects. If classes are not described at the project close-out, specific and also collective knowledge previously acquired is likely to be lost. Indeed, LL documents provide a chance to record that knowledge to make it workable and available through the organisation and, thus, to prevent knowledge loss.

Some dilemmas that ought to be taken into account as critical factors when documenting LL were recognised by Gordon (2008) and there is some interest provided in the language used. Hence, Gordon proposed that popular and relaxed language should be utilised and the author should be mindful of and shun using technical terminology, slang, and abbreviations.

Greer (2008) argues for the importance of researching and documenting excellent and bad experiences, adding that the report must be seen by the project manager or the team head and then be shown professionally, correctly and fairly to all the involved parties.

**Evaluation of LL**

A lesson learned may become an «emerging good practice» when it shows proven marked results or advantages and the evaluator determines whether it contains duplication or can be up scaled to other ILO projects.
Emergent good training must show distinct potential for substantiating a cause-effect relationship and can also display potential for reliability and broader application. It can be uncovered by contrast and analysis of activities across multiple options and planning sources, or arise from a straightforward, theoretically specific intervention (ILO, 2014).

- Disseminating LL

There are several approaches to the dissemination of evaluated lessons learned according to the ILO (2014). Lessons learned can be:

- Directly communicated to the relevant stakeholders either during stakeholder workshops or by line management soon after the evaluation takes place.

- Put on the public website, with the full report available upon request.

- Produced as reports listing the text of lessons learned identified in independent evaluations and searchable by thematic criteria, and exportable as a management report in Excel.

- Disseminated by the project manager and the evaluation manager to relevant stakeholders through formal and informal meetings.

- Disseminated by technical specialists in headquarters and the field and shown to interested officials in the office.

- Disseminated at conferences, workshops, training sessions, or seminars.

The dissemination of LL can occur by two methods: push and pull.

Push methods offer the LL straight to the user based on their position, interests, instruction and experience, while pull strategies leave the burden of research to the user, who should give their awareness of the foundation (Weber & Aha, 2002). In that situation, Weber and Aha (2002) examine the distribution gap which refers to «the difficulty of transmitting lessons between a lessons learned repository and its prospective user».

This can arise for several reasons: circulation is not an element of organisational processes, consumers may not know or be reminded of the repository, consumers may not need the full time or skill to recover and read textual classes and, consequently, use the classes successfully.
Chapter 2  

(Weber & Aha, 2002). An examination by Fong and Yip (2006) discovered e-mail or published papers were probably the most appropriate circulation channels for classes to construction specialists, with intranets or sites having the smallest amount of appropriate use.

2.7.7.3 Effective lessons learned

At general scale and according to the ILO (2014), there are four key elements of LL:

- A lesson learned can refer to a positive experience, in the case of successful results; or to a negative experience, in the case of malfunctioning processes, weaknesses or undesirable influences.

- A lesson learned should specify the context from which it is derived, establish potential relevance beyond that context, and indicate where it could be applied and by whom.

- A lesson learned explains how or why something did or did not work by establishing clear causal factors and effects. Whether the lesson signals a decision or process to be repeated or avoided – the overall aim is to capture lessons that management can use in future contexts to improve projects and programmes.

- A lesson learned should indicate how well it contributes to the broader goals of the project or programme and establish, when possible, if those goals align appropriately with the needs of beneficiaries or targeted groups.

Although these four cited key elements of LL management were important, it was still necessary to conduct a deep literature review related to LL management within an EPC project.

2.7.7.4 LL in EPC projects

In this regard, Kamara et al. (2003), Orange et al. (1999), and Busby (1999), in their studies of LL in the project environment, stressed the significance of LL capture at the end of a project’s execution period, through a post project review session to be conducted by project teams with the attendance of other project staff external to the project team.

Busby (1999, p. 23) concluded that «post-project reviews were important learning
mechanisms and their value seems to be underestimated by individuals who do not appreciate the need to disseminate insights throughout the organisation.

In a study of the improvement of UK companies with regard to LL practices, Carrillo (2005) investigated five areas of concern within the most famous Canadian EPC companies addressing lessons learned on their construction projects:

- Commitment,
- Timing of LL sessions,
- Participants,
- Format for documenting LL
- Dissemination method.

Carrillo built a number of recommendations on how the process of LL may be improved in the UK in these five areas.

Nearly all writers referred to the post project review conference to collect LL, but few writers talked about tracking knowledge throughout the project phases.

Kasvi et al. (2003) introduced the thought of a project memory system and explained that it must not handle only codified knowledge like databases and documents but also the contexts and (social) functions behind these documents. To effectively materialise this and have it stored in the system as personalised knowledge, it requires extra effort from a project team and support within the organisation to put in place essential techniques such as particular relationships and dialogue workshops that should take place frequently during the project’s life. The dependence of knowledge-sharing mechanisms on situation facets is underlined by Boh (2007) who produced four knowledge-sharing mechanisms for distributed knowledge in short-term agencies.

### 2.7.8 Limitations in the current knowledge management theories

An in-depth review of the existing KM literature has identified some limitations in today’s KM theories. These theoretical inadequacies and the problems faced by project based
organisations in KM, offer an enormous range for further research in the subject. The concepts, ideas and frameworks mentioned have presented fantastic contributions to the field of knowledge management. However, in the situation of project based organisations, they have many limitations.

Perhaps the key issue is that these concepts are insufficient and a thorough view of knowledge management in distributed and project based organisations is required. Croasdell et al. (2002) help this position and note that the KM research neighbourhood is still at a principle creating stage.

Geoff Turner and Clemente Minonne (2010) said that knowledge and skill of employees is one of those factors and it requires proactive management attention. With cultural integration being considered a prime contributor to the success of KM practice, it is critical for the development of an organisation’s KM culture to have senior management involved to the extent of practising what they preach.

Though disparate, a lot of the current KM concepts and frameworks emphasise one or perhaps a few organisational factors. For instance, Nonaka and Takeuchi (1995) provide good insights to the forms of knowledge and ways of knowledge creation. A few cases were studied from Western and American corporations, such as Honda, Cannon, NEC, GE, and Kraft, to demonstrate the ways of knowledge creation. However, the theory concentrates too heavily on the method of knowledge creation while sidelining other elements, such as organisation and diffusion of corporate knowledge. The writers give little attention to knowledge integration, and tend to underplay the position of engineering in knowledge management.

The results suggested that an individual's knowledge sharing behavior to KMS was motivated by organizational-culture dimensions (such as management support and rewards policy) and the system technical characteristics (such as system quality). Information technology service quality and peers trustworthiness were not significant motivators on individual knowledge sharing behaviour Kamla Ali Al-Busaidi, Lorne Olfman2, Terry Ryan, and Gondy Leroy (2010).
Chapter 3

RESEARCH METHODOLOGY
3 Research methodology

The aim of this chapter is to describe and justify the research methodology and the emerging research design that is used in executing this research work.

It describes how the research is to be carried out, including which research methodology will be adopted, and how data will be collected. It will also provide justifications for why the research will rely on a qualitative approach, and the integration of quantitative data into the qualitative analysis through the descriptive nature and approach.

3.1 Research emerging phases

The main objectives, methods, outcomes, and relationships between the three emergent phases of research are described below and summarised in the detailed research road map illustrated in Figure 14.

**Phase 1: Initial interviews**

- **Objective:**

  To map out the understanding, issues and current practices related to KM in leading oil and gas companies in Libya.

  - **Data collection method:**

    Twenty semi-structured interviews were conducted with senior managers and project managers from three companies.

  - **Outcomes:**

    - Responses to the research questions 1.1, 1.2, and 1.3
    - Emerging issues related to KM in leading oil and gas companies in Libya
    - Identification of existing practices can be aligned with formal KM (meetings, workshop training, etc.)
    - Emerging of existing KM individual initiatives judged as failed at organisational level but very useful for the research
    - Emerging of preliminary framework to be developed with more axial coding establishing relationships)
Chapter 3 Research Methodology

- Updating of research questions 2.1 and 2.2.
  - **New emerged research area:**
  - This first phase of research conducted with the project team involved in the existing KM initiative to investigate more the causes of failure.

**Phase 2: KM initiative case study**

- **Objective:**
  - Demonstrate the influencing factors of KM implementation
  - Develop and confirm the emergent KM issues in leading oil and gas companies in Libya.
- **Data collection methods:**
  - Semi-structured interviews with lead engineers
  - Online survey with project team (confidentiality guaranteed).
- **Outcomes:**
  - Responses to research questions 2.1 and 2.2
  - Identification and categorisation of KM commitment barriers, and the causes of emergent issues
  - Emerging KM issues, causes and effects depend on project execution (time and phase of project)
  - Emerging of the role of the projects department
  - Developing and tuning the preliminary framework
  - Updating of research questions 3.1 and 3.2.
  - **New emerged research area:**
  - Research conducted in two in-depth case studies in which EPC projects were followed up from initial start phase to completion and handover.

**Phase 3: In depth EPC project case studies**

- **Objective:**
  - Studying the KM issues, causes, consequences, and the relationships between KM and PM in function of project time.
  - Tracking K created initiatives during the project life cycle and the gap emerging.
- **Data collection method:**
Chapter 3

Research Methodology

- A company agreed to allow periodic follow-up of their projects from start to end; in which reasonable access was given to the project team and attending part of the project meetings and workshops.
- Interviews with project team before and after each project phase.
  - **Outcomes:**
  - Responses to research questions 3.1 and 3.2
  - Demonstrate the strong relationship between KM and PM, in particular in terms of implementation.
  - Demonstrate the knowledge loss gap between project phases.
Chapter 3

Research Methodology

Figure 14 Research road map (Source: Author)
3.2 Justification of research methodology

A number of authors in the literature have suggested that the selection of the research methodology is straightforward depending on the problem to be solved and the research question to be answered (Denzin & Lincoln, 2005; Yin, 2002).

The choices of research philosophy, approach and strategies, methods, data collection technique and procedure, data analysis technique and procedure are justified in relation to the research problem and supporting literature in the following sections using Saunders’ research onion.

Saunders’ research onion is a generic research procedure which helps the interpreter describes issues supporting the selection of data collection and research methods. Saunders made an important contribution in terms of his research onion. There are six layers in the onion: namely philosophies, approaches, strategies, choices, time horizons, techniques and procedures (see Figure 14).

Saunders, Lewis and Thornhill (2009) developed this Research Onion; the spirit of the research onion approach is to peel off the different layers of the onions to arrive at the core. To reach the core or central area requires that a step by step process is followed. Many postgraduate research students often have a tendency to think about research methodology in the commencement of the search phase, for instance if they should use a questionnaire to conduct their interviews or any other techniques. However, if any one follows and adopts Saunders’ research onion, then it is obvious that the research methodology is one of the later steps to be followed to arrive at the core; other important layers of the core first need to be peeled away.

The purpose of this chapter is to consider the philosophical position of the research (interpretive), the strategies adopted (grounded theory and case study), and methods employed (interviews, questionnaires and observation) in the context of the nature of the phenomenon under investigation.
3.2.1 Selection of research philosophy

3.2.1.1 The Interpretivist philosophical paradigm

A paradigm is a theoretical framework which includes a system by which people view events (Fellows & Liu, 2003). It provides an approach to questioning and discovery.

Research undertaken in the field of natural science has a different perception of the nature of research philosophy than that of social science. The different perspectives have provided two different flows of research with different concepts and priorities. The literature on research methods also provides diverse tags for these paradigms. Rationalist, Normative and Quantitative terms are frequently used to explain the «Positivism Paradigm» and the Social Constructivism paradigm is frequently phrased as being Interpretive and Qualitative.

Fellows and Liu (2008) described research as a suspicious search and investigation as a «voyage of discovery». The main reason for research is to add value and contribute to the existing available knowledge and to make the learning process easy within organisations. It is a structured, data-based, essential examination into a known specific problem (Sekaran, 2000).
Given the fact that there is a lack of KM research in the oil and gas industry in general and more particularly in Libya and with the interest in generating new insights into the existing literature, the deductive hypothesis testing approach was discarded in this study. Moreover, KM was conceptualised as a social-technical system, where the dichotomy between social context and technical object dissolves in the complex link of socio-technical actors (Latour, 1987).

The primary core argument of the «interpretive» paradigm is that the world is not objective and the actual world is determined by individuals rather than by defined objective and external visible facts (Easterby-Smith et al., 2002). Facts and truth are social creators rather than existing independently «out there» (Fellows & Liu, 2003) whereas the Positivism Paradigm’s main principle is separation of the researcher (subject) and the research object.

This strict separation is intended as necessary to get impartial results. Positivists believe that the world is concrete and external. Therefore, exploration can only be based upon observed and captured facts using direct data or information (Easterby-Smith et al., 2002). Any subjective influence exerted by the researcher is regarded as a disturbance that must be minimised through standardisation of the elicitation process. The premise of this separation is that it facilitates coherence of the research process through hypothesis testing. Hypotheses are the means of connecting two disjointed parts of the research process and the research activity involves attempting to refute them (Fensel, 1991).

Miles and Huberman (1994), while explaining the main purpose of the «Interpretivism» or «Social constructivist» paradigm, state that in this paradigm the researcher’s primary role is to gain a holistic overview of the context under study.

The main task of this sort of research is to explicate the ways people in particular settings come to understand, account for, take action, and otherwise manage their day to day situations. Researchers belonging to this school of thought posit that 93 human discourses and actions cannot be analysed using natural and physical science methods. Human activity could be seen as «text», a collection of symbols expressing layers of meaning. The unveiling of these layers to get a deep understanding of a certain process is the objective of the Interpretive Paradigm.
However, researchers are not detached from their objects of study because they have their own understandings, convictions, and conceptual orientations. They are affected by what they hear or what they observe in the field in noticeable ways.

An interview, which is a common research instrument, does not simply involve gathering information by one party. It is a «co-elaborated act» by both the parties (Fensel, 1991). Most analysis is done with words in this sort of research. Words can be assembled, sub-clustered, or broken into semiotic segments and organised to permit researchers to contrast, compare, analyse and bestow patterns upon them (Patton, 1990).

In contrast to normative methods (that require a representative sample to verify the significance of the hypothesis statistically), qualitative researchers do not intend to explore representative samples. Rather they claim that the human-related things they wish to explore are present in one form or other in every individual (Fensel, 1991).

There are many arguments among the followers of these paradigms. Rationalists claim that there is no such thing as qualitative data. Everything is distinctively measurable, either one or zero, black or white. Interpretive paradigm researchers counter this view by arguing that all data are basically qualitative and so they attach meaning to raw experience, words or numbers (Miles & Huberman, 1994).

The problem of low response rate in returning questionnaires (a popular means of conducting quantitative research) in the construction industry is becoming a real concern to construction researchers. Liu and Fellows (2003) note that most postal questionnaires yield a low response rate of 25-35% and with this rate it is not always possible to test hypotheses statistically or provide conclusive results. This deficiency in quantitative research also reduces keenness in carrying out research with positivistic undertones and reinforces the decision of undertaking an interpretative research approach.

Harriss (1998) counter argues that adopting the interpretive paradigm approach may involve rejecting theory and generalisation. However, one can argue that the nature of the construction industry (with its huge variability and diversity) does not demand generalisation and a «one size fits all» approach. This research has not aimed for generalisation at this point in time, as KM initiatives are not being undertaken industry-wide.
Instead of embarking upon the quantitative investigations of factors and determinants for the whole industry through a quantitative analysis (using predominantly survey techniques), it is considered more sensible to focus on good organisations (less in number) that are undertaking these initiatives and carry out in-depth exploration, with an aim of generating good practice for other organisations in the oil and gas industry to follow.

3.2.2 Selecting research approach and strategies

The social constructivism or interpretive approach is inductive, and is not consistent with hypothesis development, testing and deductive reasoning. Theory building is at the heart of the process as shown in Figure 16.

![Figure 16 The research process-interpretive approach (Adapted from Sekaran, 2000, p. 54; Galliers, 1992, p. 61; and Finegan, 2001)](image-url)

Various approaches or strategies that usually fall within this interpretive paradigm are collated below in Table 5.
Table 5 - various approaches in the Interpretive Paradigm (Adapted from Galliers, 1992)

<table>
<thead>
<tr>
<th>Research Approach</th>
<th>Questions</th>
<th>Key Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Archival Analysis</td>
<td>Who, what, where, how many/much</td>
<td>Based upon the quantitative and qualitative analysis of archival records to describe the incidence or prevalence of a phenomenon, or to be predictive about certain outcomes.</td>
</tr>
<tr>
<td>2) Grounded Theory</td>
<td>What</td>
<td>A structured approach to forming and eliciting theory grounded in data.</td>
</tr>
<tr>
<td>3) History</td>
<td>How, why</td>
<td>Explanatory studies that deal with operational links over time.</td>
</tr>
<tr>
<td>4) Subjective Argumentative</td>
<td>What</td>
<td>A creative, free-flowing, unstructured approach to theory building that is based upon opinion and speculation. A subjective approach that places considerable emphasis upon the perspective of the researcher, its objective is the creation of new ideas and insights.</td>
</tr>
<tr>
<td>5) Case Study</td>
<td>How, why</td>
<td>Case studies can either be explanatory, exploratory, or descriptive, in all cases focusing on contemporary phenomenon in real-life settings. They allow the capture and analysis of many variables, but are generally restricted to a defined event or organisation, making generalisation difficult.</td>
</tr>
<tr>
<td>6) Action Research</td>
<td>What to do, how, why</td>
<td>This is applied research where there is an attempt to obtain results and benefits of practical value to groups with whom the researcher is allied, while at the same time maintaining a holistic perspective and adding to theoretical knowledge. The underlying philosophy is that the presence of the researcher will change the situation under investigation.</td>
</tr>
<tr>
<td>7) Descriptive, Interpretive</td>
<td>What, how, Why</td>
<td>Based upon the philosophy that phenomena are the essence of experience, this form of research seeks to represent reality using an in-depth self-validating process in which presuppositions are continually questioned, and the understanding of the phenomena under study is refined. The approach allows the development of cumulative knowledge by incorporating the thorough review of the literature and past research as well as the current investigation. This encourages additional insight, as well as ensuring that subsequent research builds on past endeavours.</td>
</tr>
</tbody>
</table>
3.2.2.1 Grounded theory

Creswell (1994) identifies a qualitative approach to research as the most appropriate when the objective of the research is to develop new theory, techniques or process. The aim of the research reported upon in this DBA study is to investigate the role of KM in enhancing learning and sharing of knowledge in a project environment. This research objective makes this research predominantly «demonstrative», where demonstrating that KM in a project environment produces learning and enhances sharing of knowledge which contributes to project success as the primary objective. Grounded theory then becomes the most appropriate choice in this scenario.

The first step in this study is to map the present circumstances of the organisation subject to this study. Grounded theory provides an efficient means of generating theory (grounded in data) extracting the present situation as it occurs «out there» in reality. For this reason grounded theory becomes the natural choice as a means of carrying out the research.


Seymour and Rook (1995) argue that the rationalist approach is dominant in the industry and although a lot of research in this normative paradigm has been conducted, noticeable improvement has not yet been felt. Seymour and Rook (1995) also attribute this to the culture of the industry, consisting of various participants collaborating in different capacities to overcome the fragmented nature of the industry. This leads them to explore and understand human related factors involved in better collaboration and improvement of the project delivery process and also to develop an understanding of various phenomena (such as when some things that are expected to work do not). Quantitative research offers procedures and mechanisms in the form of models, tools and techniques to improve predictability and analytical process improvement, but why any construction project procedure is not applicable or not able to produce promised benefits can only be explored by «understanding» the phenomenon following an «interpretative approach». Seymour and Rook (1995) state that «If the researchers have to play a role in changing the culture of industry, then the culture of
Chapter 3

Research Methodology

research must change also». Ofori (1993) endorses this idea by arguing that key research approach changes are necessary to bridge the gap between research and practice.

Select a version of Grounded Theory

A number of versions of the strategy were mentioned by Chiovitti and Piran (2003) that show the necessity for evident connection to the process by which ideas are generated. Jones and Noble (2007) criticise the «free-for-all» way in which grounded theory (GT) has been used to date, quoting the requirement for more discipline in the methodology.

Goulding (2005) confirms this position, by substantiating that many research papers which maintain they used grounded theory are nothing more than interviews, lacking any level of theoretical sensitivity. In an overview of scientific studies that have reported using grounded theory, Jones and Noble (2007) discovered that several had misplaced their theoretical method, resulting in a principle without density and variability. This might be due to specialists not understanding the essential side of the strategy and concentrating just on code (Strauss & Corbin, 1994). In seeking to relocate integrity to grounded theory, Jones and Noble (2007) suggested that the researcher must clearly state the edition of grounded theory they intend to use, and adhere to their procedures.

Following a comprehensive study and analysis of documents published in the KM field that had implemented GT within their work, the author noted that there have been similarly Glaserian and Straussian approaches to GT, and proceeded toward the determining work of Glaser and Strauss (1967). In addition, the author also incorporated equally a critical use of Goulding (2002), and different documents that compared and considered the Glaserian and Straussian approaches.

Finally, the Straussian version was chosen since it offers a far more structured and linear way of applying the methodology, contemplating also the lesser amount of experience in applying GT. For this reason, the Straussian approach will steer and guide the data analysis. The author then built in more readings in relationship including Strauss and Corbin’s (1990; 1998).

Bringer et al. (2006, p. 246) cite this constructivist modification of grounded theory as being particularly ideal where ideas «relevant to the specific topic and population of study do not exist». In this research work, Chapter One has demonstrated the clear importance of more
Chapter 3  Research Methodology

scientific KM research, and certainly, research specifically targeted at the leading Libyan oil and gas organisations.

The grounded theory approach was first presented by two sociologists, Glaser and Strauss, in *The Discovery of Grounded Theory: Strategies for Qualitative Research* (1967) when they were researching in the field of «nursing». Later on, the founders of this approach worked independently to form two different approaches which are termed the Straussian approach and the Glaserian approach (Hunter, Hari, Egbu, & Kelly, 2005). The Glaserian approach is detailed in Glaser and Strauss (1967), Glaser (1978), and Glaser (1992), whereas the Straussian approach can be found in Strauss (1987) and Strauss and Corbin (1990). Both approaches advocate that theory derived should be grounded in data. Instead of trying to deliberately find out something, the theory should just emerge by itself from the data. The debate over various differences among these approaches has become a part of the literature. It is therefore necessary for any one aiming to use grounded theory to first understand the two approaches and then clearly state what approach they want to adopt.

Differences lie in the process of theory generation with different emphasis on induction, deduction, and verification, the form the theory should take, and use of the literature (Heath & Cowley, 2004; Hunter et al., 2005). Glaser (1992; cited by Heath & Cowley, 2004) considers the Straussian approach as no longer grounded theory but «full conceptual description».

Heath and Cowley (2004) illustrate the differences between the two approaches. Induction is a key process in a Glaserian approach, with a researcher moving from the data to empirical generalisation and on to theory. Glaser considers deduction and verification the servants of the emergence (Glaser & Strauss, 1967).

However, the Straussian approach claims that in the original development of grounded theory, inductive aspects were overplayed (Strauss & Corbin, 1990) and deduction and verifications must be made before a new data set is considered.

Glaser (1992) has criticised the Straussian approach because deduction emphasises asking various questions and speculations about what might be rather than what exists in the data (Heath & Cowley, 2004).
Another difference is that Glaser has argued against hypothesising while a Straussian approach considers it acceptable to form the hypothesis before the start of the research. This leads to the debate on positioning of the «literature» in grounded theory. Glaser and Strauss both acknowledged that the researcher cannot enter the field free from ideas but differ considerably in the role they see for the literature (Heath & Cowley, 2004).

Figure 17 Glaser (1978, 1992) place of induction, deduction and verification in grounded theory analysis (Source: Heath & Cowley, 2004)

Figure 18 Strauss (1987) and Strauss and Corbin’s (1990) place of induction, deduction and verification in grounded theory analysis
Both Glaser (1978) and Locke (2001) argue that a researcher should approach the research problem with minimal or almost no prior models or constructs in mind. The literature should be considered and incorporated only when it becomes relevant to the course of the research as it unfolds. If there is a prior understanding, it should only be based on the general problem area. More focussed reading should be done when theory is sufficiently developed (Heath & Cowley, 2004).

At that stage the literature can also be used as additional data (Dick, 2005). Glaser’s belief is to use the literature to gain an overall picture of the research problem and to subsequently confirm any developed theory (Hunter et al., 2005). Strauss (1987) strikes a different note by mentioning that both past experiences and understandings may be used to stimulate theoretical sensitivity and generate hypotheses.

A research question can be established to identify the phenomenon to be studied and what is known about the subject (Heath & Cowley, 2004; Hunter et al., 2005).

Locke (2001) reported that grounded theory has undergone adaptations, one being to approach the problem with existing theory in mind to narrow and direct the analysis. This adaptation occurs because researchers using a grounded theory methodology encountered an enormous amount of data that was very hard to sift through and make any sense of without due reference to the literature.

Locke (2001) quoted the research of Harris and Sutton (1986) and Eisenhardt and Bourgeois (1988) who started their research activity with several different constructs in mind that emerged from the literature.

Martin and Turner (1986) also indicated that «preconceptions» cannot be totally abandoned, and they stressed the need to approach the data with a fair mind rather than lock into data in already established categories.

The distinctive differences between the two approaches present an extremely intellectual challenge for the researcher when selecting a research approach.

Hunter et al. (2005), while acknowledging this complexity, state that grounded theory is very diverse in its application and can be modified and applied to suit the nature of the research problem and the particular style of the investigator.

Qualitative analysis is a cognitive process and each individual has a different cognitive style and this in turn profoundly effects how the research is carried out (Heath & Cowley, 2004).

Glaser and Strauss (1967) originally described two levels of coding, first into as many categories as possible and then integration of categories. Neither in the original publication, nor in later separate contributions from the two researchers, are coding stages meant to be distinct and linear in their use.

However, for Strauss and Corbin (1990), two levels become three. Strauss and Corbin (1990) describe the first level procedures as open coding whilst Glaser (1978) refers to substantive coding.

The procedural descriptions are similar, leading some (Kendall, 1999) to suggest they differ only in the emphasis on emergence. However, as has been discussed, this difference is of profound importance for ensuring the theory’s relevance as well as elegance.

The intense questioning advocated by Strauss and Corbin (1990) extends far beyond the data to generate hundreds of codes and it is possible that it is this proliferation of codes that necessitates considerable reduction and thus the extra level of axial coding.
Since the theory should be kept in a state of permanent confrontation with data and given that grounded theory explores complex phenomena where often little understanding exists, the selection of participants for the interviews (function, duty, responsibility, etc.) is critical. Thus, intensity and maximum variation sampling are frequently used to select a broad range of information-rich participants (Brown, 1999; Stevens, 2000; Troiano, 1999).

Sampling could not be planned in detail before the start of the field study. It is not determined to begin with, but is directed by the emerging theory (Goulding, 1998). It is not persons or organisations that are sampled but rather incidents and events. Although sampling during the

### Table 6 Straussian vs Glaserian approaches of GT

<table>
<thead>
<tr>
<th></th>
<th>Strauss and Corbin</th>
<th>Glaser</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial coding</strong></td>
<td>Open coding</td>
<td>Substantive coding</td>
</tr>
<tr>
<td></td>
<td>Use of analytic technique</td>
<td>Data dependent</td>
</tr>
<tr>
<td><strong>Intermediate phase</strong></td>
<td>Axial coding</td>
<td>Continuous with previous phase</td>
</tr>
<tr>
<td></td>
<td>Reduction and clustering of categories</td>
<td>Comparisons, with focus on data, become</td>
</tr>
<tr>
<td></td>
<td>(Paradigm model)</td>
<td>more abstract, categories refitted, emerging</td>
</tr>
<tr>
<td><strong>Final development</strong></td>
<td>Selective coding</td>
<td>Theoretical</td>
</tr>
<tr>
<td></td>
<td>Detailed development of categories, selection of core,</td>
<td>Refitting and refinement of categories which integrate</td>
</tr>
<tr>
<td></td>
<td>integration of categories</td>
<td>around emerging core</td>
</tr>
<tr>
<td><strong>Theory</strong></td>
<td>Detailed and dense process fully described</td>
<td>Parsimony, scope and modifiability</td>
</tr>
</tbody>
</table>
beginning of the project is rather unfocused, it will become more focused as the project progresses (Goede & Villiers, 2003). Initially the researcher considers the most obvious incidents and events.

However, as concepts are identified and the theory starts to develop, further data may need to be incorporated in order to strengthen the findings. This is known as «theoretical sampling» (Goulding, 1999). Sampling will only end when all the categories are saturated.

The function behind «theoretical sampling» (Strauss & Corbin, 1998) is a process of searching for ideas relating to «incidents, events or happenings» (p. 202) which can influence outcomes over a period of time. Building requirements begin with creating many requirements and then improving these to contribute towards theory.

Theoretical sensitivity is the capability to realise what is crucial in data and to provide it with meaning. It helps to produce principles loyal to the truth of the phenomena under examination (Glaser, 1978). Theoretical sensitivity has two basic premises.

First, it arises from being well grounded in the technical literature as well as qualified and personal experience. The researcher carries that complex knowledge into the research situation.

Nevertheless, theoretical sensitivity is also obtained during the research process through frequent connections with the data through the variety and analyses of the data.

While many of the analytic practices employed to develop theoretical sensitivity are innovative and creative in personality, it is very important to help keep stability between that which will be developed by the researcher and the reality.

One is able to do so by: (a) asking, what is really going on here? ; (b) maintaining a perspective of scepticism toward any categories or hypotheses taken to or arising early in the research, and validating them repeatedly with the data themselves; and (c) by subsequent data collection and analytic procedures.

Great research (good theory) is made through that interaction of resourcefulness and the skills obtained through training.
3.2.2.2 Case study

The use of a case study approach is acceptable for in-depth study of unique cases of a sensation to protected theoretical, rather than statistical validity and can be used as part of grounded theory, wherever an idea «is inductively derived from the study of the phenomenon it represents» (Fellows & Liu, 2008, p. 112).

Case study design requires intensive examination of a number of persons or cases in a real life context. To obtain apparent findings about data, it is recommended by several published researchers that the amount of cases is restricted.

The data that is obtained might include: seeing aspects of their behaviour or of the placement, interviews with individuals, and record searching.

The grounded theory approach can be combined with case study to form a theory that would explain how people make sense of their everyday activities so as to behave in socially acceptable ways.

In this research work, case study is considered and viewed as a methodology, as complementary to the main grounded theory methodology used in the research.

3.2.2.3 Action research

Action research (AR) strategy is concerned with addressing issues to find and implement solutions.

The process of action research moves from a clear objective to diagnosis of the problem by generating a list of actions to resolve the addressed or identified problem.

It deals with the problem of the separation between theory and real practice, more willingly than research using a linear process of producing knowledge that is later applied to practice settings. Action research incorporates the development of practice with the construction of research knowledge in a cyclical process.

The descriptions of action research refer to its cyclic or spiral nature. For Stephen Kemmis and Robin McTaggart, each cycle consists of «plan - act and observe – reflect». Ernie Stringer (1999) selects a different starting point; he uses the alternates between action and critical reflection. In turn, critical reflection can be divided and subdivided into analysis of what has occurred, and then planning for the next action and so on.
The action research study used in this research work involves dynamic (live and in continuity) participation in a change situation, frequently through an existing organisation, while at the same time conducting the research to move from a clear objective to diagnosis of the problem and generation of a list of actions to solve the problem.

As part of this search for a solution, the strategy adopted allows the researcher to be part of the organisation or case study that requires the solution. It allows for continuing discussions and collaboration between the subject organisation (company) and the researcher.

From the perspective of data collection, Action Research is more of a multi direction approach to problem-solving, rather than a single method for collecting and analysing data. Accordingly, it permits several different research tools to be utilised.

These diverse methods, which are generally common to the qualitative research paradigm, include: keeping a research diary, documenting the collection and analysis of data, participant observation recordings, questionnaire, surveys, and interviews in a structured and unstructured form.

**Combination with Grounded Theory**

On an external examination, action research and grounded theory appear quite different. A number of these obvious differences are real. Grounded theory usually tends not to be participative. Action research has a tendency to be someone else’s responsibility. Action research is action oriented and usually participative.

A deeper examination, however, makes known some important similarities. In particular, emergent in both, are that understanding and the research process are formed and built up additionally through an iterative process.

The emergent nature of both action research and grounded theory is evident. Both use an iterative approach, data analysis and interpretation and theory building occurs for both at the same time as data collection.

Dick (2005) argued that the combination between GT and AR is possible through two ways.
First, action research can be the meta-methodology, in a grounded theory as grounded theory can be reviewed and refined using overarching action research cycles.

Second, action research can also be substituted for the grounded theory processes of coding and memoing to have a «more economical analysis of data» (Dick, 2005).

This second form of complementary is considered for the purposes of this research.

**3.2.3 Selecting research methods**

**3.2.3.1 Mixed methods**

Saunders» research onion contained three types of research methods: mono-method, multi-method, and mixed methods.

Mixed methods research is when the researcher uses quantitative and qualitative research methods in their data collection and analysis. It could be argued that by combining both types of research, the limitations of every individual method can be offset and gaps in data can be filled or predicted.

The mixed methods in this research were used during the second and third phases when quantitative data was collected in order to evaluate or give significance to some previous qualitative data. For example, in the third step of phase 2 a quantitative questionnaire was sent to participants to rate the importance of emerged CSFs of KM implementation in the previous step, based on a Likert scale rating method.

Quantitative data extracted from this questionnaire were injected into the qualitative analysis as illustrated in Figure 19.

Using mixed methods of data collection has been the subject of debate. Gillham (2000) stated that while a multi-method approach can enrich research findings, it can be difficult to blend the various findings together.

Therefore, the quantitative approach in the current research is different to what Gilham talking about, because it was used only to evaluate properties of one category and not to emerge new findings, a purpose supported by the founders of grounded theory, Strauss and Corbin, and other authors.
Qualitative and quantitative methods can be viewed as complementary according to Strauss and Corbin (1998, p. 34) who state that «qualitative should direct the quantitative and the quantitative feedback into the qualitative in a circular, but at the same time evolving, process with each method contributing to the theory in ways that only each can».

Combining qualitative and quantitative methods research could be defined as «research in which the investigator collects and analyses data integrates the findings and draws inferences, using both qualitative and quantitative approaches and methods in a single study or a program of inquiry» (Tashakkori & Creswell, 2007).

When it comes to research methods, the grounded theory approach could be complemented by the use of both quantitative and qualitative methods, as both have distinctive strengths in specific situations. By employing both qualitative and quantitative approaches in methodological triangulation, the disadvantages of individual approaches could be reduced or eliminated whilst gaining the advantages of each (Fellows & Liu, 2008).

Additionally, mixed methods research provides greater evidence for resolving a study problem than either quantitative or qualitative research alone, as researchers have the ability to use most of the tools of data collection available as opposed to being limited to the types of data collection usually linked to either quantitative or qualitative research (Creswell & Clark, 2011).

The chosen methodology, the scope of the research, and form of information required will dictate the forms of methods used (Clough & Nutbrown, 2002). Eisenhardt (1989) states that research centred on theory building will typically combine multiple data collection methods.

It is argued that both qualitative and quantitative research have a position to play in developing grounded theory; Strauss and Corbin (1998, p. 34) suggest that «qualitative should direct the quantitative and the quantitative feedback into the qualitative in.

The mixing of qualitative and quantitative methods can be looked at as complementary, echoing the decision for methodological pluralism in construction management made by Dainty (2007).

While Loosemore (1999) places emphasis upon developing grounded theory through qualitative data, Sousa and Hendriks (2006) visualise it as a fundamental distortion to argue
that grounded theory is solely a qualitative research method. In the present study, both quantitative and qualitative methods have already been adopted as necessary to suit different stages. Figure 16 illustrates how the mixed methods research structure was applied in this research.

3.2.4 Selection of data collection techniques and procedures

After all the previous decisions and selections, the researcher needed to determine what data collection methods would work best and what sort of analysis should be employed to create the results to answer the research question.

Technique and procedures include participant sampling, questionnaire content, and questions to be addressed to participants.
Chapter 3  

Research Methodology

There are a number of issues to consider in selecting and using methods, for example, validity, reliability, and simplicity (Birley & Moreland, 1998). The purpose of triangulation is to ensure findings through convergence of different perspectives, check the integrity of inferences drawn, and ensure validity (Jack & Raturi, 2006).

Triangulation in the «social sciences attempts to describe more fully, the richness and complexity of human behaviour by studying it from more than one standpoint and/or using a number of methods, even combining qualitative and quantitative methods» (Burns & Chisholm, 2003).

In terms of data collection methods, triangulation will be employed in this research phase by:

- The compilation of different samples:
  - Phase 1 (senior and project managers from three companies)
  - Phase 2 (lead project engineers, IT, and HR managers from three different departments)

- The compilation of different data collection methods:
  - Phase 2 (online questionnaire and interview)
  - Phase 3 (observation and interview)

- The compilation of data of different natures:
  - Phase 2 and 3 (mixed data collected).

For example, during the second phase of research it was decided to triangulate the results obtained in the first step by using another data collection method in a second step (online questionnaire) and by the participation of other department members in a third step (IT and HR departments).

As mentioned above, this research uses three different data collection methods:

- Interviews
Chapter 3

Research Methodology

- Online questionnaires
- Direct observation.

The online questionnaires Online (Internet) surveys are becoming an essential research tool for an assortment of research fields, including marketing, social and official statistics research. «According to ESOMAR, online survey research accounted for 20% of global data-collection expenditure in 2006» (Vehovar & Manfreda, 2008).

Observation involves watching behaviour, actions, or no physical reaction characteristics in participants’ natural setting. Observations can be evident or explicit (everyone knows they are being observed) or hidden (no one knows and the observer is covered). The main benefit of concealed observation is that persons are more likely to behave naturally (do not know they are being observed). However, generally it is typical to conduct evident observations because of ethical codes requirements and problems related to concealing observation (ETA, 2008).

According to Brace (2008), all the decisions and tools employed in this final stage must fit in with the philosophies, philosophical stances, strategies, choices, and time-horizons already fixed upon if valid results are to be created and withstand criticism.

To be able to build a thick and tightly structured theory, Strauss & Corbin, (1998) suggest that 10 good interviews during the early phases of research should «provide the skeleton of a theoretical structure», which can be «filled in, extended, and validated through more data gathering and analysis, although coding can be more selective.

(Yin, 1994) identified six primary resources of evidence for case study research. The use of each one of these might require different skills from the researcher. Not all sources are crucial in every case study, however, the importance of multiple sources of data to the reliability of the study is well established (Stake, 1995; Yin, 1994). The six sources identified by Yin (1994) are: documentation, archival records, interviews, direct observation, participant observation, and physical artefacts.

No single source includes a complete advantage over others; rather, they may be complementary and might be utilised in tandem. Thus, a case study should use as many sources as are relevant to the study indicates the strengths and weaknesses of each type.
### Table 7 Comparison of data collection methods (adapted from Tellis, 1997)

<table>
<thead>
<tr>
<th>Source of Evidence</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Documentation</td>
<td>stable - repeated review</td>
<td>irretrievability – difficult</td>
</tr>
<tr>
<td></td>
<td>unobtrusive - exist prior to case study</td>
<td>biased selectivity</td>
</tr>
<tr>
<td></td>
<td>exact - names etc.</td>
<td>reporting bias - reflects author bias</td>
</tr>
<tr>
<td></td>
<td>broad coverage - extended time span</td>
<td>access - may be blocked</td>
</tr>
<tr>
<td>Archival Records</td>
<td>Same as above</td>
<td>Same as above</td>
</tr>
<tr>
<td></td>
<td>precise and quantitative</td>
<td>privacy might inhibit access</td>
</tr>
<tr>
<td>Interviews</td>
<td>targeted - focuses on case study topic</td>
<td>bias due to poor questions</td>
</tr>
<tr>
<td></td>
<td>insightful - provides perceived causal inferences</td>
<td>response bias</td>
</tr>
<tr>
<td></td>
<td></td>
<td>incomplete recollection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>reflexivity - interviewee expresses what</td>
</tr>
<tr>
<td></td>
<td></td>
<td>interviewer wants to hear</td>
</tr>
<tr>
<td>Direct Observation</td>
<td>reality - covers events in real time</td>
<td>time-consuming</td>
</tr>
<tr>
<td></td>
<td>contextual - covers event context</td>
<td>selectivity - might miss facts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>reflexivity – observer’s presence might</td>
</tr>
<tr>
<td></td>
<td></td>
<td>cause change</td>
</tr>
<tr>
<td></td>
<td></td>
<td>cost - observers need time</td>
</tr>
<tr>
<td>Participant Observation</td>
<td>Same as above</td>
<td>Same as above</td>
</tr>
<tr>
<td></td>
<td>insightful into interpersonal behaviour</td>
<td>bias due to investigator’s actions</td>
</tr>
<tr>
<td>Physical Artefacts</td>
<td>insightful into cultural features</td>
<td>Selectivity</td>
</tr>
<tr>
<td></td>
<td>insightful into technical operations</td>
<td>Availability</td>
</tr>
</tbody>
</table>

#### 3.2.5 Data recording and validation procedures

During interviews, the data delivered were recorded as an audio files then transcript manually in papers and printed out in such way that the encoding of the text is available. Using the Constant comparative method as a process, any newly collected data is being compared with the previous data that was collected in one or more earlier studies. This has to be a continuous and ongoing procedures, for the theories are formed, enhanced, confirmed and even evolved as a newly emerged data on the study in order to allow a qualitative validation process to take place with direct interaction with individuals on a one to one basis.
In order to analyse further to as such, the text were printed using a double spacing font in order to help the analyst mark the page and be able to write the code ideas and labels between the lines. In addition, a wide margin was used so the labels and other comments can be written on the left and right sides of each page (refer to Appendix 2) and therefore, all Data will proceed to be analysed by a constant comparison procedure.

An equivalent applicable analysis can be used simultaneously to above is the Content analysis, according to Satu Elo & Helvi Kyngä’s (Nov. 2007) for the Content analysis is a method that may be used with either qualitative or quantitative data; furthermore, it may be used in an inductive or deductive way. Which of these is used is determined by the purpose of the study. If there is not enough former knowledge about the phenomenon or if this knowledge is fragmented, the inductive approach is recommended (Lauri & Kyngä’s 2005). The categories are derived from the data in inductive content analysis. Deductive content analysis is used when the structure of analysis is operationalized on the basis of previous knowledge and the purpose of the study is theory testing (Kyngä & Vanhanen 1999). It is important to make defensible inferences based on the collection of valid and reliable data (Weber 1990). To increase the reliability of the study, it is necessary to demonstrate a link between the results and the data (Polit & Beck 2004). This is why the researcher must aim at describing the analyzing process in as much detail as possible when reporting the results.

3.2.6 Sampling and ethical considerations

While a statistical strategy focuses on the ability to make generalisations based on the selected sample, theoretical sampling should focus on samples which are large enough to provide meaningful data of depth and quality (Birley & Moreland, 1998; Leonard & McAdam, 2001). Unlike quantitative research, qualitative studies need not be overly concerned with representative, typical, or extreme types in the selection process (Denscombe, 2003). With theoretical sampling it is essential to establish the criteria upon which the selection of participants will be based (Eisenhardt, 1989; Schwandt, 2001). In the case of grounded theory, Goulding (2005) suggests initially talking to informants who are most likely to provide information which may lead to provisional concepts and «direct the researcher to further «theoretically» identified samples, locations, and forms of data».
Due to the complexity of the oil and gas industry, particularly in terms of the types and sizes of organisations engaged in construction-related activities, it was decided to utilise theoretical sampling.

The first phase of research was focused on the major leading Libyan oil and gas companies, based on their potential and current contribution to the oil and gas production and planned development projects in Libya.

The three selected companies in the first phase were leading companies in terms of production that were jointly responsible for over 70% of the Libyan Oil, Gas and Liquid hydrocarbon production.

As the second and third phases of research were focused on two cases studies concentrated on specific objectives and according the theoretical strategy of sampling, just one organisation was selected for each case study. For the second phase, the organisation that had explained a failed initiative of KM implementation was selected for this reason and in this regards, the objective was to learn from the initiative failure.

Initially, the solutions of individuals in sampling were based on individual experience and the position held in that company.

Hence, in the first phase of research, project managers (PMs) and senior project managers (SPMs) presents a wide exposure in terms of projects responsibility within the company organisation.

Their wide experience, role and positions within authority of projects organisation meets with research initial objectives for mapping the general situation of knowledge management in the studied organisations.

In the second and third research phases, the individual’s samplings were more specified. In this second phase the sample selected was almost the same participated in previous KM implementation initiative and in the third phase focusing on the process of knowledge creation, lead project engineers were selected as specific sample because the importance of their discipline management role, as usually, knowledge is created through discipline in the project environment.
Issues related to the access to database were emerged during second and third phase.

For ethical principles, before requesting participant’s permission to particle, the participants were duly informed about the aims and objectives of study, details about the data collection process were explained to all participants.

To ensure confidentiality, all the interviews were completed anonymously by replacing all names with a given codes (numeric).

However, it was not easy for the participated organisations and individuals to accept giving the researcher access to their project databases in many projects for security (phase 2) and confidential (phase 3) reasons.

For these reasons, the researcher used online questionnaires without face to face meeting to guarantee the security and confidentiality for participating individuals.

The second case study was the most difficult as it emphases data collection through life projects documents and signing project meetings observation.

The researcher has managed to convince the organization that can benefit from participating in the action research strategy by allowing access to its project data in order to use it in developing solutions for KM implementation in project following phase or aim the new projects this can contribute to their projects success.

3.2.7 Selection of data analysis technique and procedures

3.2.7.1 Open coding

Open coding is an activity of developing types of concepts and themes emerging from the data. It is the very first analytical step which targets the discovery of concepts by breaking the data into discrete incidents, ideas, events, and acts. It can be an «open» process for the reason that the data is explored without making any prior assumptions in what may be discovered. Strauss and Corbin (1998) describe a concept being an abstract representation of an event, object, or action/interaction that an investigator identifies as being the significant element in data. They advocate concepts since these are the building blocks of theory and suggest that «to uncover, name and develop concepts, we must open up the text and expose the thoughts,
ideas and meanings contained therein». The concepts identified from the data are labelled with names which represent or are a symbol of them.

3.2.7.2 Axial coding

Axial coding begins «the process of reassembling data that were fractured during open coding» (Strauss & Corbin, 1998, p. 124). In seeking to uncover relationships among categories, they allow a paradigm in which to systematically gather and order data during axial coding, the components of which are outlined in Table 8 below (adapted from Gibbs, 2002 and Strauss & Corbin, 1998).

<table>
<thead>
<tr>
<th>Component</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Causal conditions</td>
<td>Conceptual way of grouping answers to the questions, why, where, how come and when.</td>
</tr>
<tr>
<td>Phenomenon</td>
<td>The central idea, event, happening, incident which a set of actions or interactions is directed at managing or handling, or to which the set of actions is related.</td>
</tr>
<tr>
<td>Context</td>
<td>Location of events.</td>
</tr>
<tr>
<td>Intervening conditions</td>
<td>Shaping, facilitating or constraining the strategies that take place within a specific</td>
</tr>
<tr>
<td>Action/interaction</td>
<td>Strategic or routine responses made by individuals or groups to issues, problems, happenings, or events that arise under a set of perceived conditions.</td>
</tr>
<tr>
<td>Consequences</td>
<td>Outcomes or results of action or interaction result from the strategies.</td>
</tr>
</tbody>
</table>

Procedurally, axial coding is the behaviour of relating categories to sub-categories along the lines of their properties and dimensions. The properties and dimensions of a group are further created with the axial coding. This calls for determining and explaining the variety of causal problems, actions/interactions and effects of a group or phenomenon.
3.2.7.3 Selective coding

Selective coding, that is «the process of integrating and refining the theory» (Strauss & Corbin, 1998, p. 143), may be both the easiest and the hardest period of grounded theory and is determined by the total amount of axial coding which has been completed. That decision pertains to selecting the central or core group, which represents the key theme of the research. In selecting the central group, Strauss and Corbin (1998) provide these standards: all other categories can be related to it, it must appear frequently in the data, the reason is sensible and regular, the expression which identifies it must be effectively abstract to be used in different options, and the concept should have the ability to describe variation.

When a Core Category is decided, all other categories become sub-categories. The sub-categories in the relational hierarchy end up being the Core Category descriptors: the properties, dimensions, contexts, and processes for knowledge are the consequences.

To facilitate the identification of the central category and the integration of concepts, Strauss and Corbin (1998) supported publishing the premise using diagrams and reviewing and organising through memos.

3.3 Data collection/analysis and the iterative process until theoretical saturation

The research design emerged through this iterative process of data collection/analysis leading to three «phases».

Figure 20 illustrates the iterative data collection-analysis process, conducted in the current research over three main phases: initial interviews phase, case study phase, and in-depth case studies phase.
The analysis took place during the data collection period, and was thoroughly integrated into all aspects of it, including an analysis of every interview and observation directly after they were given. In this way, each step of the data collection could feed into the analysis that utilised mixed methods, mainly qualitative, and these were triangulated.

The empirical materials collected during each research phase would be coded and reviewed frequently to improve the data collection process and its outcomes.

Crawford, Brown and Majomi (2008) emphasise that the data collection and analysis should be an interwoven process, prompting the sampling of new data. Silverman (2005) also notes that the «data analysis should not only happen after all the data has been safely gathered», but suggests transcribing the interviews even if a researcher has only one interview record.

Charmaz (1995) supports this notion and proposes that data should be studied as it emerges. Therefore, the following systematic review protocols are introduced in the design to enhance the data collection process of this research study.

- The data should be coded and reviewed after each interview.
- The semi structured questionnaire should be enhanced after each interview based on the key review findings.
After completion of each case study, all the collected empirical data should be reviewed as a whole, and the questionnaire should be enhanced accordingly.

During this level of coding, theoretical saturation should be reached. This means that no new properties, dimensions, or relationships will emerge during analysis. Saturation is «the state in which the researcher makes the subjective determination that new data will not provide any new information or insights for the developing categories» (Creswell, 2002).

Theoretical saturation is realised when no new data comes out regarding a category and when the category is intense enough to protect modifications and process, with relationships between categories delineated sufficiently (Brown, Stevenson, Troiano & Schneider, 2002).

According to Goulding (1999) an idea is considered valid if the researcher has reached the point of saturation. This implies residing in the field until no new evidence emerges from future data. It can also be based on the assumption that the complete interrogation of the data has been conducted, and bad instances, wherever discovered, have already been determined and accounted for.
Chapter 4

RESEARCH PHASE 1

INITIAL INTERVIEWS WITH SENIOR MANAGERS AND PROJECT MANAGERS
4 Initial interviews

4.1 Introduction

This chapter maps out the current situation regarding the implementation of knowledge management (KM) in the Libyan oil and gas industry by investigating different issues related to currently used KM practices in EPC-type projects and comparing the outcomes and findings with the literature to identify gaps.

The main objective and goal of this research study as presented in this chapter is not to compare cases studied in the selected companies but rather to try to identify specific issues and gaps; thus by studying the current working situation under the specific and unique conditions, such as cultural, educational and political conditions, specific to Libya.

These sought to identify issues that must be addressed for the adoption of KM in EPC projects in the oil and gas industry in Libya by trying to answer the initial research questions:

− Q1.1: What issues should be addressed in relation to KM adoption within Libyan oil and gas EPC project organisations?

− Q1.2: What measures should organisations take to resolve effectively these knowledge management issues?

− Q1.3: How can these measures be suitably implemented and accepted in EPC projects within Libyan oil and gas companies?

The response to this question will enable the research to pinpoint and focus on the area that should be dealt with most to achieve the main objective of the research study, which is an attempt to develop a KM process framework of activities aimed at improving local projects organisational business performance.

4.2 Sampling

It is true that a larger sample size is encouraged in qualitative interviews to gain better precision (Bryman & Bell, 2007), but according to Smith (2002), with a relatively small sample size data can be sufficient to produce theoretical saturation.
Figure 21 First research phase design.
However, since the study was descriptive, a smaller sample size was seen by the researchers to be representative and manageable due to the type and structure of the EPC projects in the oil and gas industry as well as to satisfy time constraints.

The specific and limited sample studied in this research didn’t represent a disadvantage given, firstly, the descriptive nature of the research and secondly the progressed phase of data collection and analysis, as the initial phase that needed a wide sample had already been completed and this phase was more focused on a specific sample.

In the early phase of conducted interviews (initial research phase) a number of methodologists recommend a minimum number of separate interviews (20, 30, 40) or observations with the use of detailed coding as an essential step for building a grounded theory in the early stages of research.

Strauss and Corbin (1998, p. 281) suggest that ten good interviews in the early phases is sufficient for building a frame for a theoretical structure upon which to base further development.

The researcher started with a stratified sampling between senior and project managers to have a wide look at the beginning, invitations were sent to all the project and senior managers of the three companies. The author was lucky enough to conduct twenty separate interviews with six senior project managers (three from company A, one from company B and two from company C) and fourteen project managers (six from company A, three from company B and five from company C).

The 20 participants in this interview all had in the range of 12 to 25 years’ oil and gas experience, and they had extensive knowledge in the field of engineering and project execution as well as management skills.

Intensity and maximum variation sampling are often used to select a broad range of information-rich participants (Brown, Stevenson, Troiano, & Schneider, 2002). Sampling could not be planned in detail before the start of the field study. It is not determined to begin with, but is directed by the emerging theory (Goulding, 1999).

As a starting point, the author had chosen a mixed sample composed of different functional positions within the company organisation. The positions selected were senior project
managers and project managers. This sample provides a bigger and wider exposure in terms of work responsibilities within the company organisation, to guarantee a verification and validation of responses among the participants through constant comparison. Spiggle (1994) describes it thus: «Comparison explores differences and similarities across incidents within the data currently collected and provides guidelines for collecting additional data».

In addition, due to not having a clear and preliminarily existing framework of KM within the oil and gas organisations, this selected sample will allow us to better understand the workflow within the organisation and assist in having an initial framework to build on for the next and follow-up research work.

4.3 Data collection

Semi-structured interviews have been adopted in the research study as one of the data collection methods. According to Mason (2002), there are several core features: there is an exchange of conversation; it has a fairly informal style; there are a number of topics or issues to be enclosed; and appropriate knowledge is constructed.

A semi-structured face-to-face interview was implemented by the researcher because of its good flexibility in allowing for rich questioning of the respondents. More often than not, semi-structured interviews involve a pre-prepared list of questions characterised into various issues that may be altered, modified and/or changed depending on the context and development of the interview, and the feedback of the interviewer (Saunders et al., 2009).

Face-to-face interviews as used in this research work were considered essential, as they provide a rich opportunity to attain as much detailed information about the particular issue (topic) under investigation as is necessary, in accordance with their nature, by involving follow-up questions. An additional benefit of this type of interview is that the researcher can also have a very close view of the body language of the interviewee or respondent and observe their expressions and keenness for the research topic, which could really affect the outcome of the research interview questions.

The interview questions (Appendix 1) were developed based on the initial literature survey results and the researcher’s experience.
The research interview questions were divided into two sections. The first section contained the background information and the second section contained the main questions. The questions were mostly open-ended to persuade the respondent to provide elaborate answers (Saunders et al., 2009).

The interview questions were prepared and structured in advance of the interview session and then sent to the respondent once the interview date had been confirmed. The researcher also forwarded to the interviewee an introductory letter describing the main purpose of the research study.

The individual semi-structured interviews took 2 to 4 hours, and were recorded as pre-agreed with the respondents and then written down as a transcript.

The researcher had given permission to record the interviews using a mobile phone and computer. Written notes and/or observations were also taken during the interview to support the quality and accuracy of the answers recorded. Notes concerning the thoughts of interviewees, body language, attitude, tone of voice, etc. were equally taken during the interviews.

Starting with the pre-prepared list of questions that was used as a guide, as the interview progresses from one topic to another or even within the same topic, the line of enquiry can be customised and tailored in order to better explore for expansion on interesting responses (Robson, 1993).

Within the process the interview guidelines were reviewed and analysed and questions enhanced after each interview (to consider the results of the previous interview).

This followed the procedure supported by Crawford et al. (2004) who stress that the data collection and analysis should take into consideration the interview process, prompting the sampling of new data. For example, when a respondent does not differentiate between K type and K formats in question 1-c (Appendix1), the researcher asks him the following additional question: Your colleagues interviewed before you identified two formats of K, which are documented and not documented K. Do you recognise these two formats?

Silverman (2005) also remarks that the «data analysis should not only occur after all the data has been safely gathered». He recommended transcribing the interviews even if a researcher
has only one interview recorded. Charmaz (1995) had also supported this concept and recommends that data should be studied as they emerge in a continuous manner.

Furthermore, an opportunity to contact the respondents for any follow-up queries was also agreed; the researcher made a note of their contact details on the interview documents to make sure he had the correct details available for future use as and when needed.

To avoid any risk of confidentiality-related issues, and to avoid declaring any particular commercial information belonging to a company, interviewee names are not allowed to be recorded but only project names and interviewee function.

4.4 Data analysis and findings

Open coding was used to code the transcript of the semi-structured interviews gathered.

It was the first coding process used for new data collected.

The analysis of the data began with a microscopic (sentence-by-sentence) examination of each interview (Strauss et al., 1990).

In this first phase of the research, the codification process was done without predetermined ideas or a preconceived model to guarantee the originality of theory.

As discussed in the data collection section (see 4.2.2), the process of conceptualisation was interwoven with the data collection and the emergent open codes from one interview played a role in enhancing the subsequent interview questions.

The example below (Appendix 2) shows the open coding of a short passage from a lead project engineer’s transcript text talking about the difficulties that he confronted during the attempt to implement KM.

During the process of data collection and analysis, the author also started to conceptualise some of the open codes in the light of previous literature review outcomes and using the constant comparison method to create categories.

The author also started to dimensionalise some properties of categories (Strauss & Corbin, 1990) as he believes that dimensionalising a category’s properties is a core task in developing
a category, and the relationships between categories, so the researcher had developed the
categories in terms of their properties and the dimensions of the properties.

Throughout the open coding, the author wrote memos as a way to sketch and note our ideas,
reflections and concepts in parallel to data collection and open coding.

Strauss and Corbin (1994) discussed memoing at length, dividing it into three types associated
with each phase of coding. It is curious that Strauss values memoing as an analytic aid.

The focus of our reflections was often on using the actual wording or formulation used by
interviewees, which the author then interpreted during the analysis.

After conducting 20 interviews and analysing the outcomes through an open coding process,
several categories had emerged; however, after their refinement process the categories were
reorganised into four main groups: knowledge, knowledge management process, knowledge
management activities and organisation support (Appendix 2).

Some of the main identified categories are subdivided into subcategories; those subcategories
will be discussed in this section.

Categories and their relevant properties will thus be more refined and developed as the
research work proceeds. In addition, other valuable information was identified, such as K
definition and individual initiative. This information will help in the next step of analysing
data and conducting research for the next sampling.

4.5 Discussion

This section summarises the work performed by discussing the findings that emerged during
the initial interviews. Initial findings include emerging categories and other information after
several iterative cycles performed; this is clearly defining what we’re after with each iteration.
The better the feedback and the value we’ll receive from each cycle: after completing each
cycle, the author had compared the findings from each cycle and then after he refined the
categories that emerged and then enhanced the next interview guidelines. Data collection
analysing was further discussed in the context of the literature survey to identify similarities
and differences.
4.5.1 Knowledge definition

It is important to analyse interviewees’ responses in the light of their proper definition of knowledge.

There was no common definition of knowledge in the responses that almost every participant had given regarding their own personal definition; however, in general many referred to the information, experience, competence or skills acquired.

The definitions of knowledge given by respondents are in close proximity to and to an extent overlap with that of Davenport and Prusak (1998) who defined knowledge thus: «Knowledge is a fluid mix of framed experience, values, and contextual information».

The first three respondents defined K as information but nobody was able to describe the difference between K and information like Nonaka and Takeuchi, who recognised that knowledge and information are different in terms of belief, commitment, action and meaning (Nonaka & Takeuchi, 1995).

4.5.2 Category 1: Knowledge

Property 1: Epistemological Level

From the overall responses to the question «How many formats of knowledge you recognize? And what are they? » it has been noted that two forms of knowledge were distinguished by the respondents during the interview process: a documented and a non-documented knowledge. In the literature, documented knowledge is classified as explicit knowledge and non-documentated knowledge is referred to as tacit knowledge.

Nonaka and Takeuchi (1995), Michael Polanyi (1967: p. 4) and Quintas (2005) talked about these two epistemological levels and agreed that tacit knowledge is more difficult to share with others who haven’t been through a similar learning experience.

Kazi et al. (2005) identify tacit knowledge as the form of knowledge that is the most valuable to construction organisations.

Respondents shared this idea as according to many of them project success is mostly related to the tacit knowledge of the project manager and his team. Through responses to the question «What is the format of knowledge that predominates in your organisation? » it emerged
that tacit knowledge is the predominant format of company knowledge; this presents a problem for maintaining and enhancing knowledge within the organisation.

Several interviewees (senior managers) had stated that knowledge within our organisation is not documented, coded and archived and is in reality scattered between the team’s members in a non-documented format.

**Property 2: Ontological Level**

The dimension of knowledge was also mentioned and discussed by some respondents when they replied to the question «What are the different kinds or types of knowledge existing in your organisation? »

Individual and collective knowledge emerged as two levels of knowledge. The individual dimension was more approachable and more elaborated and discussed by interviewees.

The ontological dimension considers the levels of knowledge creating entities such as individual, group, organisation and inter organisation levels (Nonaka & Takeuchi, 1995). It can be confirmed that the individual entity is represented by the project team member, and the group is represented by the project team, while the organisation level is represented by the company organisation.

The inter organisation level as referred to by Nonaka and Takeuchi represents the sister companies within the oil and gas sector in Libya; this dimension is quite weak with no evident knowledge shared or transferred among the organisation.

Form the initial interviewee with the project managers and senior managers it was clearly noted that most knowledge is created at the individual level and not captured by the organisation. Thus there is almost no updating of policies and procedure.

**Property 3: Knowledge Domain**

The property of the knowledge domain is classified into three dimensions: technical, commercial and procedural; this was based on the categorisations proposed by Rod Coombs and Richard Hull (1997, p. 10): «the broad categories of the knowledge domain are technical, market (market is not commercial in the literature according to Rod Coombs and Richard Hull, but in our case it will be considered as commercial) and organisational procedures."
According to interviewees, technical includes highly specified areas of scientific, engineering and/or technical knowledge of particular products or processes, while commercial includes knowledge of a commercial and financial nature; procedural knowledge is a kind of knowledge that presents the features of the organisation, and knowledge of project management.

In the EPC-type projects it is common that the oil and gas companies (operators) do not have the function of market services and the more relevant terminology that they use is commercial.

From the interviewees’ responses and feedback, a substantial lack of procedural knowledge emerged, and it was noted that even if some good procedures are available, most of the interviewees were not aware of them and in some cases even if they were aware of them they are not benefiting from them.

Although reflections on commercial and technical knowledge were quite reasonable, there is no link between them; this as a consequence creates gaps and grey areas in the development of the project work, which according to some of the respondents can generate delays and additional cost to the projects.

**Property 4: Knowledge Aspect**

It was identified by respondents when they replied to the question «What is the main source of knowledge in your organisation?» that knowledge in the project organisation can take different forms, such as LL, best practices, workshop outcomes and other various means.

**Lessons learned**

In terms of learning and capturing from experience in a project-based environment, Salisbury (2003: p. 115) states: «Once the project is finished, the key challenge is learning, that is to capture all the LL in this project so that they can be reused by other teams».

LL (LL) practices are an important aspect of KM and refer to «the activities, people and products that support the recording, collection and dissemination of LL in organisations» (Snider et al., 2002: p. 291). The purpose of LL is to capture experiences, successful or otherwise, allowing an organisation to avoid repeating costly mistakes, improve future performance and ultimately their profit (Carrillo, 2005b; Kartam, 1996).
During the research investigations, several interviewees had said that they don’t profit from LL obtained from previous completed projects, and several mistakes were repeated.

One of the interviewees had said: «In our offshore installation period we were installing a heavy top side module and the design data used related to site locations (wind speed, wave height and length…) was not accounting for a daily, weekly but the average of the month; this has forced us to be on standby for 4 days offshore in which additional cost was incurred in addition to a delay on the first gas production.

During the execution of the work we were unofficially informed that exactly the same thing happened to one of the company’s previous similar projects just 6 years before».

There is no formal and recognised LL managing system that operates to help project teams to capture and reuse the previously created knowledge resulting from previous company-executed projects.

**Best practices**

Best practices can be generated based on a new innovation or as a result of successful acts. Best practices as a result are reasonably shared according to interviewees; however, the form and process of these practices are still tacit.

Many individuals see that sharing knowledge with others in terms of how they achieve the best use of the existing practices can have a negative effect on them by losing their images and power in the project organisation.

**Workshop outcomes**

Workshop meetings are one of the important drivers in updating or creating new knowledge. They provide a challenging and encouraging environment for the project team participants to develop solutions to the problems to be solved according to the objectives of the workshop.

From the interviews carried out the researcher noted that the participants in the workshop meetings are selective and this does not allow for extended numbers of team members to attend; in addition, the outcomes of the discussions were not recorded and in most of cases mostly what is recorded and distributed is only the agreed action with no details on the
discussions that took place and the different technical arguments explored during the WS discussions.

In this regard, it can be concluded that most of the K obtained is kept as tacit knowledge and maintained only among the attendees; not much documented knowledge is available to the rest of the project team.

**Other knowledge aspects**

Other knowledge aspects such as occasional project events, telephone or video conference communications need to be supported in particular by a proper ICT system to be shared. The role of ICT in sharing and enhancing communication between individuals is recognised as an important support service by several interviewees.

4.5.3 Category 2: Knowledge management process

It is essential to manage the created knowledge within the organisation to benefit from it.

The interviewees recalled only four processes of managing knowledge: capturing, updating, archiving and sharing:

- **Capturing**: Respondents used the term «capturing» to describe the collection of knowledge during and after project completion from external and internal sources.

- **Updating**: The term «updating» was used by interviewees to describe the process of enhancing and developing knowledge located in the organisation.

- **Archiving**: This is the process of knowledge storing, according to the majority of the respondents. The storage of knowledge in different project phases is an archive of the project events, and if it is made complete and structured in the company server in an easy and accessible way, it can present a real archive of the project.

- **Sharing**: This was cited by respondents as the process of transferring knowledge between project members and also between projects. Most of the interviewee respondents stated that we share knowledge during our technical review meetings and through the subject’s workshop meetings; during those meetings we exchange new ideas on how to resolve a technical problem.
In the literature, the KM process is characterised by highly detailed and complex studies. The author found in the literature many other processes of KM not recognised by respondents, such as **identification, storage, mapping, dissemination, embedding, producing, driving, understanding and measuring, leveraging**…

Some of the emerged processes overlap with the cited process. Certainly there is a gap in the understanding and application of KM processes, but this gap cannot be evaluated at the present stage due to the preliminary character of the research phase.

Given the wide range of terms used in the literature, the author will use during this phase five hybrid subcategories of KM processes, which are: **creation, capturing, sharing, saving** and **dissemination**.

These subcategories were fixed after comparing the KM processes found in the data and the literature. The researcher saw that they are the main and broadest processes to elaborate in this initial phase.

- **Creation**: This is concerned with adding value to previous knowledge through innovation, particularly in developing new skills and competencies of employees (Hussain & Lucas, 2004), who discuss KM as a process that helps organisations identify, select, organise, disseminate and transfer knowledge. The main focus for creating knowledge was related to researching new ideas and products from external sources. In terms of creating knowledge, it may be created in a purposeful manner such as through R&D or much more serendipitously through the problem-solving process on a construction project as noted by Kazi, Koivuniemi, & Moksen (2005).

- **Capture**: Capturing Created knowledge is the first essential process of KM. This process was judged as not effectively implemented, and according to several interviewees, knowledge is not captured from individuals.

- **Saving**: Saving can include updating old knowledge and archiving new knowledge). This procedure is not implemented in several Libyan organisations according to interviewees. Knowledge is not updated and archived.

- **Dissemination**: While sharing, transfer and dissemination seem to have the same meaning; they are different depending on the two sides participating in this process. After conducting an in-depth literature review (Chapter 2), the author selected and adopted the definition that makes sharing a process more related to the interaction
between individuals; transfer is more related to exchange between groups (project teams, subteams), while the dissemination terminology comprises both the sharing and transfer of knowledge. According to the interviewees’ outcomes, in this case, more specifically, the project managers’ knowledge transfer within the company organisation is very weak. One of the respondents stated that «it’s quite rarely that we meet with other project teams and project managers and discuss critical issues, as it’s not a habit that other project managers attend review meetings related to a specific project. This is the situation we have and in my view it’s not supporting the share and transfer of knowledge within our company». It seems that there is a sort of commitment issue related to knowledge sharing at the individual level. One of the respondents said: «I am not prepared to share my acquired knowledge in the best practices with other members of the project team; it’s a result of my personal accumulated experience, which is the result of years of efforts spent on self-development».

Individual sharing constraints within project teams, including project managers and their teams, will be discussed with further consideration as the research proceeds, to evaluate the gap and identify causal conditions of this issue.

4.5.4 Category 3: Existing learning activities

Property: Formality

There are many activities of knowledge management that provide the opportunity to «reflect upon their work achievement, job skills stories and ideas with co-workers, or catch up on professional theory and practice» (Grisham & Walker, 2005: p. 554). But according to interviewees, there are organisational issues that require attention: project and individual activities are not decent and effectively exploited to help and/or accelerate managing knowledge; projects activities are implemented to support the tracking of knowledge outcomes being integrated into a knowledge management system.

Meeting

Problem-resolving meeting

According to interviewees, when a problem appeared during any phases of project execution, an urgent meeting was organised, but in most cases the project manager felt that there was enough time given to problem-solving and reflection during the course of the project work: «If there is a problem we just get whoever is involved from the team». Problem-resolving
meetings are usually urgently organised and there is no prerequisite set up or preparations to guarantee or support their satisfactory achievement.

Only very occasionally were reports issued and distributed from this kind of meeting; the problem causes, factors and proposed and adopted solutions were generally left with the individual team members involved and there was no opportunity given to have them shared with others, i.e. they were kept in the form of tacit knowledge.

The author noted from the respondents that the majority of problems faced by projects during the execution are not officially declared; according to the respondents, this is for several reasons, such as the feeling that the project teams are reporting a failure (not a success!), which can be judged as a negative reflection on their personnel’s professional evaluation. Individuals are very sensitive on this matter as this can be a bottleneck in the development of their career. The author also noted that in this regard the local cultural system does not help and in a way does not support the reflection of problems in a transparent manner.

Project workshop meetings:

From the interviewee respondents it is noted that in general, only the project managers and senior staff (including lead discipline engineers) participate in this kind of meeting, for several reasons. First, it’s common to limit the number of attendees to contain the discussed subject within the senior team members only. Secondly, the team members are quite busy and it is important to understand that keeping them on the work they have is better than involving them in other issues.

In addition, it was also observed that no records and dissemination of the meetings’ results, conclusions and agreed actions were taken place and by whom? This creates non-continuity in terms of the work trends and cycles, and it generates gaps between engineers that are involved on work detail levels and their senior management. With this evolves a risk on technical work levels, and interfaces among different activities, which at the end can create potential negative impacts on the project.

Contractor meetings

It’s common that there are planned meetings between the contractor and his subcontractor as it is also a contractual obligation to have meetings scheduled on a weekly and monthly basis.
Those progress review meetings are usually attended by the company project manager and his lead engineers along with senior contractor staff and support services.

**Project progress internal meetings**

What usually needs to be accomplished during such regular meetings is progress on the work deliverables, the status of the schedule, man-hours spent, and cost versus what was planned and an explanation of any variance. According to the interviewees’ replies, those meetings are only attended by the project manager with his first line reports; as a consequence, any knowledge developed or updated is only maintained within the project management team and not disseminated to their subteams (project team members), and, as is typical among organisations, the reports issued only concentrate on the high level and do not elaborate on details that, in our opinion, are important to gather, record and distribute to all team members. In addition, those reports are kept within the senior team and not distributed to all project team members.

There are other barriers to knowledge sharing within the project team: gaps exist and there is no constant and consistent flow of information among all the project contributors. This, according to the interviewee respondents, is one of the major constraints in knowledge sharing and enhancement.

**Post-project review meetings**

According to interviewees, this kind of meeting rarely occurs. There are no post-review meetings to discuss and evaluate the outcomes of the project, criticalities and problems faced during the development period and how this was treated by the project management team.

Some of the company’s respondent team emphasised that post-review meetings were not organised for the projects that they participated in; one of the respondents stated that «the post-project review meetings, if they took place, only concentrated on the final aspects; they are mainly to close any pending payments to contractors and to close out the project cost by closing the related job cost centres».

**Informal meetings**

Informal meetings between project team members and contractor teams were recognised as a real opportunity to share knowledge between individuals. Most knowledge-capturing opportunities occurred during those informal meetings that usually take place in coffee breaks.
or after official project meetings: «Even if it was for a short period of time, but it was an environment that encourages individuals to talk and share ideas». said one of the interviewee respondents.

Other respondents said that «those occasions provide more opportunities for informal accidental learning than any other single type of learning». Accidental learning occurs in everyday activities when an individual learns something that he or she had not intended or expected.

**Site visit**

Most of the work site visits are performed by senior and experienced team members that are involved directly in site visit activities; exposure to others is not usual and if reports are issued they are not accessible to the rest of the team. Any outcomes such as comments, observations and instructions to contractors are valuable information for the rest of the team if they are circulated.

**Training**

Training is a process of knowledge sharing that is very formal and should have defined objectives. Olomolaiye and Egbru (2004) consider training to be an important activity of KM. They suggest that awareness of KM can be improved by training as a vehicle to focus on achieving quality, creativity, leadership and problem solving.

Interviewees recognised the role of training but they declare that although the organisation spent time and money on training, the outcome results are not encouraging and it doesn’t meet company target. They believe that a strategic map of knowledge should be elaborated. Another added that people who receive training should share the knowledge acquired from that training with others via mentoring. Finally, training always results in tacit knowledge, according to interviewees.

**Mentoring**

According to Gregson (1994: p. 26), mentoring «is an attempt to transfer experience and expertise from experienced individuals in an organisation to the less experienced». Mentoring is commonly used in organisations to develop and nurture potential future managers from an early stage (Mondy & Noe, 1996), but has also proven effective in developing employees at more senior levels (Gay, 1994).
«Research shows that mentored individuals are more likely to be the organisation’s future leaders» (Scandura et al., 1996). Mentoring must be seen as more than merely assigning a novice to a more senior member of staff; it requires the careful selection and training of the mentor in the first instance (Gregson, 1994).

According to interviewees, mentoring is a very effective K management activity, because most knowledge is tacit and people need to profit from the experience of others. However, like training, knowledge still always takes a tacit form when it is shared through mentoring.

4.5.5 Category 4: Role of organisation

Both senior and project managers recognised the lack of a KM supportive environment in organisations. According to the response made by one of the project engineers, «the company don’t help us to benefit from knowledge, there is no clear map of knowledge created and knowledge needed during a project».

One senior manager agreed by adding that «Unfortunately, knowledge management does not represent a strategic objective in our organisation».

Both mapping knowledge and considering it as an objective can be included as strategic support to be provided by an organisation in order to manage knowledge effectively.

The strength of this kind of support was evaluated as low in the organisations studied. Although the technological issues related to information and communication rarely exists in terms of infrastructure in place, the issues related to this domain are more related to convenience and ease of use than to availability.

Some interviewees recognised that access to organisations’ databases are not allowed in some conditions, while it’s strongly needed. One project engineer said: «During some site visits we needed access to our database via the Internet and it was impossible to gain access via the intranet; this caused a problem».

Another subcategory of organisation support is management support, including motivation and guiding. This kind of support was recognised by all project managers, and they assured us that the organisation does not provide for them a guide or procedure of managing knowledge within their teams and between teams.
4.5.6 Individual initiative

a. Description

Although many issues emerged, one of the respondents mentioned initiatives for capturing knowledge. During project managers’ interviews, it emerged that he had attempted to give his middle management team the task of knowledge keeping and dissemination within their own professional family.

It was an initiative and individual commitment from the project manager to managing the knowledge within his team even if the results were not very successful, as it was much less than the expectation «he reported».

The project manager recognised the role of an LPE in knowledge management. «It appeared that there are no knowledge keepers (or manager) within the project organisation». This was noted in all projects apart from its complexity in scope or size.

This will not help the project team in coding, archiving and sharing any type of knowledge created within the project; almost all knowledge at the end of the project period will be kept as tacit knowledge within the individuals with no further development among the teams, and as such the organisation benefits become minimal if not none «and The project manager decides to give lead project engineers (middle project managers) this role.

According to him, «lead P engineers are the correct persons to achieve this role » he said.

As a result, he requested his team to capture the knowledge created during the project and formulate a LL report at the end of the project. He asked the project team to call and organise KM meetings whenever deemed necessary.

b. Results

The PM stated that no significant information was reported. Even if the reports were existing and available as part of the project close out dossiers they don’t contain much information to reflect the reality of the issues that occurred during the project, i.e. not the thorough reflection of what occurred during the project development period.
As the majority of knowledge managers within the project teams were not committed to KM objectives from the beginning to the end of the project cycle, it was impossible for the PM to synthesize a lesson learned report to deliver to the company’s senior management.

He added that he knew that the volume of knowledge created during the project life cycle was certainly more than reported.

He further added that most knowledge managers delivered their reports with no LL or any new or updated knowledge identified at the end of the project. This present task is easier as the terminology is known and the task is not difficult to accomplish; however, in accordance with the interview results the outcome in this respect is quite negligible. Projects started, developed, ended and handed over and closed out reports don’t contain any LL or new knowledge captured during their development.

c. Causes of failure

In addition, he added another area of concern by highlighting that it’s a failure in the practice that most K managers adopts, they use to prepare the LL and K reports at the latest phase of the project nearly to the end, even some times after the completion of the project; hence the issues reported, if any, became superficial and not representative, it was quite impossible for a project team to remember all the causes and effects during the project period, during the different execution phases, from the beginning up to the end if it was not properly recorded, EPC projects usually had quite long work execution durations (2 to 5 years is typical).

The project manager explained that the cause was due to the awareness and qualification of project lead(s) engineers (middle project management team) in playing the role of knowledge manager as this role is considered a new discipline and within the culture of project management. The above demanded a further investigation among project leaders» (or middle managers) to further examine and assess the source of the failure.

4.6 Conclusion

4.6.1 Responses to research questions

This chapter has sought to present and discuss the research work findings and the literature review outcomes of the initial phase of the research work, the aim of which is to investigate
the field of KM adoption within the Libyan oil and gas industry through a number of major operating companies.

After this initial research phase, the three research questions posted in Chapter 1 can be answered based on the findings that emerged.

- **Q1.1:** What issues should be addressed with regard to KM adoption within Libyan oil and gas EPC project organisations?

It has been noted from the interviews that almost all project knowledge is maintained as tacit knowledge and is mainly kept within the project manager (PM).

The practice of capturing, coding and archiving new or updated knowledge, including LL (LL), including the mistakes that occurred during the project(s)’s current and previous work phases or that happened in earlier projects, did not exist.

The main issue that emerged was how to maintain and enhance knowledge sharing and transfer within organisations, within sole project teams, within different project teams and within the overall company organisations.

It was recognised that almost no knowledge transfer (KT) occurred within the project team or from one project to another.

It can be argued that the studied organisations currently manage knowledge mostly on an informal basis; knowledge is not considered a target or a strategic objective in the organisations.

It is logical that respondents talked about ineffective use of knowledge within the organisation as a consequence of a great lack of knowledge in the management process.

Knowledge used and developed in the organisation was resulted from an extensive accumulated time upon which many projects were executed by the organisation.

However, this was not organised and not updated, which may cause many unpleasant issues, such as not benefiting from past experience, previous mistakes, unnecessary additional money spent; unnecessary delays, etc.
Based on the evidence provided, oil and gas organisations manage knowledge informally without an adopted strategy and defined system, but there are some learning activities which can contribute towards KM implementation, such as meetings and workshops, site visits and training, however such activities have not been effectively exploited.

In practice, knowledge created in projects is often lost when the team splits up and the members return to their tasks in the organisation. This leads to inefficiency as time and money are spent on inventing things that are already known inside the organisation.

- Q1.2: What measures should an organisation take into account to resolve effectively those knowledge management issues?

An organisation should enhance both the dissemination and capture of knowledge. It should let people disseminate their knowledge and make sure that this knowledge is captured by an organisational learning system in an appropriate way. To achieve this, generally, the following practices and activities should be addressed to achieve an effective adoption and implementation of KM:

- Placing more value on learning from previous executed projects and incorporating the LL documentation as the main aspect of knowledge outcome in an EPC project.

- Placing more importance on procedural knowledge, as it represents the main influencing domain of knowledge in EPC project management, and the need to externalise it in an explicit form to facilitate and enhance its management.

- Building upon and expanding and facilitating existing work practices, such as meetings, mentoring and site visits, as they appear to be the most appropriate approach for developing and implementing KM.

- Building upon existing formal and informal learning activities that present the only actual opportunities for knowledge exchange in the absence of an organisational learning system.

Encouraging a supportive organisation environment where KM can operate, including strategic, management and technological support, helps to facilitate the commitment of all professionals towards the project objectives.
Q1.3: How can these measures be suitably implemented and accepted in EPC projects within Libyan oil and gas companies?

Project-based organisations that consider by nature the project’s knowledge and especially LL from problem-solving activities as the most important kind of created knowledge should have a clear and suitable strategy to benefit from the LL generated from each project.

In this context, the potential of integrating KM with Project Management emerged, where the role of meetings, workshops and site visits needs to be taken into consideration to achieve an effective KM implementation.

But in order to reply to the above question, the potential of integrating KM with PM integration of the point will be further investigated to be proven or disproven during the next phase through studying the critical success factors of KM implementation in the case of Libyan oil and gas companies.

4.6.2 Framework

The preliminary framework was built from the categories that emerged. It is primal as relationships between categories are not yet fully elaborated. It includes the knowledge levels that emerged and the four main processes identified to manage this knowledge. A knowledge management system can be built upon the use of current practices and activities, meetings, training, mentoring and site visits, which present the basis of KM implementation.

This implementation needs to be enclosed by the support of organisations including strategic support at the first level, management support and technological support at the second level.

The framework will be further developed to be more consistent and representative as the research proceeds.

In view of the above, the research work will be focused on developing the related categories, subcategories and properties through axial coding, which will present more in-depth investigation.
4.6.3 Next phase

Through the analytical process conducted and writing memos, a number of areas identified for further data collection and analysis have emerged. In the pursuit of theoretical sampling that will be supplemented by a further review of relevant literature, the research will focus on middle project managers or lead project engineers and project engineers to investigate in depth the status and conditions of knowledge management in the organisation.

One project manager has represented the exception through an individual initiative, which will be described in detail in the following section.

This individual initiative presented a golden opportunity and was conducted in two new research areas.

The first new area that should be investigated further is the knowledge management initiative to identify the reliable influencing factors of an effective and suitable KM implementation in Libyan oil and gas companies.

For this first new area a case study emerged in which the lead project engineers participated in the individual initiative as they were involved in the semi-formal or elemental KM experience, which can help to enhance the research and give more reflective and valuable results.

The second area that should be further investigated is the issue of knowledge transfer between project phases. It was argued by the project manager who made an initiative «that the knowledge captured at the end of each project was not representative at all and not useable for other projects.

For this second new area, an observation of an EPC project emerged as necessary for tracking the knowledge flow from phase to phase and for identifying the origin of knowledge loss and how to react against this issue.
Figure 22 first phase framework (source: author).
Chapter 5

RESEARCH PHASE 2

CASE STUDY A
5 Case Study A

5.1 Introduction

As already stated in the introduction of this research (Chapter 1), the main objective of the research is to develop a KM process framework, activities aimed at improving organisational business performance, and to deliver improvements in both learning and business performance within organisations.

As discussed in the introduction, to achieve this main objective, it was necessary to understand the issues hindering the implementation of KM, and the best ways to go about adopting KM.

After conducting initial interviews with project managers and senior managers from three leading oil and gas companies, a lot of issues emerged.

Issues related to managing this knowledge emerged, such as how to maintain knowledge, enhance knowledge sharing and transfer within the organisation, within the sole project team, within different project teams and within the overall company organisation.

It was noted from the interviews that almost all project knowledge is maintained as tacit knowledge and is mainly kept within individuals. The practice of capturing, coding and archiving new or updated knowledge, including LL (LL), counting the mistakes that occurred during the current project and previous work phases or that happened in earlier projects did not exist. It was recognised that there was almost no knowledge transfer (KT) within the project team or from one project to another.

However, during one of the project managers’ interviews, it emerged that he had attempted to give his middle management team the task of knowledge keeping within their own professional family.

It was an initiative and individual commitment from the project manager to manage the knowledge within his team but he thought that the results were not very successful, as it was much less than he had expected? Although the KM implementation initiative made by the project manager seems like an underperforming, negative and non-contributing issue in real-world terms, in academic terms it gives us an opportunity to identify lessons from that incident because good lessons can be learned from failures.
Chapter 5

Thus the initiative was considered to be a golden opportunity for research development; it enabled investigation of a reality and unusually real experience of knowledge management across oil and gas companies in Libya.

In other words, it was very important and helpful to identify the real causes of initiative failure as they reflect directly on the critical areas or influencing factors of KM implantation.

The project manager explained that the cause was due to the lack of awareness and qualification of project leaders (middle project management team) in playing the role of knowledge manager as this role is considered a new discipline within the culture of project management. The above demands a further investigation among project leaders (or middle managers) to further examine and assess the source of the failure.

While in the initial phase (Chapter 4) the researcher tried to formulate a researchable question that is flexible enough to allow for in-depth investigation, in this step of the research, as a case study, a sufficient narrowing down of the research questions is needed to allow them to be better used.

- Q2.1: What critical factors can influence the adoption of KM in the Libyan oil and gas EPC project environment within the oil and gas companies?

- Q2.2: Building upon the existing practices, how can these factors be addressed and how can roles and duties be distributed within the company to implement an effective KM management.

In this research phase, the researcher used two methods of data collection – semi-structured interviews and an electronic online survey – and two methods of data analysis: qualitative and descriptive quantitative.

To answer the first question of this phase – two items should be addressed: firstly, identifying influencing factors and then evaluating them to select the most important in order to find the appropriate measures and solutions.

To identify influencing factors, it was decided to e-mail a questionnaire to the project department team of the organisation.
Figure 23 Third research phase design.
But first a pilot study based on semi-structured interviews was conducted with the lead project engineers who played the role of K manager in the failed KM implementation initiative in order to draw the primary broad lines of the questionnaire.

After interviewing three lead project engineers as a pilot step, the idea of making some modifications to the data collection method emerged. As will be demonstrated later, according to the interviewees of the pilot step, emailing the questionnaires will make some difficulties to obtain good rate of responding. It was decided to use an online questionnaire and email to participants just the link to the questionnaire to maintain more confidentiality for the respondents and to increase the number of participants.

Thus, in the second step, a fine-tuning of the questions in the questionnaire was carried out based on the outcomes of the pilot step before inviting the project team to respond online.

After receiving the second step responses of the online questionnaire, it was decided to triangulate the results obtained from new participants from the IT and HR departments and also rate the items that emerged from the first and second steps to evaluate the importance of factors.

Before completing the third step to rate the factors, the new participants were invited to reply to the second step to realise the triangulation of results and validate the concepts that emerged.

The third questionnaire was based on a Likert scale rating method, which will be explained in more detail later. Quantitative data extracted from this questionnaire were injected into the qualitative analysis as illustrated by Figure 20 in Chapter 3.

Gillham (2000) stated that while a multi-method approach can enrich research findings, it can be difficult to blend various findings together.

Therefore, the quantitative approach in this research was used just to evaluate properties of one category and not to discover new findings.

For this purpose, qualitative and quantitative methods can be viewed as complementary. Strauss and Corbin (1998: p. 34) state that «qualitative should direct the quantitative and the
Chapter 5  Case study A

quantitative feedback into the qualitative in a circular, but at the same time evolving, process with each method contributing to the theory in ways that only each can».

In addition, the sampling was based on the diversification of participants, project engineers and lead project engineers, to maximise the reliability of findings.

Asking someone precise and direct questions in the context of a bad experience can present many challenges, such as the reliability and accuracy of answers.

This issue was proved in the first interview as the respondent seems to cover some realities and avoid going in depth through the causes of the experience of failure and this was due to different causes.

The problem was that during the data analysis process, having false or inappropriate data can generate inappropriate or false categories and affect the quality of the final theoretical framework.

Many researchers in social sciences suggest using triangulation techniques in the data analysis phase to improve the validity and reliability of the research findings (Denzin, 1970; Easterby-Smith et al., 1991; Jick, 1979; Miles & Huberman, 1984). Hussey and Hussey (1977) suggest that the use of different approaches, methods and techniques in the same study can overcome potential bias and sterility. Therefore, data triangulation and investigator triangulation will be employed in this research phase through a compilation of face-to-face interviews, online questionnaire and literature review to improve the accuracy, reliability and validity of the findings.

5.2 Step 1

5.2.1 Sampling

As with theoretical sampling, it is essential to establish the criteria upon which the selection of participants will be based (Eisenhardt, 1989; Schwandt. 2001). The lead project engineers (LPEs) were considered for this step to be the most appropriate candidates for the interviews.

A first pilot step was carried out to check the performance of the new semi-structured interviews with three lead project engineers who participated in the KM initiative.
These leading project engineers were selected for a number of reasons:

- The importance of LPEs as good interviewees lies in their discipline management role, because usually, knowledge is created through discipline.

- The importance of the role of lead engineer or middle manager in KM as «the hub» in terms of communication and knowledge sharing between the project disciplines and project manager.

- This role is supported by a number of authors who view the middle level of management as being central to KM-related activities (Davenport & Volpel, 2001; Mohamed, Stankosky, & Murray, 2004; Nonaka, 1995).

### 5.2.2 Data collection

The participants were asked about their reflections on the KM experience. They gave their explanation of the «failure» of the experience, and the challenges and difficulties confronted.

During the interviewing of the three participants, their psychology and behaviour were scrutinised and related notes were taken as suggested by Creswell, J. (2003), who said about such notes: «During and after each interview, notes would be made to describe important observations that are relevant to the research questions. »

### 5.2.3 Data analysis and findings

In gauging the acceptability of the questionnaire, throughout this pilot study, the participants suggested avoiding questions investigating where the responsibility for the failure lay, and refused to enter in depth into some confidential details about the KM initiative.

The analysis of the data of step 1 began with open coding as a microscopic (sentence-by-sentence) examination of each interview (Strauss et al., 1990).

While in the first phase of the research, codification was done without predetermined ideas or a preconceived model, the present open coding was based on the outcomes of the previous phase; in other words, the codification process was proceeded in the light of the ideas that emerged from the initial interviews and in the context of the step.
This continuity of the conceptualisation was maintained in order to enhance the previous findings and build upon them.

The example below shows the open coding of a short passage from a lead project engineer’s transcript text talking about the difficulties that he confronted during the attempt to implement KM.

To help the analyst mark up the page, the text has been printed using double spacing, so that it is possible to write code ideas and code labels between the lines. In addition, a wide margin is used, so that code labels and other comments can be written there. The transcript was printed out in whatever way supports the approach to coding the text.

In this example, although many old codes (Chapter 4) such as «knowledge sharing», «group level», «knowledge creation» etc... had been retrieved, three new codes were generated: «work overloading», «lack of time» and «tight schedule».

These three new codes describe the lack of opportunities for knowledge management activities during the project life cycle.

The lack of opportunities can be considered as a cause related to project management.

This example demonstrates how new categories and subcategories emerged through the open coding process. Many other concepts that emerged from the data collected are shown below in the table (findings) and then discussed in the section (discussion).

The data collected have been coded line by line through open coding (Appendix 2).

The concepts that emerged during the first step were classified into two main categories:

1. Factors related to ICT

2. Factors related to project management
Chapter 5

5.2.4 Discussion

- Category 1: Project management factors
  - Subcategory 1: Opportunity for reflection

The lack of opportunity to share information and knowledge is strongly related to a lack of time, which is a specific issue that was highlighted by many in the EPC-type project environment.

Opportunities to share experiences are inhibited by the pressurised execution environment of projects in general but more specifically in EPC configurations. Project engineers talk about a lack of learning opportunities in the EPC: «Because everybody is busy, overloaded by their job, there is no time to talk about their tasks».

Project teams work under high pressure and against time to achieve the project objectives. «Time is money; time is killing» said one lead project engineer. It is a factor that does not stop pressurising the members of the project team. Because of these constraints, projects are managed without enough time to discuss, think and exchange knowledge.

Generally, after a project is completed, the team is directly engaged in a new project, and because of this, there is always a risk of knowledge losses at the end of the project.

In light of the above time constraints a very influential parameter emerged.

This factor is very important: «employees must have time for learning and management must regard learning as real work» (Davenport, L, & Prusak, 98).

- Subcategory 2: Project team structure

In a complex structure (Appendix 8), there are many barriers to knowledge sharing between individuals, such as: different buildings, different offices, and barriers in face-to-face meetings and discussions. Then what can be seen as an unconvincing argument (initially), if discussed face to face (round the table), new ideas can develop and new knowledge can be created, ready to use on the spot for the current project matter and for further implementation; if this opportunity is not made available (this generally happens in complex projects, involving big teams), then knowledge sharing and creation can sometimes be put at risk.
Subcategory 3: Time lapse

The length of time of a project is a factor influencing knowledge management: knowledge can be potentially lost due to time lapse. EPC projects are quite long and typically take between 24 and 36 months to execute. During these long time thousands of activities are running, some in parallel others in series and this involves teams composed of hundreds to thousands running throughout the project life. Thus, in the absence of a good KM system that tracks the knowledge created and used during the project, most project knowledge will not be available at the end of the project period and what will possibly be identified is what the project team can remember and record in the project close out report.

Subcategory 4: Procedure and policies

KM tasks are requiring to be considered in the projects base line schedule or plan, providing resources to project team to take part in the learning activities and exercises is essential. The role of KM needs to be identified and assigned to key project contributors to perform as part of their work duty and responsibility.

Category 2: Technological and communication factors

According to Husted and Michaiova (2002), language can be an issue if the company’s native language differs from that of the project members. This was confirmed during the interviews by a number of responses: «In projects where I was lead project engineer there were many different nationalities and even if we used the English language as the project’s official language, on many occasions we discovered that when we wrote a sentence or paragraph, it could be interpreted in different ways by different team members due to different mother languages».

Subcategory 1: Lack of social network

Sharing knowledge and LL with one another among the project team members is often facilitated through the use of technology, which has regulations and practices that need to be taken care of before it can be used (Riege, 2005). The project team members almost all agreed that technology never necessarily constrained sharing knowledge.

Subcategory 2: Lack of network access

Access to the company database and archive from anywhere at any time is very important to ensure the continuous capturing of knowledge.
Some technological barriers to sharing and capturing K have emerged from the project team’s interview analysis.

Some interviewees stated that the company’s server is only accessible from their office desks.

And when a professional is at company sites, away from the company’s physical location he cannot gain access to the company’s server.

5.3 Step 2

5.3.1 Data collection

Changing data collection methods was not preconceived from the beginning of this research phase. It was decided to let the method used in subsequent steps emerges from the data analysis and findings.

An online questionnaire was chosen as the method of data collection in this step.

The second step emerged as necessary for further investigation into the real causes of failure and validating the concepts that emerged from the first step.

During the first step the need to apply the triangular technique in analysing data was proved by the behaviour of the respondent as it seems that knowledge managers didn’t want to talk about the real causes of failure in the first step, thus this leads the researcher to conduct another method of data collection which was an online confidential survey.

This method helped the researcher to discover the real barriers that stopped the project team committing to the initiative.

The questions addressed to the respondent sought to validate the categories that emerged in the previous step. They were asked to validate the two emergent categories and develop them if possible.

The online data collection method presents some advantages and disadvantages compared to the face-to-face interview: there is no controllable dialogue, no constructive questions and responses and no psychological notes taken, however it gives more freedom for respondents to give sincerer replies.
This method is based on an online survey, and responders will not indicate their role and/or personal information. It guarantees the confidentiality of responders and encourages them to reveal data without fear of causing work problems.

That’s why the online method was not used in the goal to reveal new concepts rather than to validate the emerging previous categories and ensure with the literature review the triangulation technique in terms of coding.

For this application, online survey software was selected and used. This can be found at https://www.surveymonkey.com.

Although the form was more structured and based on «yes» or «no» responses, justifications and arguments were always requested from the respondents.

This method was chosen because of its high reliability and the large sample that participated in the questionnaire.

### 5.3.2 Sampling

The online survey, as discussed, was an open questionnaire sent to all the project team involved in the step.

The sampling targets in this step were all the project department members.

**Project managers**

They can be responsible for KM transfer within the project team and from one project to another.

When managing their project knowledge, they contribute to building an organisational K in the company.

**Lead project engineers**

They have managerial responsibilities but with lower levels of responsibility and were also interviewed because they are involved in decision-making, and could be responsible for any KM activities within the sub-teams; the appropriate person in charge of KM issues did not exist in the Libyan oil and gas industry.
Chapter 5

Case study A

Project engineers

They have non-managerial responsibilities but represent the highest percentage of project department members and are the main source of knowledge created as project knowledge is strongly related to individual tacit knowledge.

The online survey had also been sent to project engineers to further confirm the response of leaders and to facilitate the evaluation of emerging barriers.

By addressing many targeted people from different hierarchical levels, a high accuracy and comprehensiveness of data was sought by means of triangulation. The number of respondents and position can be seen in Table 11.

<table>
<thead>
<tr>
<th>Level</th>
<th>Number invited</th>
<th>Number that participated</th>
<th>Percentage of participation %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project manager</td>
<td>4</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Lead project engineer</td>
<td>18</td>
<td>15</td>
<td>83.33</td>
</tr>
<tr>
<td>Project engineer</td>
<td>105</td>
<td>88</td>
<td>83.80</td>
</tr>
<tr>
<td>Total</td>
<td>127</td>
<td>107</td>
<td>84.25</td>
</tr>
</tbody>
</table>

Respondents received an online invitation to participate in the survey questionnaire via a given link. Their responses were sent to the researcher who manages the survey from his account in the Survey Monkey, which is very popular software that has been in use since 1999.

5.3.3 Data analysis and findings

Open coding was used again to code justifications and arguments given by respondents in the online questionnaire, as it is always the first coding process used for new data collected in this kind of research.

The concepts that emerged during the first step were validated by online respondents.....
In addition, new facts were discovered and classified into two main categories:

- Organisational factors
- Professional factors

The data collected were coded line by line through open coding (appendix 2).

While the project manager justified, in the first phase of the research, the non-commitment of the project team in his KM management experience by the absence of the skills needed to accomplish their roles within the KM system, lead project engineers have another explanation for the experience of failure caused.

Other KM failure causes were identified in their responses in the interviews.

These causes, reflecting the critical area or influencing factors of KM implementation, can be classified into four main categories: project management causes, technological/communication, organisational and professional causes or factors.

These emerged categories include different subcategories, which are described below and shown in Table 12.

**Category 3: Organisational factors**

It was demonstrated that the role of K manager is not recognised by the organisation according to respondents; they identified a new source that contributed to the inhibition of the KM system. Specific and identified duties related to KM are to be assigned to the project team (identified members), the assignee becomes responsible for performing them while he or she is performing their other project tasks and their management will evaluate their performance (have they completely met the objectives?) and the KM task will be one of the tasks subject to their evaluation. Incentives are a good tool to be used for the development of Km, and are a new discipline (partially) within the project team. If his or her efforts and outcomes are not recognised by the organization, the KM system is not likely to be established within the organization.
Category 4: Professional factors

When the respondents participated in the online questionnaire, they had the opportunity to talk about new problems that they confronted.

There are people who don’t share K if they know something about the project because of job security, loss of power, value of information, professional evaluation, developing skills, and trust in others. Trust in a project team can be another barrier to knowledge sharing between project members. For company project team members, creating an environment of trust requires an extended period of time, and that is very difficult to find during a project as it is always a temporary organisation built for a specific task within a defined period of time (most project members are not permanent company staff, they are contracted with the company for the duration of the project). Project members in most cases are quite new to each other and as such they always try not to share much of their knowledge with others to secure their continuity within the project or even with the company in other projects.

5.4 Step 3

5.4.1 Data collection

Step 3 was based on another online questionnaire aimed at evaluating the importance of the merged KM implementation factors.

The respondents rated the importance of the four categories of influencing factors that emerged during steps 1 and 2.

Respondents were given a total of 16 elements to rate, with five questions regarding organisational challenges, three regarding PM challenges, four regarding professional challenges and four for ICT challenges.

They rated them on a scale of 1 = not important at all, 2 = slightly important, 3 = moderately important, 4 = very important, and 5 = extremely important.

Four pilot questionnaires were sent, firstly to 10 participants to calculate the reliability before sending to 136 participants to rate the items.
Data collected during this step were analysed by descriptive quantitative methods with the purpose of evaluating the importance with good accuracy.

5.4.2 Sampling

Sampling the participants of this step was different as the team who had an initial experience of KM implementation was asked to rate the potential performance in the third step, while all the company staff were asked to rate the actual performance of KM implementation in the fourth step.

The sample targets in this step were the same as in the previous step but included in addition participants from the ICT department and HR department in order to collect more accurate information related to ICT and the professional challenge situation.

The number of respondents and position can be seen in Table 13.

<table>
<thead>
<tr>
<th>Level</th>
<th>Number</th>
<th>Number that participated</th>
<th>Percentage of participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project manager</td>
<td>4</td>
<td>3</td>
<td>75</td>
</tr>
<tr>
<td>Lead project engineer</td>
<td>18</td>
<td>10</td>
<td>55.56</td>
</tr>
<tr>
<td>Project engineer</td>
<td>105</td>
<td>89</td>
<td>84.76</td>
</tr>
<tr>
<td>IT managers</td>
<td>4</td>
<td>3</td>
<td>75.00</td>
</tr>
<tr>
<td>HR managers</td>
<td>5</td>
<td>5</td>
<td>100.00</td>
</tr>
<tr>
<td>Total</td>
<td>136</td>
<td>110</td>
<td>80.88</td>
</tr>
</tbody>
</table>
Items to rate

The items to rate during this step were the emerged categories and subcategories of the previous steps.

**Q 1 Organisational factors**

1) Incentive
2) Job description
3) KM as objectives
4) Management support (procedure)
5) Social relations

**Q 2 Project management factors**

1) Maintaining the context
2) Giving the opportunity to learn
3) Managing the team structure

**Q 3 Professional factors**

1) Loss of power
2) Professional evaluation
3) Developing skills
4) Trust in others

Q 4 ICT factors
1) Archiving system
2) Server availability
3) Communication technology
4) Linguistic communication

5.4.3 Data analysis

The research should not stop at the phase of emerging issues of KM implementation in the Libyan oil and gas industry, but should go beyond this preliminary objective and seek to find a solution to adopt KM in the organisation studied.

This was illustrated by the Straussian paradigm as different emergent issues formed the conditional elements of the paradigm, but the strategic element that should describe the action and interaction to take was undeveloped and needed to be further addressed.

To develop the strategic element, it was necessary first to evaluate the importance of the emerged categories.

5.4.4 Discussion

This section focuses on the description and analysis of the data obtained from the third online questionnaire sent to all the project department members.

For successful implementation of KM, it is important to understand the important implementation areas required to support the capture, creation and transfer of tacit and explicit organisational knowledge.

Q1: Organisational factors

The data collected were analysed using an Excel calculation sheet, which calculated the many descriptive measures, such as mean and standard deviation.

The descriptive ranking is presented in Table 14.
Table 11 Organisational factor ranking

<table>
<thead>
<tr>
<th>Factors</th>
<th>Items</th>
<th>Mean</th>
<th>Deviation</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incentive</td>
<td>Company adopts a compensation scheme for any achievements in implementing knowledge management in projects</td>
<td>3.14</td>
<td>0.82</td>
<td>4</td>
</tr>
<tr>
<td>Job and procedure description</td>
<td>The company reviews the organisational procedure and job description to better define the KM role in Clearer way, suitable and applicable procedure of KM within the project department</td>
<td>4.59</td>
<td>0.44</td>
<td>1</td>
</tr>
<tr>
<td>KM as objectives</td>
<td>The senior management has a clear vision and goals for KM, with budget allocation</td>
<td>3.19</td>
<td>0.81</td>
<td>3</td>
</tr>
</tbody>
</table>

Job description was identified as the most important challenge concerning the organisational terms.

Table 12 Project management factor ranking

<table>
<thead>
<tr>
<th>Factors</th>
<th>Items</th>
<th>Mean</th>
<th>Deviation</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure and policies</td>
<td>KM tasks to be considered in the project’s base plan and schedule</td>
<td>4.81</td>
<td>0.82</td>
<td>2</td>
</tr>
<tr>
<td>Work sites (different)</td>
<td>Acceleration of site visits, workshops and meetings for wide-scale participation</td>
<td>3.05</td>
<td>0.68</td>
<td>4</td>
</tr>
<tr>
<td>Time lapse</td>
<td></td>
<td>3.32</td>
<td>0.73</td>
<td>3</td>
</tr>
<tr>
<td>Giving opportunity</td>
<td>Providing the opportunity to reflect and learn</td>
<td>4.89</td>
<td>0.75</td>
<td>1</td>
</tr>
</tbody>
</table>

Managing the project K with procedure and policies rated (4.84) is the most important challenge related to the project. Knowledge management within the project will be based on a clear procedure provided by the organisation.
Table 13 Professional factor ranking

<table>
<thead>
<tr>
<th>Factors</th>
<th>Items</th>
<th>Mean</th>
<th>Deviation</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job/Power security</td>
<td>Sharing knowledge in problems faced should not be seen or viewed as a failure pertains to project team</td>
<td>3.3</td>
<td>0.84</td>
<td>1</td>
</tr>
<tr>
<td>Professional evaluation</td>
<td>The professional evaluation should not only be based on individual tacit knowledge</td>
<td>3.25</td>
<td>0.43</td>
<td>2</td>
</tr>
<tr>
<td>Developing KM skills</td>
<td>Individual training and support in KM commitment should be given to project team members</td>
<td>3.04</td>
<td>0.81</td>
<td>4</td>
</tr>
<tr>
<td>Trust in others</td>
<td>Trust should be enhanced between members</td>
<td>3.15</td>
<td>0.65</td>
<td>3</td>
</tr>
</tbody>
</table>

Loss of power is the most important challenge related to professional issues.

Table 14 ICT factor ranking

<table>
<thead>
<tr>
<th>Factors</th>
<th>Items</th>
<th>Mean</th>
<th>Deviation</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archiving system</td>
<td>Implementation of easily accessible and secure archiving system</td>
<td>4.32</td>
<td>0.84</td>
<td>1</td>
</tr>
<tr>
<td>Server availability and accessibility</td>
<td>Server availability and accessibility at any time and in any location</td>
<td>4.23</td>
<td>0.43</td>
<td>2</td>
</tr>
<tr>
<td>Communication technology</td>
<td>Phone, mail, conference call and internal network should be available to team members and supported by the company</td>
<td>4.1</td>
<td>0.81</td>
<td>3</td>
</tr>
<tr>
<td>Linguistic communication</td>
<td>Enhancing linguistic skills</td>
<td>4.05</td>
<td>0.65</td>
<td>4</td>
</tr>
</tbody>
</table>

The results reflect that all the factors are important for implementing an effective knowledge management, but the challenges related to project management and the organisation were identified as the most important.
Chapter 5  

Case study A

- Giving the opportunities during the project: 4.89 (project management role)
- Job description: 4.59 (organisational support)

This is considered an essential finding because a more global statement can now be made about the challenges that are most critical for KM implementation, but it is necessary to measure the actual performance of these challenges within the participant organisation in order to localise the gap and the most critical challenges concerning the implementation of knowledge management.

5.5 Conclusion

5.5.1 Responses to research questions

This chapter has presented and discussed the influencing factors affecting the implementation of KM in the Libyan oil and gas companies for the Engineering, Procurement and Construction (EPC) type of projects.

The response to the first research question (phase 1) can be further developed after the discussion of this phase.

After the second research phase, research questions 2 and 3 can be answered based on the findings that emerged.

- Q2.1: What critical factors can influence the adoption of KM in the Libyan oil and gas EPC project environment within the oil and gas companies?

Four main factors emerged from the data gathered from lead project engineers by direct interviews and online questionnaires.

- Project management factors: opportunity for reflection; project team structure; time lapse; procedure and policies.

- ICT factors: lack of social network; lack of network access; communication factors.

- Organisational factors: role not recognised

- Professional factors: Job security commitment
To identify the main influencing factors, a quantitative data collection method was used to quantify the influence of factors.

The main and most critical factor concerning the implementation of knowledge management is giving the opportunities, this challenge related to project management.

Project management challenges emerged that played an important role in KM implementation. The importance of these kinds of challenges was confirmed during the measurement of the importance of factors, and it was demonstrated that they present the most critical area of KM implementation that needs to be addressed.

- Q2.2: Building upon the existing practices, how can these factors be addressed and how can roles and duties be distributed within the company to implement an effective KM management.

To implement an effective knowledge management, particularly in the studied case study and in general in the Libyan oil and gas industry, the organisation should work on the alignment between KM and PM and create cooperation between the project management department and other auxiliary departments (HR and ICT).

There is evidence that the alignment of KM with existing project management practices such as post-project meetings can encourage professionals to engage in KM.

To understand the concept of KM and its implementation in oil and gas organisations, the respondents acknowledged the need to understand how KM integrated with existing practices. This is an issue that will be explored further in the thesis.

The potential to align KM with Projects management, where the role and experience of engineering and construction professionals and needs to be taken into consideration

5.5.2 Framework

The second phase framework was built based upon the first phase framework.

All the first phase findings were maintained and validated except for one category pertaining to the K management process.
After the integration of the role of the ICT department, the process of K saving (storing, archiving) will be included under the umbrella of ICT support in «ICT duties & responsibilities». In other words, any transfer of knowledge will be automatically saved by the ICT department via a dedicated support team.

As was demonstrated and validated in the previous research work, knowledge creation within the project management teams are not significantly lacking; therefore, the research will focus on the process of capturing the created knowledge.

In due consideration of the above, it is important to demonstrate that the four processes identified in the first phase of this research were reduced to only two and those two need to be considered in the research model; the two processes are K dissemination and K capture. They are the two main processes of managing K, which the researcher chooses to build upon in continuing with the research work.

In addition, the role of LL (LL) was validated as a main vector of project KM, and the critical factors relating to KM implementation that emerged during the second research phase (project management, organisational, professional communication and technological factors) were all integrated in the development of the framework. The said factors reflect the role of the organisation, the project management department, the ICT department and the HR department.

The newly emerged issues that were not yet validated by the triangulation method were not integrated in this step.

The connection between the above-mentioned different categories of the framework now became more understandable, reflecting the relationships between the different organisation departments and the role of each in the KM model. The elaboration of these relationships is based on the axial coding process; this was a continuous operation followed during all the research phases and was concluded by the emerging of Straussian paradigms forming the final framework. The result of the axial coding is represented in its entirety in Chapter 7.
Figure 25 second phase framework (source: author).
5.5.3 Next step

During this phase, more detailed and focused issues emerged; they are classified by the KM process and cited as follows:

Capture and sharing

- No LL captures at the projects stage gates (stage gate is the review event at the end of each project phase).
- Low participation in meetings.
- No top-management support.
- Time constraints.
- Forgetfulness.
- Employees no longer at the project/company.
- No standardised routines, templates and guidelines.
- Unstructured information format.

Saving

- Poor and complex storage system.
- Time-consuming retrieval process.
- Propensity to informal communication (oral, e-mail, etc.).
- Lack of search function.

For this, an LL system is essentially required to avoid the cited problems but it is necessary to collect additional data from the field to confirm and validate these findings according to the triangulation technique before going more deeply into axial coding.

A third research phase, investigating the organisation and more especially the project management department in greater depth, was necessary to ensure the elaboration of a suitable and effective LL system implementation that contributes to the success of the project.
Chapter 6

RESEARCH PHASE 3

CASE STUDY B
6 CASE STUDY B

6.1 Introduction

In light of the issues that emerged from the first phase and the critical adoption factors identified during the second phase of research, it was demonstrated that to achieve an effective KM within the studied Libyan oil and gas companies, the development of LL practices, and the improvement of knowledge transfer from one project to another, are urgently needed.

After reviewing the literature focused on LL in EPC projects it was decided to take the approach of Patricia Carrillo (2005) who studied the improvement of UK companies with regard to LL practices in terms of:

- Commitment

- Timing of LL sessions

- Participants

- Format for documenting LL

- The dissemination method

These five areas of concern were investigated by Carrillo within the most famous Canadian Engineering, Procurement and Construction (EPC) companies addressing LL (LL) on their construction projects; then he used the outcome to make a number of recommendations on how the process of LL may be improved in the case of the UK.

As the research area also covers the same areas of concern, the approach can be used to investigate the improvement of LL in the case of Libyan companies as the EPC project management procedure is quite similar, but the method of addressing this area to adopt an effective LL process in Libyan oil and gas companies can be different depending on the case.

Thus, the third research phase question will be as follows:

- Q3.1: How can the LL process improved to manage effectively the EPC project K and enhance its transfers between projects.
Figure 25 above describes the process adopted for the third research phase; presented in a flow chart schematic diagram to ease understanding how the author proceeded in this research phase.

Figure 26 Third research phase design.
Bearing in mind the above, the research will focus on developing an LL process for the current case study through enquiring how the five areas of concern can be improved.

In this context, the current research case study will adopt an action research strategy, in the form of linking «a spiral of cycles of planning, acting, observing and reflecting» (Robson, 1993).

The action research strategy is concerned with addressing issues to find and implement solutions, thus commitment to LL, the timing of LL sessions, participants, the format for documenting LL and the dissemination method will be addressed. This is to be done by observing, analysing and making recommendations.

This approach was selected as it is based on a combined «collaborative» approach between the participant and the researcher with the intention of solving the problem of LL weakness identified in the companies studied.

While the grounded theory was asking the question what? the simple case study was asking the questions how and why? Action research asks why, how and what to do?

Thus, the third research phase question, «How can LL practices be improved to manage the K effectively within the EPC projects? », can be answered through action research.

The presence of the researcher will challenge the change in the situation under investigation through a spiral of cycles of planning, acting, observing and reflecting.

This case study reflects a continuous testing of the solution recommended by the researcher based on the analysis of the situation until reaching the desired improvement and effectiveness of LL practice within the participant organisation «company». This means testing the LL process while it is being developed. This is an advantage as it supports the research model development as it is more valid to use and easy to accept.

In addition, and from a knowledge management perception, this action research is one of the primary «instruments for increasing organisational learning» of the company participant. In action research, researchers try to improve practice through logical feedback of their research observations in the organisation. The project team’s «practitioner» in this case wanted not only to improve his own knowledge but also to learn how to integrate an LL system within the
company, by recognising the advantage of managing LL implementation in their EPC projects.

After several trials, through personal contacts the management of one company from the three initial companies was persuaded to give the researcher access to their data and approved contact with their project teams, on all levels from project director down to the project engineer level.

This case study was conducted over twenty month’s period. Two cycles of action research emerged during this case study.

![Diagram of action research cycles](image)

**Figure 27 Case study B: Action research cycles.**
6.2 First cycle:

6.2.1 Data collection: (Focus group)

During the first cycle, the researcher decided to organise LL sessions at the end of the projects phases (gate review), using the focus group method. Focus groups are appropriate for collecting evidence from a highly specialised group of individuals, obtained in an intense or concentrated manner (Remenyi et al., 1998).

During the review gates (at each of the project phases; engineering, procurement, construction and start-up) sessions the LL were discussed and accounted as a new issues experienced during the development of the work, and resolved in a new manner and treated as LL.

The objective of these sessions was to enable the involved individuals to reply to the following main questions:

(1) What did they set out to do?

(2) What actually happened?

(3) Why did it happen?

(4) What are they going to do next time?

Six LL sessions, S1, S2, S3, S4, S5 and S6, were conducted with LPEs in the gate of engineering, procurement and construction phases.

LL discussed during the session was documented under a template designed by the researcher to reply to the LL questions.
LL captured from respondents at the end of one phase were disseminated immediately to all other project teams through the project department, and then they received their feedback to see the effect of this action. Participants were also asked about their opinion on improving the five areas of concern in relation to LL process; this was to minimise researcher subjectivity and to help the researcher find a solution for LL process improvements.

6.2.2 Sampling: (Lead project engineers and project managers)

Litosseliti (2003) contends that focus groups should be comprised of people who have similar characteristics and levels of understanding of a topic.

The sample chosen should reflect the maximum K captured during the project phases. It was decided to continue with the lead project engineers (LPEs) as they play a central role in a number of KM-related activities, including conducting performance appraisals with site-based staff, and capturing LL. In addition, project managers also participated in the sessions, as they cannot be excluded due to their leading management role.

6.2.3 Findings

The finding that emerged from the semi-structured interviews (Appendix 5) of the LL session was that a number of LL related to a number of technical and management issues.
Problems faced and/or experienced during the execution of the project were reflected by interviews and by the author’s observations. These issues were filtered, classified and then analysed. Following that, filtrated categorised issues were discussed with the project manager in a meeting to verify them.

**Participation**

The researcher invited all the lead project engineers involved during a project phase to an LL session.

<table>
<thead>
<tr>
<th>LL session</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invited</td>
<td>10</td>
<td>10</td>
<td>12</td>
<td>8</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Participated</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>7</td>
<td>10</td>
<td>2</td>
</tr>
</tbody>
</table>

The table above shows the rate of participation of invited lead project engineers in the LL sessions during the studied phase of the project.

**LL of engineering phase**

- **Constructability**

Technical issues cited by respondents: these kinds of issue are related to the constructability and development and elaboration of technical documents. One project engineer stated: «We had completed a review and approval of detailed engineering of certain documents and work is proceeding in accordance; then later during the HAZOP session discussions we discovered that some technical information was not provided to part of the project team and as such their review, as it was made before, is considered premature. This has made us revise the approved scope and redo part of the work». Another added that «the results of project interface documents (during the monthly updates of the project interface register we made some comments related to the management of the engineering interface between two vender packages, then we discovered later that the interface management team had not communicated it to the other teams, nor discussed it during the work review meetings) were not considered during the detailed engineering review and approval; this as a consequence obliged us to recheck several approved documents, by reissuing them for comments and approval linked to...».
the interface management documents issued. This had taken more time from the project team and had disturbed the schedule for document approval.

- **Delay in receipt of drawings at site**

Loss (in time) can be occurred because of delay in receipt of drawings at a site, according to one of the respondents. He explained that «the project team was obliged to redo some of the work because of the late response by some of the project team members to critical documents had forced us to review and reconsider their comments even if we had already processed the document for the next step of work development. We lost extra time that was not accounted for in the project baseline schedule and we were more stressed because of the end date we had committed to the management». Another added that «clarifying the problems took up a lot of time, which could have been avoided if they had had the right information at the right time».

Other issues that emerged during the engineering phase were related to variation in project scope, delay in approval of detailed engineering documents, drawings etc....

**LL of Procurement phase**

- **Difference/delay in equipment delivery schedule**

The problem of time loss in clarification also emerged in the procurement phase. One respondent declared that missing information within the group of procurement can cause several clarification conversations with the vendor, which need extra time.

Jeopardising the quality of the procured materials was the main issue caused by differences in equipment delivery schedules among project teams. One of the project engineers interviewed just after the procurement phase explained this concern. He said: «Our contribution to the equipment test plan (or inspection plan) is vital. We received the vendor test plan and we made our comments accordingly as part of the team concerned with engineering (other team members will also contribute); however, finally we noted that not all team comments were considered when transmitting the plan to the vendor for consideration. There was a meeting for reviewing such documents, but we were not part of the team called for these discussions. This is one of the situations experienced that resulted in risking or jeopardising the quality of the equipment delivered as a consequence of not implementing some essential tests related to the performance as was requested by us».

- **Difference in equipment interface**

A certain additional cost was experienced by the project team due to interface issues/problems with some of the procured equipment/machinery, and this was another problem related to K
transfer or KS sharing according to one project participant who said: «We suffered from the different vendors» interfaces and it took a much longer time than was planned to freeze the technical interfaces and fix the responsibility matrix among them». The main problem was due to different engineering progress stages and their review and approval by the different project groups (multidisciplinary activity). This difference in approval time made us obliged to accept additional interface activity from some vendors that had not really been considered and as a consequence generated extra time and extra cost for the project.

**LL of Construction phase**

- **Alignment issues**

«Many construction problems emerge in the construction phase, like alignment issues in tubes and pipe track» said one project engineer. This was one of the more commonly faced problems and in certain plant areas it can generate difficulties in handling non-alignment, either because of a shortage or materials or availability of space to resolve the non-alignment, in addition to more time and risk in constructing additional spools and carrying out welding.

One very big impact of these issues was announced by one of the lead project engineers interviewed at the end of the construction phase: destructive modifications. He said: «We were faced with destructive modifications of several pieces of equipment after implementation. This problem was caused by the missing of important project information prior to the construction phase; we were forced to relocate the newly installed equipment to a nearby area due to further field expansion requirements».

These problems can easily increase project costs dramatically, due to construction time losses, additional materials, and delay in the first oil or first gas.

- **HSE issues**

Many HSE issues were recognised by HSE engineers as LL.

One HSE engineer in a project team, during one of the interviewees conducted, said: «Many accidents might be avoided if we had received or were aware of all the necessary information related to equipment and machinery installation. The HAZID workshop (sessions) conducted did not address or reveal the full scope in terms of the extended work packages and how they were distributed in terms of supply and responsibility». The incomplete HAZID sessions caused negative HSE consequences.

The following table illustrates the stage gate LL collected from project 1 after verification by project managers.
## Table 16 Project 1 action research findings

<table>
<thead>
<tr>
<th>Project Phase-Session</th>
<th>Categories (Issues/success)</th>
<th>LL (findings)</th>
<th>Impact</th>
<th>Recommendation</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 - Variation in schedule</td>
<td>Basic Engineering Design deliverables were insufficient</td>
<td>Extra cost</td>
<td>Project delay</td>
<td>*</td>
<td>Transferred to Projects 2 and 3: Engineering phase</td>
</tr>
<tr>
<td></td>
<td>Geotechnical survey for pipeline routes has not addressed well the crossings with other pipelines and rivers</td>
<td>Extra cost</td>
<td>*</td>
<td></td>
<td>Transferred to Projects 2 and 3: Engineering phase</td>
</tr>
<tr>
<td>1 Delay in freezing company input data to contractor</td>
<td>Project delay</td>
<td>*</td>
<td></td>
<td>Transferred to Projects 2 and 3: Engineering phase</td>
<td></td>
</tr>
<tr>
<td>2 Variation in company input data</td>
<td>Project delay</td>
<td>*</td>
<td></td>
<td>Transferred to Projects 2 and 3: Engineering phase</td>
<td></td>
</tr>
<tr>
<td>2 - Delay in approval of detailed engineering documents, drawings</td>
<td>Lack/delay in the team in some engineering disciplines</td>
<td>Project delay</td>
<td>*</td>
<td>Transferred to Projects 2 and 3: Engineering phase</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Design project was not standardized, required more time for review &amp; approval</td>
<td>Project delay</td>
<td>*</td>
<td>Transferred to Projects 2 and 3: Engineering phase</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Insufficient company team at contractor engineering offices</td>
<td>Project delay</td>
<td>*</td>
<td>Transferred to Projects 2 and 3: Engineering phase</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Delay in issuing tenders for project long lead items</td>
<td>Project delay</td>
<td>*</td>
<td>Transferred to Projects 2 and 3: Engineering phase</td>
<td></td>
</tr>
<tr>
<td>3 - Constructability</td>
<td>Key engineering team during execution is different from the one during execution tender &amp; pre-</td>
<td>Project delay</td>
<td>Project delay</td>
<td>*</td>
<td>Transferred to Projects 2 and 3: Engineering phase</td>
</tr>
<tr>
<td></td>
<td>Tender scope of work was not detailed in addressing company requirements</td>
<td>Project delay</td>
<td>*</td>
<td></td>
<td>Projects 2 and 3: Engineering phase</td>
</tr>
<tr>
<td></td>
<td>Many HOLD points in the technical documents attached to the execution contract</td>
<td>Extra cost</td>
<td>*</td>
<td></td>
<td>Transferred to Projects 2 and 3: Engineering phase</td>
</tr>
<tr>
<td></td>
<td>Delay in approval of vendor engineering documents</td>
<td>Project delay</td>
<td>*</td>
<td></td>
<td>Transferred to Projects 2 and 3: Engineering phase</td>
</tr>
<tr>
<td></td>
<td>Delay in issuing bank guarantees from contractor for downpayment</td>
<td>Project delay</td>
<td>*</td>
<td></td>
<td>Transferred to Projects 2 and 3: Engineering phase</td>
</tr>
<tr>
<td>1 - Procurement (S2)</td>
<td>Delay in long lead items (LL) contract award by main contractor</td>
<td>Project delay</td>
<td>*</td>
<td></td>
<td>Transferred to Projects 2 and 3: Procurement phase</td>
</tr>
<tr>
<td></td>
<td>Delay in approval of vendor engineering documents</td>
<td>Project delay</td>
<td>*</td>
<td></td>
<td>Transferred to Projects 2 and 3: Procurement phase</td>
</tr>
<tr>
<td></td>
<td>Delay in issuing bank guarantees from contractor for downpayment</td>
<td>Project delay</td>
<td>*</td>
<td></td>
<td>Transferred to Projects 2 and 3: Procurement phase</td>
</tr>
<tr>
<td>Construction (S6)</td>
<td>Alignment issues</td>
<td>Extra cost</td>
<td>*</td>
<td></td>
<td>Transferred to Project 3: Construction phase</td>
</tr>
<tr>
<td></td>
<td>HSE issues</td>
<td>Construction accidents</td>
<td>Project quality</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>
6.2.4 Discussion

LL collected were distributed between projects to test its effectiveness regarding the five areas of concern identified by Carrillo: commitment, timing of LL sessions, participants, format for documenting LL, and the dissemination method.

Timing of LL sessions

Organising an LL session at the end of a project phase has improved the capture of LL as the captured LL were judged to be beneficial by parallel project teams. They acknowledged that this was good move made by the researcher to give them the opportunity to use LL issued from other parallel projects and not just previous completed projects.

For example, LL captured from the first session (S1) relative to the engineering phase of project number 1 was distributed to the engineering teams of projects 2 and 3.

The engineering team of project 2 acknowledged that they faced the same issues during the execution of the project. The project manager declared: «If we had used these LL from the start of the phase, the execution of the project could have been better».

The engineering team of project 3 used the LL of project 1 and at the end of the phase (S4) they reflected that it was very helpful for avoiding the same problems.

In the same way, LL identified in the procurement phase of project 1 (S2) were injected into the procurement phase of project 3; the team then validated the effectiveness of these LL during the interview of S5.

Both the team delivering LL and the team receiving them acknowledged the improvement resulting from organising LL at the end of each phase».

According to the delivering LL team, «for a long project like an EPC project, it is difficult to wait until the end to attempt to capture what is learned » said a lead mechanical engineer. Another process lead engineer added: «We work with many experts within the team; those experts were occasionally requested by management to move from the project to joint other
project before the start-up. They used to not participate in the post-project review and always keep LL as tacit knowledge».

According to the receiving team, «waiting for LL to be issued at the end of other projects, it may be too late to use and the opportunity to benefit can be lost». The timing of the LL session at the end of phases was demonstrated as being effective and improves LL practices in EPC studied projects.

However, too often participants declared that they cannot reflect all the LL during the phases and they have forgotten much of what should be captured from the problem-resolving process because of the long duration of the phases.

It was decided by the researcher to study further the improvement of K capture by implementing an effective LL collection and recording process.

**Commitment**

The commitment of participants to the LL session organised by the researcher was considered to be low except for in S4 and S5.

<table>
<thead>
<tr>
<th>LL session</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invited</td>
<td>10</td>
<td>10</td>
<td>12</td>
<td>8</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Participated</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>7</td>
<td>10</td>
<td>2</td>
</tr>
</tbody>
</table>

To enable and encourage commitment to LL sessions, Carrillo (2005) argues that «the difficult issue remains how to demonstrate that LL have added value».

In this context, acceptable participation in S4 (project 3) and S5 (project 2) can be justified because the related teams had recognised the importance of LL reporting at the end of the phase. After receiving an effective LL from project 1 in S1 and S2, the project managers of
projects 2 and 3 acknowledged the benefit of this action and encouraged their teams to participate with the researcher in subsequent sessions.

**Participants**

LL sessions S2, S3 and S5 were reported several times, because the project managers requested strongly the participation of some lead engineers to discuss many issues that occurred during the phase.

This confirms that in the oil and gas EPC project, knowledge is created essentially by discipline, such as mechanical, process, civil discipline... etc... The participation of the lead project engineer of each discipline was recognised as important by the researcher and confirmed by project managers.

The role of middle managers (lead project engineer in the case of the EPC project) in LL practices is supported by a number of authors who view the middle level of management as being central to KM-related activities (Davenport et al., 2004; Nonaka., 1995).

**Format for documenting LL**

The format of documentation used by the researcher in the LL session included the key information related to LL (cause, impact and recommendation). This format was easy to manage and acceptable for capturing the context of LL.

However, the researcher recommended that the organisation develop this format.

**The dissemination method**

As this cycle of action research was on a small scale and did not include all the company projects, the researcher disseminated the documented LL manually, but it is recommended that the organisation develop a system of dissemination with the ICT department.

**6.2.5 Next step**

The researcher decided to conduct a second cycle of data collection with a new strategy, which is tracking the emergence of LL monthly and recording each potential LL as a knowledge creation initiative KCI.
It was demonstrated that the LL of one phase can be effective and provide benefits for other projects before the end of the project and without waiting for a post-project review to avoid loss of context and value of LL.

However, the researcher observed that teams participating in an LL session at the end of each phase had some difficulty remembering and building a clear description and understanding of LL.

That’s why it was decided to proceed with a new cycle of data collection with a different strategy. The new strategy is to track the emergence of potential LL monthly and record them as knowledge creation initiative KCI, which can be developed to valid LL at the end of the phase.

### 6.3 Second cycle

The second cycle emerged because most of the respondents in the three projects had difficulty reflecting the LL at the end of phases; this was due to the long duration of phases and to the changes that occurred in the project team.

The objective of this second cycle was to further develop the LL collection and recording process.

It was decided to follow and track LL within project phases, to demonstrate the gap between what was captured and what should be captured and how this gap can be covered...

The second cycle sought to improve LL practice to enhance LL capture within the same project. This cycle was based upon following the emerging LL from the start to the end through weekly and monthly progress meetings and also through other execution meetings.

#### 6.3.1 Data collection: (Interviews, observation)

The researcher followed up the project execution issues and problem-resolving solution to identify the emergence of potential LL during the project before its validation. The captured knowledge was defined by the researcher as a knowledge creation initiative KCI.

Notes, remarks and observations concerning knowledge creation initiatives (KI) were recorded throughout the project phases, organised into a matrix composed of: date of
capturing the KCI, occasion of capturing KCI, discipline of KCI and brief description of KCI.

A code was given to each KI by the researcher.

<table>
<thead>
<tr>
<th>Date</th>
<th>occasion</th>
<th>discipline</th>
<th>description</th>
<th>code</th>
</tr>
</thead>
<tbody>
<tr>
<td>27/02/2012</td>
<td>workshop</td>
<td>civil</td>
<td></td>
<td>E11</td>
</tr>
<tr>
<td>04/03/2012</td>
<td>problem resolving meeting</td>
<td>process</td>
<td></td>
<td>E12</td>
</tr>
<tr>
<td>12/03/2012</td>
<td>workshop</td>
<td>civil</td>
<td></td>
<td>E13</td>
</tr>
<tr>
<td>01/03/2012</td>
<td>problem resolving meeting</td>
<td>mecanical</td>
<td></td>
<td>E14</td>
</tr>
</tbody>
</table>

Figure 29 Example of data collection of created K tracking.

The researcher captured a sample of KCI, coded it and then tried to follow its development during the project life cycle by observing the maximum amount of data issued during the project execution (reports, minutes of meetings, notifications, mail) in order to track it.

These KCI(s) were captured, organised and recorded by the researcher, then distributed to the project members that participated in LL sessions at the end of the project phase (gate); this occurred after collecting from them their LL at the end of the phase. Then he asked them to update the LL again for a second time and to identify whether the given document «including the KI» makes any difference to them. Does it help? The researcher also, using his wide experience, compared the two versions of LL to see the effect of tracking KI during the project.

The possibilities for observation are almost limitless – people, behaviours, reactions, physical settings, environmental features, record-keeping systems, project reports, and more. Even within an educational event, a variety of elements can be observed to evaluate the delivery and potential outcomes of the event.

Often, it will be impossible to observe all people, sites or programme documents; in these cases, you will need to sample. The same sampling principles apply to observations as to other forms of data collection (Taylor-Powell & Steele, 1996).

The researchers try to observe the project team in depth and capture the K creation initiative.

The author participated in many meetings and workshops and tried to capture the maximum K creation initiative.
6.3.2 Findings

The researcher during the initial (engineering) phase has captured ninety-eight knowledge creation initiatives (KIs), which can be considered as very good number of K creation opportunities and proves again the possibilities of K creation and that there is no lack in the process of K creation at the individual level. These KIs are always created during the life of a project, especially in problem-solving situations.

These 98 captured KCIs were considered as the initial sample of KCI and will be tracked during the project to investigate the KI transfer during the phases.

Although other new KCIs emerged in the subsequent phases, it was noted that the majority of the engineering KCIs were lost at the end of phases; for example, in the procurement phase, only 32 KCIs from the sample of KCIs were reflected in the stage gate LL session, and 67 KCIs were lost.

As discussed previously, the management of the company was persuaded to give the researcher access to their data. The project management team were requested to support the researcher and to allow him to collect information and attend some of their project meetings.

The researcher was flooded with data. The quantity of new data being generated was greater than his capacity (bearing in mind the time factor) for analysis, but the researcher’s extended experience in the execution and management of oil and gas projects played an important role in conducting the tracking operation to the appropriate data and minimising efforts.

6.3.2.1 Discussion

The data analysis method used during this part was gap analysis.

In the literature, gap analysis is the comparison of actual performance with potential performance. If a company or organisation does not make the best use of current resources, or misses investment in capital or know-how, it may produce or perform below its potential. It is a comparison between the actual and the potential transfer of knowledge created. The objective of this research step is to investigate the gap between Total K creation initiative (TKCI) and the K creation initiative captured after transfer (KCIC) TKCI and KCIC.
The potential transfer in this case refer to the ideal transfer of all the initial sample of 98 knowledge creation initiative KCI captured by the researcher during the first phase of project. They should be identified through tracking process during all the project phases.

For this, a semi-structured interview with the lead project engineers (LPEs) was conducted after each project phase to collect their LL and compare them with what had been captured by the researcher.

The gap to be studied between the actual and potential transfer may be due to the researcher and/or the project team as some other KCIs might not be captured and are still maintained as tacit knowledge with individuals; in this case, they can be considered and treated as K lost within the project (K creation initiative lost: KCIL) or they may not be tracked by the researcher for many different reasons.

Thus, the equation of KCI transfer can be formed as follows:

**Equation 1:** (source: author)

\[
TKCI = KCIC + KCINT + KCIL
\]

- **TKCI**: K creation initiative captured
- **KCIC**: K creation initiative captured
- **KCINT**: K creation initiative not tracked
- **KCIL**: K creation initiative lost

The researcher tried to minimise the risk of not tracking the creation initiative (KCINT) by triangulating the analysed data for each project stage gate.)

According to the stage interviews, the results show that the KCIs reported by respondents were very low compared with what the researcher recorded.

It was rare that LPEs reflected a KI that the researcher lost from the tracked sample in each phase.

This confirms that the researcher had tracked almost his entire initial KCI sample and the KCINT can be neglected.

Thus, if the risk of not tracking a knowledge creation initiative becomes very low, the KCINT can be neglected from the equation.
Equation 2: (source: author)

![Equation](TKCI = KCIC + KCIL)

TKCI : K creation initiative captured
KCIC : K creation initiative captured
KCIL : K creation initiative lost

In the ideal conditions, when K is created in a project phase, it should be totally captured during this phase. Thus, all the KCIs captured during the project by the researcher are expected to be maintained until the end of the project, as illustrated in the figure below.

There is a big gap between what should be reported at the end of the project (graph 2) and the created K captured at the end of the project by the researcher (graph 1). This gap is in terms of quantity of KCI and the domain of K (engineering, procurement, construction and start-up).

Thus, the gap is due to K loss from phase to phase, which demonstrates the strong need for a K tracking system.

The comparison between what the researcher captured and what the respondents reported demonstrates that there is a second gap that explains the cause of the first gap.

This gap is happened because the researcher recorded all the KCIs faced at any time, while the respondents didn’t record KCIs as they occurred.

![Figure 30](Potential LL (KCI) captured by participants and researcher.)
6.4 Conclusion

In the 3rd phase of research works the opportunity for further study investigations was only limited to one company, for which an action research case study was conducted. Descriptively, the sample can be considered reach and wide.

Projects team of this company were certainly following, managing and responsible for several projects within the organization, their way in applying project management and knowledge management is typical quite the same way.

Findings were replied well to the questions of this phase:

6.4.1 Responses to research questions

Q3.1: How LL process may be improved to manage effectively the EPC project K and enhancing its transfers between projects.

The significant recommendations were issued from the field in adopting LL practices especially related to two areas of five improvement areas which are commitment and timing of LL.

To improve the timing, the recommendation was tracking knowledge created as it is occurred to avoid its loss and maintain the context.

The project K is essentially created through the problem-solving process on EPC projects, and should primarily be captured as LL during monthly meetings by LPES, verified and evaluated by the experts’ team continuously.

Tracking LL throughout the project should as much as possible by tracking LL as it occurs on the project, everything so fresh in the head as it is just occurred.

KCI (s) at the end of phases and project can be compiled as more comprehensive and developed LL.

To enhance the commitment factor, the need for incentive, senior management support, and integration in existing work practices such as project meetings.
Chapter 6  Case study B

For other area of improvement, participants, documentation and dissemination method the proposed practices in literature can improve the LL practices, this will be more discussed in the subsequent chapter.

6.4.2 Next step

No new issues were emerged during the last part of research phase 03, it was a pure demonstrative part. All the previous interviews findings were validated saturated and became more reliable.

The action research strategy used was based on a cycle of action to improve LL and observation of this improvement until the maximum of optimisation limited by time, participation, and research objectives.

The research framework reaches its development, turn into steady, reliable and a pragmatic model usable to managing the knowledge in more effective manner as it is elaborated in the research discussions and model development part of this research work (see chapter 07).

At this stage of research work, it can be concluded that the theoretical saturation is reached after the completion of this phase.
Chapter 7

DISCUSSION AND MODEL DEVELOPMENT
7 Discussion and model development

7.1 Introduction

In the initial phase of this research, tacit individual experience was viewed as the principal important knowledge used in the organisation. A need to integrate this tacit K into the organisation to maintain the knowledge was identified. Professional, project and the organisational knowledge management have emerged as three significant levels which require management through a variety of processes including creation, capturing, storing, validation (verification), sharing and dissemination. The practices in the areas of project management were identified in the second phase as having a potential role to play in KM.

With these issues in mind, Case Study A sought to evaluate critical factors of KM implementation, whilst Case Study 2 investigated the KM issues depending on the project life cycle exploring the potential for KM between middle managers and the development of LL practices. The presence of a supportive learning procedure from the organisation was also viewed as essential for addressing some of the identified challenges.

This chapter aimed to develop, refine and integrate the results of the two case studies carried out by the author as part of this research work (reported in chapters 5 and 6) considering the outcome of the research’s initial phase (reported in chapter 4) in the context of the literature review and data analytical process.

7.2 Emerging of research paradigms through axial coding

During the open coding of case studies, A and B (reported in chapters 5 and 6), once the codes were organised into categories and validated by the triangulation technique, the analytic process moved into «axial coding» for a higher level of conceptual abstraction. In this stage of data handling and analysis, two systematic processes were interlinked. The processes were: revising of existing categories followed by combining categories, subcategories and properties. The purpose was to define and extract relationships in the axis of the category of focus (Strauss et al., 1987).

Development of these relationships according to Strauss and Corbin (1990) needs to set the previously fractured data back together in new ways «by making connections between a category and its subcategory». Connections between a category and its subcategory were accomplished through the use of a coding paradigm, which focuses on three aspects of the
Chapter 7  Discussion and model development

phenomenon. Specifically, these included the conditions or situations in which the phenomenon occurs, the actions and/or interactions of the people in response to what is happening in particular situations, and the consequences or results of the action taken or inaction (Corbin & Strauss, 1998).

Following the development of a theoretical structure framework, data were then reassembled to find out and record the relationships between categories and subcategories. In this line, Corbin and Strauss (1998) recommend the use of a paradigm by which the data could be collected together and controlled using axial coding. (Table 18)

<table>
<thead>
<tr>
<th>Element of paradigm</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Causal conditions</td>
<td>Conceptual way of grouping answers to the questions, why, why, where, how come and when.</td>
</tr>
<tr>
<td>Phenomenon</td>
<td>The central idea, event, happening, incident which a set of actions or interactions is directed at managing or handling, or to which the set of actions is related.</td>
</tr>
<tr>
<td>Context</td>
<td>Location of events</td>
</tr>
<tr>
<td>Intervening conditions</td>
<td>Shaping, facilitating or constraining the strategies that take place within a specific context.</td>
</tr>
<tr>
<td>Actions / Interactions (strategy)</td>
<td>Strategic or routine responses made by individuals or groups to issues, problems, happenings, or events that arise under a set of perceived conditions.</td>
</tr>
<tr>
<td>Consequences</td>
<td>Outcomes or results of action or interaction resulting from the strategies.</td>
</tr>
</tbody>
</table>

The first phase categories (initial interviews – chapter 4) were compared and discussed with the obtained categories in the second phase (cases studies A & B – chapters 5 and 6) in light of the Straussian paradigm, then revised and integrated in order to establish further possible relationships. Many categories and subcategories emerging from the research phase (first & second phases) were revised and then related and integrated into the paradigm (Appendix 6)

As a result of axial coding the following paradigms emerged (Figure 31)

1. Management of organisation knowledge
2. Management of project knowledge
3. Role of project management department
4. Role of lead project engineers
5. Role of HR Department
6. Role of ICT Department
In order to consolidate the emerging paradigm models and move towards a KM framework, the analysis now focuses on selective coding, which Corbin and Strauss (1998) defined as «the process of integrating and refining the theory».

The selection of the central or core category is important; this category represents the main theme of the research, to which all other categories can be related. Once the central category has been selected, it should be systematically related to the other categories. Much of the selective coding process is more abstract than open and axial coding, with less reference back to the findings (Gibbs, 2002).

At this stage of analysis, the use of diagrams is particularly beneficial in prompting more conceptual thinking about the interrelationships between categories. According to Corbin and
Chapter 7  Discussion and model development

Strauss (1998), these diagrams «need not contain every concept that emerged during the research process, but they should focus on those that reach the status of major categories» As can be seen, there are a number of recurring themes across the models/categories, including: the nature of the industry, the project as the best place for learning, problems associated with project fragmentation, the need for a LL system and a variety of actions/interactions which mirror the KM processes in the organisational department, and project level. As previously discussed, there is also significant overlap between a number of the categories: for example, the role of HR in supporting push dissemination of LL and providing informal K sharing opportunities. Also the ICT department participates in the pull dissemination of LL through intranet.

The selection of a central category, which represents the main theme of the research, is the first step in the selective coding process. Since the main focus of this research is demonstrating a link between managing of K, project success and transformation of an organisation into a learning organisation through managing the K derived within the EPC projects in oil and gas Libyan companies, the central category selected was «managing project K». This category comprises aspects of managing the K within the same project and within different projects making reference to the expert team leading the practices of the LL system. The projects department contributes also in managing the organisation K and collaborates with other departments.

Project K management was selected as the central category according to which the other paradigms are related and integrated through the selective coding process. This leads to the development of an integrated KM framework for the Libyan oil and gas organisations.

This incorporates a definition of K, drivers for KM, a definition of KM, developing a KM strategy, the role of HR and ICT, the role of middle managers and the management of professional, project and organisational K. The developed framework was then evaluated with staff from a leading Libyan construction organisation, who confirmed its validity.
Chapter 7  Discussion and model development

<table>
<thead>
<tr>
<th>Management of organization knowledge</th>
<th>Management of project knowledge</th>
<th>Role of project management department</th>
<th>Role of lead project engineers</th>
<th>Role of HR Department</th>
<th>Role of ICT Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Causal conditions</td>
<td>Causal conditions</td>
<td>Causal conditions</td>
<td>Causal conditions</td>
<td>Causal conditions</td>
<td>Causal conditions</td>
</tr>
<tr>
<td>K is informally managed no system of feedback, no job</td>
<td>K is created at the end of the project</td>
<td>Need to transfer K between different project</td>
<td>Need for communication between project team and project department</td>
<td>Need for push dissemination</td>
<td>Need for push dissemination</td>
</tr>
<tr>
<td>People are not interested, motivated for K sharing, K is a valuable resource</td>
<td>K created is lost with persons involved in the case</td>
<td>K created is lost from phase to phase</td>
<td>Company policy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strategy need for formal KIM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Phenomenon**

Managing the K of the organization

Management of EPC project K through a LL system

Project management department oversees and supports the project K management through LL system

Senior engineers play the role of capturing and validating

HR plays a central role in facilitating the dissemination and the use of available K.

**Context**

Presented industry,

Projects geographically dispersed

Best opportunity for learning

Content

Non-standard problems

Project phases

Content between many professionals' degree and disciplines

Contribute to the organization through KM

P dept head is a member of the approval management transforming project K into organization K

Member of the management committee providing and evaluating the needed K

Network of relationship

**Intervening conditions**

Willing from seniors

Cultural barriers

Job satiety

Time allocation

Intervening conditions

K transfer outside of work fragmentation of intra project disciplines

Communication between project team and project departments

Staff and budget

Procedures and policies

Intervening conditions

Reviewing roles

Intervening conditions

Timing, location, language

Intervening conditions

Fragmentation of organization

**Actions / Interactions (strategy)**

Set up a LL feedback system

Set up expert's network

Capture K from project department

Sharing the K and using it

Actions / Interactions (strategy)

Tracking the transfer of K created from phase to phase

Giving the opportunity to discuss KM issues facing projects

Recognising the shared K (problem solving)

Actions / Interactions (strategy)

Superior the LL system

Communicate with HR and ICT

Integrate and align LL with existing work practices

Provide time resources and expert

Actions / Interactions (strategy)

Encourage individuals to submit LL

Enhancing informal K sharing

Push the dissemination to deliver the LL

Guarantee job security

Actions / Interactions (strategy)

Store LL on the archive server

Replace default alerts and notification

Regular updating of archive

**Consequences**

Cost and time reduction,

Quality and work process improvement

Professional K improvement

Improvement policies and procedures in the organization

Consequences

LL can be integrated into project management or organizational processes

Resolving problem existing

Project K maximized and developed

Consequences

Improvement of the efficiency of LL practices

Organizational learning

Projects department success

Consequences

K reuses improved

Improvement of implementation of K reused

Improvement of the role of the K reused

Contributes to the organizational learning

Consequences

Organizational learning

Retaining staff

Increasing the capability

Developing skills

Consequences

Improvement of LL system

Supporting the K sharing and transfer

Figure 32 The central paradigm
Chapter 7  Discussion and model development

7.4  Paradigms Integration and Model development

The strategy element of the central paradigm is based on the management of a LL tracking system.

As it is illustrated by the Figure 33 the strategies of the six paradigms can be integrated through the development of a LL tracking system integrating all the emerged necessary actions and interactions during this research.

<table>
<thead>
<tr>
<th>Management of organization knowledge</th>
<th>Management of project knowledge</th>
<th>Role of project management department</th>
<th>Role of head project engineers</th>
<th>Role of HR Department</th>
<th>Role of ICT Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Causal conditions</td>
<td>Causal conditions</td>
<td>Causal conditions</td>
<td>Causal conditions</td>
<td>Causal conditions</td>
<td>Causal conditions</td>
</tr>
<tr>
<td>K is informally managed no system of feedback, no job done</td>
<td>K is firmly attended, motivated for K sharing</td>
<td>K is firmly attended, motivated for K sharing</td>
<td>K is firmly attended, motivated for K sharing</td>
<td>K is firmly attended, motivated for K sharing</td>
<td>K is firmly attended, motivated for K sharing</td>
</tr>
<tr>
<td>People are not motivated for K sharing</td>
<td>K is firmly attended, motivated for K sharing</td>
<td>K is firmly attended, motivated for K sharing</td>
<td>K is firmly attended, motivated for K sharing</td>
<td>K is firmly attended, motivated for K sharing</td>
<td>K is firmly attended, motivated for K sharing</td>
</tr>
<tr>
<td>Strategic need for formal KM</td>
<td>Strategic need for formal KM</td>
<td>Strategic need for formal KM</td>
<td>Strategic need for formal KM</td>
<td>Strategic need for formal KM</td>
<td>Strategic need for formal KM</td>
</tr>
</tbody>
</table>

Figure 33 Integration of paradigms
7.4.1 LL tracking system development

As a result of the project from start-up phase to completion (research phase 3 - case Study B - chapter 6), and considering the feedback the interviewees made regarding the project life with the involvement of project management team, and the feedback from the questionnaires distributed to project team, it became evident to the author that the K transfer from any of the project execution phases to the following phases is crucial. In the author’s view, the project management team should implement a K tracking system, a process by which the K created at any of the project phases can then be tracked during the subsequent development phases.

The said tracking process shall have two directions: LL collection and LL validation-updating. The first is to mark up any development that occurs with the K during the next phase after its creation and the second direction is to update (after validation) this development in the earlier phase (the phase at which the subject K is created), this process will continue until project completion and handover phase (Figure 34).

![Figure 34 EPC project K tracking process (source Author)](image)

In summary, the tracking process as highlighted above will resolve a critical issue related to project K context; the losses and deformation of context due to the technical development of the project work from phase to subsequent phase, i.e. the K created in the previous phase if not tracked as mentioned above will either be lost or deformed by taking a different shape.
Chapter 7  Discussion and model development

- Tracking the project KM should be through a LL system and based on:

- Collection of LL:

  As acknowledged by Disterer (2002), the identification and capture of LL is an extremely difficult process: with a variety of tools identified, such as post-project reviews and debriefings (Disterer, 2002; Kartam, 1996). Fisher et al. (1998) identified the «sought input» type capture of K process where a custodian of the LL process obtains input from various agencies (Fisher et al., 1998,) while Kartam (1996) talked about a requirement for individuals to submit LL themselves.

  In the case of this research, the two methods of capturing and the sought input role will be played by the lead project engineer. Project reviews and debriefings as tools for LL capture should be motivated by incentives for members to share their K created within the project and not just at the end of project in order to allow for K development within the project by the expert team. In addition, the lead project engineers should get the description of K keepers to capture the K created by sought input methods in the post-phase review, to avoid the loss of content. Furthermore, the documentation of LL requires consideration of the following: title, information about its source and context, and its classification for easy retrieval in a manner that allows fast, clear retrieval by multiple parameters (Kartam, 1996).

- Validation of LL:

  Validation of LL must be important and valid in that it is factually and technically correct and applicable in that it identifies something that eliminates the potential for future failures or reinforces a positive result (Weber & Aha, 2002). Fisher et al. (1998) recommend that analysis of LL be carried out by a team of senior staff with extensive industry experience. The expert group will validate K through two tasks identified by Laurent (1992):

  - verification: activities that intend to reach the structural correctness of the K
  - evaluation: activities that intend to demonstrate the K ability to reach correctness

- Dissemination of LL:

  The expert group releases the LL report of the K in two versions:
Validated released for information: after verification

Validated released for implementation: after evaluation

The validated LL dissemination can occur via two methods, push and pull. Push methods deliver the LL directly to the user based on their role, interests, training and experience, whilst pull methods leave the burden of searching to the user, who must devote his/her attention to the source (Weber & Aha, 2002).

Figure 35 Final Research Framework
Chapter 7 Discussion and model development

A pragmatic form of the model can help the organisation departments especially projects management department to achieve their role with success.

• Determining what K is required by the organisation
• Identifying where this K is located (internal or external)
• Capturing, classifying and modifying K in an appropriate manner
• Disseminating the information effectively within the organisation

7.4.2 Practical version of Model:

A pragmatic version of the final research framework was developed based on the development project - chart of EPC organisations type, (Appendix 8)

The pragmatic model describes the KM through its alignment with LL practices from LL emergence up until the final approval and issue for internal implementation and use. During the project work development, any K creation «initiative» is require to be reported by the project engineers (multi-disciplinary team) through their usual project reporting, without additional reporting requirements of the team; in this case the weekly report is appropriate.

Once the knowledge initiatives (KI) are reported by the project engineers, it will be received /collected by the lead project engineers as per the discipline, for example, if it is related to electrical, the Lead Electrical Project engineer is the concerned discipline and it is his/her duty to report it in the monthly report issued to the project manager (PM).

First for internal team discussions: dimensions, importance, experience from project management point of view should be brought up. Then the PM will review and discuss it with the Lead Project engineers (all disciplines) and once reviewed within the project team, the PM will issue it to management through the Projects Department Manager. Then it will be presented and reviewed by the concerned PM with other PMs (within the organisation) during the monthly interface meetings providing a good opportunity since all PMs are in attendance.

The projects department manager receives monthly reports from his/her PMs; within the monthly report there is a section related to K created as a potential LL and he/she disseminates it with a pull method through the ICT department (e-mails, notification, alerts), if there is an end phase gate the department manager requests a meeting of the expert committee to verify and validate the KI and convert the potential LL to a validated LL specific to the related project phase which can be used by other projects even if the projects
are running in parallel and not subsequently. This model improves the collection and use of LL and maximises their benefits in particular for the other projects that are running in parallel without the need to wait till to the end of the project.

With a continuous tracking of potential LL and reporting them as K creation imitative through monthly project reports, everything is conducted with fresh memory from the LL session. At the end of the phase (engineering phase, procurement phase, etc.) and end of project they can later compile a comprehensive LL without the loss of context and it can be very effective to use.

In terms of commitment, incentives can be awarded to the project member who identifies KI and to the expert committee. The dissemination of K can then be improved through the push and pull methods which are the roles of HR and ICT departments.

Push methods (HR role) offer the LL straight to the user based on the position, interests, instruction and experience, while pull methods (ICT role) leave the burden of search to the user through intranet, who must devote their attention to the source. For this reason, those two departments should be involved with the approval committee before issuing the LL approved for use.
Figure 36 Developed model for KM within EPC projects in Libya (Project C in this case)

7.5 Framework Evaluation:

After having completed the work, the developed framework should be proposed to PMs, Lead Project Engineers from the three oil companies. The participants were selected on the basis of their interest and potential role of a KM proposed framework also due to their experience and their time spent within their organisation as detailed in the table below.

As can be seen, while PM «A» has been with the company for a relatively short period of time, he had previously worked in the project management field for over 20 years. PM «B» had 18 years of experience in the oil sector, with both PMs having not less than 10 and 15 years of experience, respectively, in similar oil companies within the oil sectors in Libya.
Chapter 7

Discussion and model development

<table>
<thead>
<tr>
<th>Position</th>
<th>Experience (global)</th>
<th>Experience with Company studied as part of research work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager «A»</td>
<td>23</td>
<td>17</td>
</tr>
<tr>
<td>Project Lead Engineer «A»</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>Project Senior Engineer «A»</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>ICT Manager Company «A»</td>
<td>24</td>
<td>10</td>
</tr>
<tr>
<td>Project Manager Company «B»</td>
<td>26</td>
<td>21</td>
</tr>
<tr>
<td>Senior Manager; Director for Engineering &amp; Projects (Member of Company Management committee) «B»</td>
<td>25</td>
<td>9</td>
</tr>
<tr>
<td>Project Lead Engineer «B»</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Project Senior Engineer «B»</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>ICT Manager Company «B»</td>
<td>19</td>
<td>11</td>
</tr>
<tr>
<td>HR Manager Company «B»</td>
<td>28</td>
<td>21</td>
</tr>
<tr>
<td>Project Lead Engineer «C»</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Project Senior Engineer «C»</td>
<td>12</td>
<td>8</td>
</tr>
</tbody>
</table>

Figure 37 Distribution of validation committee participants

A meeting with the participants was conducted in the company’s (A) head office; Company «A» offered a meeting room, presentation facilities and refreshments to all the invited participants. The aim of this gathering «in the form of a workshop» was to ascertain whether the framework developed with the research work by the researcher can improve their understanding of K and facilitate KM within project execution. Could it be easily accepted and adopted? What are the difficulties and/or un-clarity in the proposed framework? Can the framework provide a sufficient case for the adoption of KM within projects departments in companies? And could it confirm the importance of developing a KM strategy within their organisation?

The workshop began with a presentation on the main course of the research work, including scope, objectives and final outcomes. The feasibility of accepting the proposed framework was the main focus and area for discussion with the participants from the three companies. It is important to note that the invitation was made to the original approached companies, who participated in the research work even if their participation was not at the same level. All three companies had confirmed their attendance (via email communications extended to personal invitation as was required in some cases). Specifically, in integrating the different emerged roles in the framework, participants were requested to review, comment and discuss the different aspects of the framework throughout the workshop session, which was recorded for
later analysis. The following is a summary of the main findings derived from the meeting which lasted for approximately two and a half hours.

1. **Management of organisational K**

In terms of improving the framework, the manager (PM Company A) stated, «I think it would be good if you had some examples of KM in practice to show how it is done». This was something which the lead Project Engineer (Company B) also picked up on: «are there any examples of companies that do KM well, and are they comparable as a result of the proposed framework». The identified benefits were viewed as acceptable by all the participants attending the workshop, although much discussion focused on linking KM within projects and KM within organisations.

2. **Management of project K**

PMs acknowledged the added value of the framework in KM improvement within the same project and between projects. They highlighted the improvement of LL practice in terms of session timing and participants which maintained the context of LL and gave more chances to use them in parallel projects and not only subsequently. Two PMs also identified the possibility of discussing the K initiatives during their projects interface monthly meetings, even before its validation by the expert committee, «we can meet with the dedicated experts to see if there is a potential for refinement or combination of K initiatives».

3. **Role of projects management department**

The PM (company B) had confirmed the need to adopt such a framework but also the need to start by setting up goals and allocating resources to achieve it; it cannot be all at once. They would need to take it step by step until the internal organisation started to get familiar with, accept it and defend utilising it. «From our point of view, it would take extra resources and more time to do this, so we would need to be clear about additional needs in order to assess what we’re getting out of it in terms of additional value in the work». He continued by discussing the potential to utilise the framework with the existing systems, stating «we already have a lot of experience and K however the proposed framework clearly addresses issues that we never considered; what then is needed is how the framework is structured». He also talked about training as he said it was not an issue integrating the framework or model as presented in our project management system with the support of our ITC department, however the issue was training the teams and establishing incentives as encouragement to use it at an early stage.
Chapter 7  Discussion and model development

The lead engineer (Company C) after long discussions about the framework’s internal and external links (within the project team, department of projects and among the organisation) and how practical to implement it, while discussing the author got support from another participant (ICT Manager Company B) who elaborated on how the link could easily be made via the software systems they already had in the organisation. I started to feel the satisfaction as I saw others defending the work done. The Lead Project engineer (Company C) said yes regarding the ICT explanations and implementation support and was now pleased to recommend implementing it in the organisation.

4. Role of lead project engineers

Lead project engineers (Company A & B) confirmed the potential for themselves to fulfil the identified roles; they said now they could pay more attention to K, although the PMs (from both Company A & B) and the Director (Company B) stated that, «we would see our role in KM as being a facilitator, we would not essentially do all of the work, but delegate and monitor it to our project teams and ensure that we do things similar to LL upon the completion of our projects but in a better structured and traceable manner».

The Lead Project Engineer (Company B) recognised the need for support he gets from his director who participated in most of the discussions, «management support is important in this respect; from my view it’s mainly related to the allocation (provision) of resources to projects on time and as per the manpower plan».

5. Role of HR

The HR Manager (Company B) stressed the important role of HR in managing K through a range of company activities, but acknowledged that the recession on subsea projects and the country’s economic situation (since 2011) has had an impact on them. He stated, «performance management has fallen by the wayside in the last four years, all of us are under pressure in the company and management is putting all of their energy into maintaining production and the essential support activities to avoid any unplanned plant shutdowns; accordingly, and due to priorities, certain things have had to take a back seat, unfortunately».

However we were interested on the proposed framework and with HR building on the detailed discussions we had with the involvement of experienced PMs from the company or from the other sister companies who had entered into detailed analysis of the framework and had viewed it from the Projects Management approach; as HR we can conclude that what we have seen today is a driver for KM tracking and development within the organisation which
will not only assist and support project teams but provide grounds for learning especially for new company employees.

6. Role of ICT
The ICT Manager (Company B) added that in relation to finding and managing K, «I still think that the limited and narrow view is common in our company and most likely the case in the other sister companies, where people think that their informal network is enough to get what they need in the company, it might be enough for experienced and senior employees within the organisation but sure will not be good at all for someone who just joined the company. They don’t have that span of network».

7. General evaluation
The participants gave their feedback about the proposed framework and they recognised the suitability of the developed framework. They confirmed the importance of the adoption and development of the proposed KM strategy within their organisation. However, they gave some comments as summarised in the points above. The researchers acknowledged the importance of the points above and believe that they should be addressed in further research when an organisation decides to apply the framework and integrate it. In this vein, a detailed system should be developed and training sessions should be conducted.
Chapter 8

CONCLUSIONS AND RECOMMENDATIONS
8 Conclusion and recommendations

This last chapter summarises the general conclusions and recommendations drawn from the research. Contributions of this study to the theoretical literature, and practical professional and empirical findings are also presented. Further, limitations of the study are pointed out and areas for further research are suggested.

8.1 General conclusions

During the first research phase, the project K is the principal type of K that needs to be managed, especially the LL. According to the PM who made an individual initiative, the LL reflected by his team were very broad, and not useable in other projects as he said, «LL reported at the end of project were very few, and there was a loss of context, the team reflected the problems confronted in the construction phase without citing the origin and how the problem began since the early phases of the project».

During the second phase, barriers related to project management were the most relevant barriers in LL implementation; the essential need for a formal KM system was then validated by a course of interviews with project team members. As also demonstrated during initial interviewees (chapter 4), project K (mostly LL) was the main type of K supporting the organisational K in EPC companies.

The success of such efforts over the long run will depend upon on how KM activities impact important outcomes as perceived by those that actually implement the activities. The input-process-output framework of team effectiveness to examine the relationship between selected KM-related activities on integrated product and process development team members’ satisfaction with their project’s success and the impact they expected it to have on the organization. The results indicate that team-level leadership and support (i.e., inputs), along with knowledge generation and dissemination (i.e., processes), are key drivers of member performance-related ratings (i.e., outputs) and possibly most importantly, a number of interactions were evident suggesting that the KM processes moderate the effects of the KM inputs. Effective knowledge management requires a good fit between the organization’s culture and its knowledge management initiatives. Knowledge Management (KM) is a key strategy which many organizations have been leveraging upon because of its potential in achieving competitive advantage as per Adeola Bamgboje-Ayodele, Leonie Ellis (Jan 2015)
8.2 Recommendations

This research considered KM from the perspective of the Libyan oil and gas organisations. Recommendations are now made in relation to those studied organisations, for KM in the wider oil and gas industry and for further research.

- **Adoption of KM Framework by Leading Libyan Oil and Gas Organisations**

It is clear that a more formal approach to managing K would be beneficial to the Libyan oil and gas organisations. The full adoption of KM in the current economic environment might not be feasible, but there is a potential for an incremental approach. Areas which require minimal time and investment could be initially developed to demonstrate the potential benefits, and get attraction from both senior management and their related staff. Such areas could include the adoption of LL practices, development of the intranet system and regular knowledge-sharing meetings for middle managers.

In addition to the adoption of a K tracking process model and to ensure an effective KM implementation in the EPC project execution, the following practices and activities should be addressed to achieve an effective implementation and adoption of KM:

- Placing more value upon learning from previous executed projects and incorporating the LL documentation as the main aspect of K outcome in the EPC project.

- Placing more importance on procedural K, as it represents the main influencing domain of K in EPC project management, and the need to externalise it in explicit form to facilitate and enhance its management within project organisation.

- Building upon, expanding and facilitating existing work practices as it appears to be the most appropriate approach in developing and implementing KM, like meetings, mentoring, site visits.

- Building upon existing formal and informal learning activities which present the only actual opportunities of K exchange in the absence of an organisational learning system.
8.3 Reflection on aim and objectives

In the oil and gas environment, organisations are increasingly using projects as a means to deliver their objectives. K management, which is a unique intangible asset, is seen to be crucial to the organisation’s success in achieving competitive advantage. It is argued that managing tacit and explicit K enables the project team to avoid rework and compress time required to plan for a project. It is from this perspective that the author decided to conduct a research study on K management adoption in EPC project management.

Objective 1

- To investigate the issues related to managing the K derived from Libyan oil and gas organisations.

From the interviews, almost all project K was maintained as tacit K and kept mainly with the PM, while the practice of capture, coding and archiving new or updated K including LL, counting the mistakes during the current project and previous work phases or what happened in earlier projects were non-existent. The main issue that emerged was how to maintain and enhance K sharing and transfer within the organisations, within the sole project team, within different project teams and within the overall company organisation. Almost no knowledge transfer (KT) was recognised within the project team or from project to project. It can be argued that these organisations currently manage K mostly on an informal basis; K was not considered as a target or a strategic objective in the organisations.

Respondents talked about ineffective use of K within the organisation as a consequence of a great lack in K of management process, K used and developed in the organisation across time as a result of many projects executed by the organisation which generally were not organised and not updated. This may cause many unpleasant issues, such as not benefiting from this K or past experience, learning from previous mistakes, unnecessary additional money spent, unnecessary delays, etc.

Based on the evidence provided, oil and gas organisations managed K informally without a strategy or defined system but there was a confirmation of minimum use of learning activities which can contribute towards KM implementation such as meetings and workshops, site visits, training and mentoring however these activities were not effectively exploited. In
practice knowledge created in projects often is lost when the team splits up and the members return to their original tasks in the organisation. This leads to inefficiency as time and money is spent in inventing things, which are already known inside the organisation.

More in depth issues related to LL practices emerged in the second phase of research:

**Capture and sharing**

- No LL capture at the stage gates (stage gate is an event that occurs at the end of each phase of the project).
- Low participation in meetings.
- No top-management support.
- Time constraints.
- Forgetfulness.

**Saving**

- Employees no longer at the project/company.
- No standardised routines, templates or guidelines.
- Unstructured information format.
- Poor and complex storage system.
- Time consuming retrieval process.
- Propensity for informal communication (oral, e-mail, etc.).
- Lack of search function.

**Objective 2**

- To identify practices and activities for managing K within the leading oil and gas organisations for EPC project which can represent the basis for implementing an effective K management system.
The main influencing factors affecting KM implementation were examined through an initiative made by a PM (in case study A) to identify which practices were most effective. The main and the most critical factor concerning KM implementation was providing the opportunity (3.81), with this challenge relating to project management. The findings of this step included the critical gaps that should be addressed to implement a KM system in oil and gas EPC. The project management challenges that emerged play an important role in KM implementation; the importance of these kinds of challenges was validated during the measurement of the factor’s importance demonstrating they are the most critical areas for KM implementation which need to be addressed. For this, project management practices (LL practices), especially meetings and workshops, can be the basis for building and implementing an effective KM management system.

Oil and gas companies investigated were project based organisations which made, by nature, the project K and especially LL derived from problem solving activities the main important kind of K created within these companies. LL was the main kind of K needing to be managed. Organisational factors like organisation support, training and mentoring and project management factors like meetings, workshops, site visits, emerged as influencing the KM process.

**Objective 3**

- To suggest a conceptual KM model based upon the emerging issues that can be used in the oil and gas industry in Libya for the development of EPC projects: a simple, less complicated and suitable model considering the low spread of K in the overall organisation that can encourage management, project management teams and their sub-team to use and implement, to facilitate K creation and sharing activities in their project environment.

While it is recognised that numerous KM frameworks have been developed in recent years, initial research conducted for this study identified the need for continuing empirical research specific to the context of KM in construction organisations. The KM framework developed during this study highlighted the integral roles that PM, HR and ICT departments played in KM in oil and gas organisations. The main mechanism of the model was to track the K during the project’s life cycle.
The tracking process should have two directions, LL collection and LL validation-updating, with the first to mark up any development that occurs to the K during the next phase after its creation and the second direction is to update (after validation) this development in the earlier phase (the phase at which the subject K is created). This process will continue until the project completion and handover phase. Project management department has a lead role to play in this regard, requiring the support of HR and ICT.

The role of lead project engineer is also very important as their position is between the project teams and the department project as they are middle managers in their projects and expert committee members in the project management department. Their role is very important because they are responsible for almost all the K tracking process within their department.

Similarly, ICT and HR need to provide the technological know-how required to translate such information into user-friendly and secure systems that are available and accessible to all staff throughout the organisation and for staff by populating and managing the staff skills database, promoting staff networks through an online environment.

The general knowledge and understanding that has resulted from the (3) objectives is that realizing the importance in knowing the significance of each sector to an organization; the needs for enhancement meant for broadness to be more efficient and effective to the organization by combining these objectives such as investigating related the issues, identifying practices and activities for managing K for EPC project which can represent the basis for implementing an effective K management system and to promote conceptual KM model based upon the emerging issues that can be used in the oil and gas industry for the development of EPC projects. In addition to providing chance and support to all level of workforces for development needed (Training and mentoring, workshops, site visits). Benefiting the performance that each sector an attribute after the enhancement process. Nevertheless, there is an plenty of studies describing how large companies are successfully exploiting knowledge management (KM) practices as according to Roberto Cerchione, Emilio Esposito, and Maria Rosaria Spadaro (July 2015).

8.4 Research contribution

This research demonstrated the importance of K to the oil and gas industry for successful execution of a project. If the industry wishes to learn from experience and to be continually
innovative, it is vital important that KM is explored at the industry level. A sensible and suitable practical model of KM including an effective LL tracking process was built for this research work and addressed the oil and gas industry in Libya. The participants from different oil and gas companies found the framework and guidance document to be easily understood, and were able to relate it to their own organisation. There is, however, still potential for further development and a need for delivery of this to a wider audience (big size samples). There is also the possibility of this module being delivered on its own as a training course concluded by the issuing to the attendees of a Certificate in Knowledge Management in Oil and Gas of Libya, which could potentially be accredited by the Libyan Engineers firm. This could be delivered to staff involved in the development of KM within their company projects organisation, Lead project engineers, HR and IT professionals, contract managers and senior management.

The progress to knowledge of new model will capture, develop, improves performance and mostly sharing of knowledge that can be useful to the organization. Economic as well as safety-related issues call for strict attention to Knowledge Management in the oil & gas industry, in order to “not make the costly error”. Work processes are related to KM, in that a process that can be seen as codified piece of “know-how” knowledge, and we therefore believe that a different approaches, trainings technically sophisticated and highly complex domain demands expert knowledge. Learning from previous projects is a key success factor. It Minimizes Downtime, develop and deploy processes and technology to improve organizational performance.

Herbert S. Robinson, Patricia M. Carrillo, Chimay J. Anumba and Ahmed M. Al-Ghassani (2005) said that Knowledge management relates to unlocking and leveraging the different types of knowledge so that it becomes available as an organisational asset. Implementing KM enables an organisation to learn from its corporate memory, share knowledge, and identify competencies in order to become a forward thinking and learning organisation. O’Leary (2001) argued that KM initiatives can help attract and nurture top talent, as 'maximizing access to knowledge across the organisation' can accelerate the learning experience of new employees, build more knowledge and increase organisational capability. KM can drive innovation, helps to attract new and retain valuable customers, and in the process increase organisational productivity and profitability. Demarest (1997) noted that 'firms without knowledge management systems will be effectively unable to achieve the re-use levels
required by the business model implicit in the markets they enter, and will lose market share to those firms who do practice knowledge Management’.

8.5 Research limitations and further research

As with any research work, there were limitations which may impact the outcome of this study. As discussed in chapter 3, the methodological approach adopted sought to reduce such impacts as much as possible. However, it is important to be familiar with the limitations in order to express a thorough understanding of the research undertaken. The limitations of the research work included the following:

- Proposed model did not address the improvement of K creation at the individual level. K sharing between individuals was not untamed because of the cultural issues and the mentality that need much time to be changed.

- Specific to Libyan oil and gas sector: this study was conducted within the Libyan oil sector, and to strengthen the findings of the research, future investigations should be conducted in a cross organisational environment and include the wider Oil, gas and petrochemical sector in Libya.

- The empirical nature of the research and the fact that it was case studies rendered the results at this stage of research work not generalizable. In addition to this, the rather small samples also imply that further research and verification are necessary to further develop and reinforce the findings.

The Libyan oil and gas organisations are in the very early stages of KM adoption. Thus, the model can be developed at an inter-organisational level (NOC sister companies) after further testing, verification and possible development of the formulated KM framework with these organisations. Furthermore, future research should investigate the influence of cultural factors on reporting and sharing LL within the project organisation as well as companies with global organisation.
REFERENCES


Belqais Allali, Kaushal Keraminyage, Udayangani Kulatunga (2014), - ”The influence of organisational culture on sharing knowledge in small information communication technology firms in Libya”. University of Salford, UK


Funmilola Olubunmi Omotayo (2015) – “Knowledge Management as an important tool in Organisational Management: A Review of Literature”


Gholamreza Jandalghi, Hamid Reza Irani., Zeinab Sadat Mousavi, Maryam Davoodavabi (2014) – “Evaluating The Readiness Of Management Schools To Execute Knowledge Management”. Faculty of Management and Accountancy, Farabi Campus, University of Tehran, Iran


Ismail W.K.W., Nor K.M., Marjani T., The role of knowledge sharing practice in enhancing project success, *Institute of Interdisciplinary Business Research 2009*/1


Mohammad J. Arif and Mohammed Hassan Bin Shalhoub (2014) – “Critical Success Factors with its Effective Role in Knowledge Management Initiatives in Public and Private Organizations in Saudi Arabia: Experts Perspectives”. Information Science Department, King Abdulaziz University, Jeddah, Saudi Arabia


Roberto Cerchione, Emilio Esposito, and Maria Rosaria Spadaro (July 2015) – “The Spread of Knowledge Management in SMEs: A Scenario in Evolution” Department of Industrial Engineering—University of Naples, Italy;


Saif Al Muzahmi (March 2015) – “Challenges in Knowledge Management Insights from Oil and Gas Industry.” University Utara Malaysia


S. Abouen, V. Ahmed, G. Aouad (2014) - “Project Manager Developement In The Libyan Oil Industry” School of Construction & Property Management, University of Salford, Greater Manchester, M7 1UN

Satu Elo & Helvi Kynga’s (2007) – “The qualitative content analysis process”. University of Oulu, Finland


Timur Narbaev (2015.) – “Project Management Knowledge Discovery in Kazakhstan: Co-Word Analysis of the Field”. International School of Economics (jointly with the London School of Economics) and Business School, Kazakh-British Technical University, Almaty, Kazakhstan.


Appendices
Appendix 1

Initial interview Guideline
1. Knowledge

a. How do you define the term: knowledge?

b. What are the different kinds or types of knowledge that exist in your organisation?

c. And what are the different formats of knowledge that you recognize?

d. What are the differences between them?

e. What is the most valuable format in your organisation? And why?

f. What is the more predominate format in your organisation? And why?

g. What is the easiest format to manage in your organisation? And why?

h. What is the main source of knowledge in your organisation?
i. Does your organisation recognise knowledge as a part of their asset base?

Knowledge Management

a. How do you define the term: knowledge management?

b. Is knowledge managed in your organisation? How?

c. What are the main processes used in knowledge management by your organisation?

d. Do you generate new knowledge during projects?

e. When and where can knowledge be created?

f. When and where can knowledge be exchanged?

g. How do you capture this knowledge?

h. Do you update knowledge utilisation in the organisation? How often?
i. Do you capture LL from projects?

j. Are LL documented? If not, why?

k. Do you share LL? How?

l. Do you benefit from LL? How?

m. Do you have an explicit procedure for managing this knowledge?

n. What do you think are the factors influencing knowledge retention in your organisation?

o. What are the problems related to knowledge retention?

p. What is one of the biggest cultural barriers in knowledge management in your organisation?
q. How much time does it take for you to get the relevant knowledge document in your organisation?

r. Do you share your self-development knowledge with others? If yes how, if no why?

s. What is the attitude of the organisation in terms of KM? Does it provide support?

t. What do you think are the kinds of support needed to effectively managing knowledge?

u. Have you made an initiative in knowledge management? If yes, could you talking about it?
1. Knowledge

k. How do you define the term: Knowledge?
Knowledge is the personnel Experience

l. What are the different kind or type of knowledge existing in your organization
There is the person K, and also company K,

m. How is the knowledge format you recognize? What are they?
There are tacit or implicit K and explicit K

n. What are the differences between them?
The documented knowledge (explicit) is what is contained in the issued reports, and implicit is in the form of a personal experience and capability

o. What is the format the more valuable in your organization?
[He replies immediately] sure the not documented is the more valuable in our organisation

p. Why?
Because documented knowledge available within the organisation is always generic and without precise context, what we have in mind of our expertise is what helps us more to find solution for any problems.

q. What is the format the more prevail in your organization?
If we consider valuable K and important K, then the not documented K is more prevail than any other.

r. What is the K set-up that is easier to manage in your organization? And why?
Always the documented K is the easier to exchange and share within the entire organisation. Thus it’s very difficult to manage the individual/personal Knowledge as it is more likely that everyone keeps his knowledge with him, not easy to explore and share.

s. What is the main source of knowledge in your organization?
In my opinion the best opportunity is to learn new knowledge occurs during project meeting and workshops discussions, meetings to discuss specific technical problems or approaches to specific work/activity.

t. Does your company recognize knowledge as a part of their asset base?
No, unfortunately this is not the case, only minor people in the hull organization considers this, but minority has no effect [he regrets]
2. Knowledge Management

a. How do you define the term: Knowledge management?
A system that helps in capturing knowledge created and profit from it in the future work

b. Is knowledge managed in your company? How?
No not effective, we only practising LL at the end of the project; we called it post project review but it is very generic and routine review but it is very generic and routine task

b.1 LL from previous projects are they well documented? If not why?
Yes they are documented within the post project review meeting but lacking precise context

b.2 Do you share LL with others? How?
LL are archived as part of project documents, it is not shared via a dedicated system to all the team, or to other projects teams

b.3 Do you benefit from the documented LL? How?
LL archived mostly is ineffective to reuse; it is taking a form of generic information reflected that’s why project teams are not encouraged to use them.

c. What are the main processes used in knowledge management by your organization?
Capture K via LL at end of projects and archive them

c.1 does the archive system “server” accessible to all the professionals? Structured to help identifying what you are searching for?
No it is not accessible to all; it requires authorization from the project manager. It is not well organized, difficult to track the phase of its occurrence and to which discipline.

d. Do you generate new knowledge during projects?
Yes for sure but it is mostly in a form of tacit K ; and minority reflected at the LL session

e. When and where knowledge can be more created?
Can be created at each project phase; during problem solving meetings or workshops

f. When and where knowledge can be more exchanged?
During workshops meetings, technical review meetings that are taking place at the end of each phase, monthly project meetings.

g. How do you capture this knowledge?
At the end of phase, post project review we recommend to reflect LL captured during the project

h. Do you update knowledge used in the company? How often?
No we have no system to do this we request always experts and persons with wide experience to share their tacit knowledge; it still always personal initiative

i. Do you capture LL from projects?
j. Does LL are documented? If not why?
   Question moved to 2b.1

k. Do you share LL? How?
   Question moved above to 2b2

l. Do you benefit from LL? How?
   Question moved above to 2b3

m. Have you an explicit procedure to managing this knowledge?
   Already replied at 2h

u. Does meetings outcome are documented and shared?
   Yes through minutes of meeting and shared just for the involved persons

n. What do you think are the factors influencing Knowledge retention in your organization?
   Cultural factors is the most influencing factor, we have no sharing culture

v. How much time does it take for you to get the relevant knowledge document in your organization?
   It depends of the luck, sometimes, immediately sometimes never found

o. Do you share your self-development knowledge with others? If yes how, if no why?
   Sincerely not much, my knowledge is my influence and contribution, and if I share all my knowledge I may loss rule in my company organisation,

p. What is the attitude of organization in term of KM? Does provides support?
   Absolutely there is no support from the top management

q. What do you think are the kind of support is needed to effectively managing knowledge?
   We need a technological and communication support.
   The accessibility of project (s) database is essential, we need the access of our database via internet from remote area to our desk, we face difficulty to access via intranet, and this causes a problem.

r. Have you made an initiative in knowledge management? If yes, could you talking about it?
   NO
Appendix 2

Case study “A” open coding example
"It is usually that we are very busy and overloaded with work, each of us has no time to exchange knowledge with other colleagues within the same sub team and it's more difficult with the other sub teams."

"In most of the cases we found ourselves in a situation where the work is accumulated, we have a lot of documents overdue and we are in delay as per the plan; this situation does not provide any chance for us to handle the knowledge created by the project in good way, we in most cases don't even circulated to other team members."
<table>
<thead>
<tr>
<th>properties</th>
<th>open codes examples</th>
<th>subcategories</th>
<th>categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>It’s more easy and accessible to have a documented written knowledge than non-documented knowledge in our company is a personal knowledge that is usually not easy to be transferred.</td>
<td>epistemological levels (tacit/explicit)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Most project team members that i worked with believe that non-documented knowledge that they are keeping within themselves is an added value to them, like strengthening their skills, and for this reason they prefer not to document it or share it with others within the project or in the project department as an overall umbrella.</td>
<td>ontological levels (individual/group or project/organisational/inter-organisational)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>From my experience being working in projects for over 15 years, the majority of the knowledge that created, or developed during project execution kept and stored in individuals’ minds. The organisation is not profiting from the knowledge created in a structure manner, only if the person who is holding this knowledge is continuing in the organisation, if he or she reason then the k created will be lost from the company.</td>
<td>domain (technical, commercial, procedural)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In my opinion there are several knowledge types; technical knowledge; commercial k and procedure knowledge, all are important and can play a role in enchasing company business.</td>
<td>documented, not documented, skill, experience, documents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We experience from not having dedicated procedure, guidelines within the company projects management organisation that engages the project team to deliver a LL report at the end of the project.</td>
<td>aspect (LL, best practices, other various information) best practice awareness, LL, project management methodologies and techniques</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In my view the ll if it is adopted as practices it helps a lot in knowledge sharing and transfer from team to team (project to other project) or even individual to other.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The organisation should encourage and support the project teams to transfer the non-documented knowledge to document knowledge to</td>
<td>capturing</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>k management process</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
To me the best chance to learn new knowledge is during project meetings and workshops, meetings to discuss specific technical problems or approaches to specific work/activity.

Development of individual skills can support knowledge creation and transfer, i.e., to train the project team members on how to enhance their knowledge and improve the organisation’s knowledge, especially during the site construction activity where knowledge creation and transfer can be more effective.

During the construction activities, site visits can accelerate the knowledge creation and transfer, especially to engineering team who started the project’s initial phase (basic design), and follow through all the subsequent phases until the construction phase.

The accessibility of the project(s)’s database is essential; we need access to our database via the internet from remote areas to our desk, but we face difficulty in accessing via the intranet, and this causes a problem.

I do believe that, first, motivation for the project team, and second, the provision of guidelines from project managers and company management are important; it provides a challenge to the team members to be knowledge creators and they will by return receive motivation and incentives from the company.

Unfortunately, knowledge management does not represent a strategic objective in our organisation.

<table>
<thead>
<tr>
<th>properties</th>
<th>open codes examples</th>
<th>subcategories</th>
<th>categories</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>formalities</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>meetings and workshops</td>
<td>km activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>site visits</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ICT support</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>management support</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>strategic support</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>organisation support</td>
<td></td>
</tr>
<tr>
<td>2nd phase semi structured interviews</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Data example</strong></td>
<td><strong>Open code example</strong></td>
<td><strong>Subcategories</strong></td>
<td><strong>Categories</strong></td>
</tr>
<tr>
<td>“We don’t have a software system that helps us in gathering and organising the new information/knowledge”</td>
<td>Software system, Information exchange, archiving system</td>
<td>Lack of local network</td>
<td>Technological and Communication factors</td>
</tr>
<tr>
<td>“As a project team we don’t have a system that archives and tracks the new knowledge.”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Most of the project team store/archive any new information and knowledge in the local folder of their desktop, with no possible access to others.”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“There are several difficulties that we face during the project execution, and it has an effect on the knowledge exchange, such as voice communication problems; if we are out of office in any of the work sites we cannot communicate on spot in most cases due to not having company phone sets. Important knowledge exchange and sharing cannot take place.”</td>
<td>Out of office, server availability, voice communication, e mail, conference call, multi-nationality</td>
<td>Lack of network access</td>
<td></td>
</tr>
<tr>
<td>“I don’t have access to my Outlook when I am away from my desk and this creates a lot of difficulties in being updated with any new knowledge developed during project development.”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“From my experience, one of the main reasons that creates difficulties in managing any new knowledge within the project life cycle is the language; we are a multinational team and the common language is English, but for most of the team members it’s not their mother tongue language, and there are on many occasions difficulties in understanding, especially when we have different opinions.”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Usually we are very busy and overloaded with work; each of us has no time to exchange knowledge with other colleagues within the same subteam and it’s more difficult with the other subteams.”</td>
<td>work Overloading, lack of time, tight schedule,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“In most cases we found ourselves in a situation where the work has accumulated, we have a lot of documents overdue and we are behind in relation to the plan; this situation does not provide any chance for us to handle the knowledge created by the project in good way, we in most cases don’t even circulated to other team members.”</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 2nd phase semi structured interviews

<table>
<thead>
<tr>
<th>Data example</th>
<th>Open code example</th>
<th>Subcategories</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>“I think the experienced problems that we have in managing knowledge are related to the fact that we as a project team are organised in one multi-store building and occupy several isolated rooms on each floor, and this set-up makes it difficult to share the new knowledge with other team members within the project”</td>
<td>Work sites (different), offices (several), work space (open/isolated)</td>
<td>Fragmented project team structure</td>
<td>Loss of context</td>
</tr>
</tbody>
</table>
"Yes, the handing of any new knowledge and KM is an important issue in my opinion,... in our organisation the role of knowledge manager is not defined, there is no job description to this role, I need to manage my discipline group as lead engineer to make sure that we complete our duties on time...time as per the schedule, this is my priority, if I have time I may focus on the KM issues within the project, but this always comes after and at a later stage."

"To perform the task of knowledge manager I need my management support; there are no incentives in doing this; it is not recognised by my management as an important contribution in my evaluation. In addition, we during the project period work under pressure, we have no spare time."

"From my experience most of the project team members feel as if they share any new knowledge with others as they lose their value within the team, they feel that if any of them have this new knowledge they have more power than others."

"In my experience sharing any new knowledge with others requires good social relations and trust; if team members know each other and worked in the past together for long periods then there is a good chance that they share knowledge. But it’s more common that project team members are new to the set-up and for this reason the knowledge created has a low chance of being recorded and shared."

"It is more common in our project teams that eachmember holds new knowledge and feels that with this knowledge he can present himself as more professional during any technical meeting with the project team, and his manager will give him a higher evaluation score."

<table>
<thead>
<tr>
<th>Data examples</th>
<th>Open codes examples</th>
<th>Subcategories</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Yes, the handing of any new knowledge and KM is an important issue in my</td>
<td>Incentive, job description, KM as objectives, management support,</td>
<td></td>
<td>organisational</td>
</tr>
<tr>
<td>opinion,... in our organisation the role of knowledge manager is not defined,</td>
<td></td>
<td></td>
<td>factors</td>
</tr>
<tr>
<td>there is no job description to this role, I need to manage my discipline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>group as lead engineer to make sure that we complete our duties on time...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>time as per the schedule, this is my priority, if I have time I may focus on</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>the KM issues within the project, but this always comes after and at a later</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>stage.&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;To perform the task of knowledge manager I need my management support;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>there are no incentives in doing this; it is not recognised by my management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>as an important contribution in my evaluation. In addition, we during the</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>project period work under pressure, we have no spare time.&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;From my experience most of the project team members feel as if they share</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>any new knowledge with others as they lose their value within the team, they</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>feel that if any of them have this new knowledge they have more power than</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>others.&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;In my experience sharing any new knowledge with others requires good social</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>relations and trust; if team members know each other and worked in the past</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>together for long periods then there is a good chance that they share</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>knowledge. But it’s more common that project team members are new to the</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>set-up and for this reason the knowledge created has a low chance of being</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>recorded and shared.&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;It is more common in our project teams that eachmember holds new knowledge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and feels that with this knowledge he can present himself as more professional</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>during any technical meeting with the project team, and his manager will give</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>him a higher evaluation score.&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 3

Case study “A” online questionnaire
Q: In your opinion, KM implementation failure during the individual initiative was caused by:

<table>
<thead>
<tr>
<th>Causes</th>
<th>Justification:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of IT system</td>
<td></td>
</tr>
<tr>
<td>Lack of opportunities</td>
<td></td>
</tr>
<tr>
<td>Lack of communication</td>
<td></td>
</tr>
<tr>
<td>Project team structure</td>
<td></td>
</tr>
<tr>
<td>Role not recognized</td>
<td></td>
</tr>
<tr>
<td>Time effect</td>
<td></td>
</tr>
</tbody>
</table>

Other causes (could you please explain them in few lines)

Please tick the mark ✓ and justify your response
Appendix 4

Case study A Quantitative questionnaire
Our study identified 4 groups of total 16 influencing factors of Knowledge management implementation. Please rate the importance of the critical factors in each group according your opinion and using Likert scale.

**Likert scale:**
1 = not important at all
2 = slightly important
3 = moderately important
4 = very important
5 = extremely important

**Organisational factors**
1) Incentive
2) Job description
3) KM as objectives
4) Management support (procedure)
5) Social relations

**Project management factors**
1) Maintaining the context
2) Giving the opportunity to learn
3) Managing the team structure

**Professional factors**
1) Loss of power
2) Professional evaluation
3) Developing skills
4) Trust in others

**ICT factors**
1) Archiving system
2) Server availability
3) Communication technology
4) Linguistic communication
<table>
<thead>
<tr>
<th>Factors</th>
<th>Items</th>
<th>Mean</th>
<th>Deviation</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Incentive</strong></td>
<td>Company adopts a compensation scheme for any achievements in implementing knowledge management in projects</td>
<td>3.14</td>
<td>0.82</td>
<td>4</td>
</tr>
<tr>
<td><strong>Job and procedure description</strong></td>
<td>The company reviews the organisational procedure and job description to better define the KM role in Clearer way, suitable and applicable procedure of KM within the project department</td>
<td>4.59</td>
<td>0.44</td>
<td>1</td>
</tr>
<tr>
<td><strong>KM as objectives</strong></td>
<td>The senior management has a clear vision and goals for KM, with budget allocation</td>
<td>3.19</td>
<td>0.81</td>
<td>3</td>
</tr>
<tr>
<td><strong>Procedure and policies</strong></td>
<td>KM tasks to be considered in the project’s base plan and schedule</td>
<td>4.81</td>
<td>0.82</td>
<td>2</td>
</tr>
<tr>
<td><strong>Work sites (different)</strong></td>
<td>Acceleration of site visits, workshops and meetings for wide-scale participation</td>
<td>3.05</td>
<td>0.68</td>
<td>4</td>
</tr>
<tr>
<td><strong>Time lapse</strong></td>
<td></td>
<td>3.32</td>
<td>0.73</td>
<td>3</td>
</tr>
<tr>
<td><strong>Giving opportunity</strong></td>
<td>Providing the opportunity to reflect and learn</td>
<td>4.89</td>
<td>0.75</td>
<td>1</td>
</tr>
<tr>
<td><strong>Job/Power security</strong></td>
<td>Sharing knowledge in problems faced should not be seen or viewed as a failure pertains to project team</td>
<td>3.3</td>
<td>0.84</td>
<td>1</td>
</tr>
<tr>
<td><strong>Professional evaluation</strong></td>
<td>The professional evaluation should not only be based on individual tacit knowledge</td>
<td>3.25</td>
<td>0.43</td>
<td>2</td>
</tr>
<tr>
<td><strong>Developing KM skills</strong></td>
<td>Individual training and support in KM commitment should be given to project team members</td>
<td>3.04</td>
<td>0.81</td>
<td>4</td>
</tr>
<tr>
<td><strong>Trust in others</strong></td>
<td>Trust should be enhanced between members</td>
<td>3.15</td>
<td>0.65</td>
<td>3</td>
</tr>
<tr>
<td><strong>Archiving system</strong></td>
<td>Implementation of easily accessible and secure archiving system</td>
<td>4.32</td>
<td>0.84</td>
<td>1</td>
</tr>
<tr>
<td><strong>Server availability and accessibility</strong></td>
<td>Server availability and accessibility at any time and in any location</td>
<td>4.23</td>
<td>0.43</td>
<td>2</td>
</tr>
<tr>
<td><strong>Communication technology</strong></td>
<td>Phone, mail, conference call and internal network should be available to team members and supported by the company</td>
<td>4.1</td>
<td>0.81</td>
<td>3</td>
</tr>
<tr>
<td><strong>Linguistic communication</strong></td>
<td>Enhancing linguistic skills</td>
<td>4.05</td>
<td>0.65</td>
<td>4</td>
</tr>
</tbody>
</table>
Appendix 5

Case study “B” LL sessions
Interview questions guidelines

1. During the current phase (part of the project execution) what worked well on this phase and what was not worked well? What would you do different in the case that you’re in the start of the phase?

2. How was your communication during the phase with your team, and management, and with other projects in your organisation? What worked well and what would you do differently next time?

3. During the phase, what are the changes that had occurred to scope, to costs, to team, and/or to the phase schedule? Was it substantial? Did you learn from this, and what was learned?

4. Have you made any frequent/occasional discussions with any person external to your project team about the project or use lessons learned to get information about similar project efforts, similar user groups, etc.? If so, was it useful?

5. Did you join the project team after while the project had already started? If so, what are the problems that you faced under this circumstance?

6. Do you have comments on any of the following items that were used on your project: project execution plan, project interface procedures, etc.?

7. Have you done a post-phase review for the phase? Please describe the review and what worked well and what did not work well.

8. Have you obtained Knowledge from the previous phase, if yes, please state them.

9. The Knowledge obtained or resulted from the previous phase (or previous project); does it have an effect on the current phase (in particular to avoid problems from occurring) and to what extent? (not effective at all, slightly effective, moderately effective, very effective and extremely effective)

10. Other?
Appendix 6
Axial coding
Research Paradigms
Appendix 7

Research paradigms
### PARADIGM 1: MANAGING THE ORGANISATION KNOWLEDGE

#### Phenomenon

Managing the K of the organisation

#### Causal conditions

- **K is a valuable resource:**

  Most of the interviewed people (members of project team(s)) during the course of the research work and at different stages and involved in different projects, all stressed the importance and value of K during project development, from the initial stages of engineering work up to pre-commissioning, commissioning and the start-up phase. Interviewees confirmed that K can be very valuable to the project work.

- **K is informally managed: no system of feedback, no job description**

  Project K (created and/or updated) is informally managed; this statement expresses the outcome of the detailed interviews and case studies conducted by the author in this research work. Many interviewees stated that ‘we don’t have a dedicated system that can archive and track K created during the project life’; other interviewees further added that ‘our project organisation did not allocate enough resources to perform, in addition to their main discipline activity, as the K facilitator and K keeper within the project team’.

- **Strategic need for formal KM:**

  The need for a more formal approach to KM in the project organisation emerged in initial interviews (chapter 4) and was then validated in case study A (elaborated in chapter 5); in the author’s view, formal KM is an expressive way for organisations to handle the process of K creation, implementation and continuous development.

- **People are not interested, motivated for K sharing:**

  K sharing requires support from the management to make it dynamic at all times, as emerged in chapter 5 (case study B) revealing that people were not motivated to share knowledge, because they were afraid to lose power within the organisation which can
lead to job security issues, in addition to no incentive scheme adopted by the organisation and no recognition for who shares K. The evaluation of competence was based on tacit K thus people preferred to keep the K as power for themselves. Another cause was considering it to be a failure when a member shared a problem.

**Context**

- Oil and gas organisations operate in a highly pressurised industry, are project based, and geographically dispersed
- Large size, defragmented organisation, difficult to managing the K
- Project based, best opportunity for learning, K based on LL
- Project K
- Professional K

**Intervening conditions**

- Willpower from seniors
- Cultural barriers: emerged in case study A
- Job security
- Time allocation

**Actions/interactions:**

- **Set up a LL feedback system:**

  LL feedback system is a structured framework formulated by the organisation and launched within a project management team with instructions and guidelines for implementation.

- **description of roles:** the job description emerged as the main gap in case study A, (phase 2 - chapter 5), the organisation should recognise the importance of K creation and sharing as a defined task that needs to be carried out during the progress of any activity, and to be assigned to individuals in the subject area of business (in this research case – project activity within the project organisation). The recognition of this task and allocation of resources must be considered in the organisation (company organisation) structure and manpower plan.
The job description of any of the individuals in the area of business within the organisation (projects in this case) should account for K creation and sharing as one of the major activities that should be executed by the employer (any of the project team individuals) and his/her work performance evaluation will account for any achieved objectives in this regard.

- **Set up expert’s network:**

  As part of the K process system within the organisation, it is essential to set up a team of experts; each team is specialised in specific K in a dedicated field of competence. Teams of experts (can be discipline group, such as process, mechanical, instrument, etc ...) need to be extended to the number necessary to cover all the different fields within the subject area of business to execute and/or develop projects (in this case). The task of experts is to review and validate any new K created or developed during the work execution in their area of competence. The team of experts is required to be recognised by the organisation, in the company organisation structure with a defined function to perform a specific scope.

- **Capture K from projects department**

  The organisation (oil and gas organisation/company) shall account for K captured from the projects department and inject it within the company K system, accessible to all company employees for direct use in any similar future or ongoing activity or for partial use and validation of any new K in the same area of interest. In addition, it is in the author’s view and opinion (*being experienced in projects with experience exceeding 28 years*) that the projects department is a major business area in the organisation in which a major part of the organisation (company) budget is allocated. Moreover, projects typically have an extended and wide scope that covers and touches all kinds of activities and involves all kinds of technical and non-technical disciplines, in addition to extensive external involvement in the form of contractors, subcontractors and vendors.

- **Storing the K and using it**

- Support K dissemination through ICT and HR

- Provide ICT support: ICT support was identified in case study A as an important factor for KM implementation.
- Motivate commitment in the LL feedback system: through recognising persons sharing their K, giving incentives, etc.

- Initial interviews (chapter 4) identified the existence of a number of potentially useful practices for informal K sharing including site visits, regular meetings, focus groups between projects, organising seminars, workshops, informal networks and collaboration

- Incorporate major LL into company policy

Comparison with literature:

<table>
<thead>
<tr>
<th>Consequences</th>
</tr>
</thead>
</table>

Managing organisational K has many benefits:

- There is a series of formal K management strategies connected with K sharing, creating, finding, capturing, analysing, storing, disseminating and transferring which can lead to enhanced performance, which can have added value in terms of cost and time saving (it can support the success rank of the projects) which at the end contributes to the overall organisation performance.

- Cost and time reduction, quality and work process improvements, etc.

- Professional K improvement within the project teams and in the company’s overall organisation.

- Improvement policies and procedures in the organisation.
PARADIGM 2: MANAGEMENT OF PROJECT K

Phenomenon:
The management of EPC project K through a LL system

Causal conditions:
- In most cases, K created in the project is lost.
- The capture, management and deployment of LL is an important ‘subset’ of the overall KM function.
- K created during one phase of the project is lost at the end of the project.
- K created during one phase is not transferred to another phase.
- Almost all of K created from problem solving case still remains tacit with persons involved in the case.
- As emerged in case study B, LL practices are not linked to company policy, users may not know or forget about the LL.

Context
- The project K is the first and main source of organisational K as the EPC project company’s work is project based.
- On EPC projects, new and non-standard problems are frequently encountered which result in specialist and technical K developed within the project team.
- The EPC project is a specific type of project comprising three main steps, engineering, procurement and construction, and the effectiveness of K management depends on the phases.
- The EPC project allows for meetings and the contact between many professionals’ degrees and disciplines.
- K disseminated in the project is more effective in the early phase of the project and more validated at the end of project.
Intervening conditions

- Due to the lack of a LL system, the transfer of K between project team and the projects department and between the projects department and organisation is lacking.
- Lessons are typically validated at the end of the project when the solution to a problem is validated.
- Size of the organisation and fragmentation of intra-organisational disciplines make it difficult to manage the K.
- Problem-resolving is not shared due to the pressurised work environment.
- Almost all of K is not manageable: need for manageable format of K.
- LL system requires the integration of organisational process and alignment with ICT practices, training and skills development practices and project management practices.
- Face to face meetings are an essential project management activity providing the opportunity to share project K.

Action/interactions

- Tracking the transfer of K created from phase to phase:
  As a result of the project from start-up phase to completion (research phase 3 - case Study B - chapter 6), and considering the feedback the interviewees made regarding the project life with the involvement of project management team, and the feedback from the questionnaires distributed to project team, it became evident to the author that the K transfer from any of the project execution phases to the following phases is crucial. In the author's view, the project management team should implement a K tracking system, a process by which the K created at any of the project phases can then be tracked during the subsequent development phases.

- Giving the opportunity to discuss KM issues during projects
  It is important to provide opportunities for the project team to identify the K developed during any of the project phases and then to track it throughout the project’s life. From the case studies performed as part of this research work, it was quite evident that providing opportunities to the project team (by the project manager) allowed them to discuss the K that was created and developed and then how it was managed throughout the project’s life. In the author’s view, this can be effectively done by allocation of a
number of workshop meetings in the overall project activity plan; i.e. time is pre-allocated and activities are defined as part of the project work breakdown structure. We are of the opinion that scheduling KM workshop meetings should be considered for at least two workshops for each of the project phases (EPC-S engineering, procurement, construction and start-up): one at the start of the phase and the other at the end of the phase.

- **Recognising the shared K (problem resolving)**

  Individual(s) who share(s) K within the project team needs to be recognised by the project manager, and must be considered as part of the K development process within the project. It is important to recognise initiatives and provide incentives. The recognition and motivation (via incentives) is a mechanism that can create a driving force, which can facilitate K creation and sharing among the team. A number of interviewees who contributed in phase 3 of this research work (refer to case study B – chapter 6) said ‘we made several efforts in the past related to new knowledge sharing with our team colleagues but this was not recognised by our superior managers’.

  **Consequences**

  - Certain LL can be integrated into project management or organisational procedures, such as best practice guidelines, standard agendas, recommended lists and working protocols and strategies.

  - K sharing during the project can improve the project success through accelerating problem resolving.

  - Project K must be maintained and developed.
# PARADIGM 3: ROLE OF PROJECTS MANAGEMENT DEPARTMENT

## Phenomenon
- The projects management department supervises and supports the projects K management through LL system.

## Causal conditions
- Need to transfer K between different projects.
- Need for coordination between project team, expert projects and management approval committee.

## Context
- Projects department as well as other organisation departments can contribute to the organisation K management.
- Projects department head is a member of the approval management committee in the organisation.
- The role of projects department is central in K management project, as it relates to the organisation of the project which is the unit of K development and creation, and it plays the role of transforming project K into organisation K.

## Intervening conditions
- Allocation of staff and budget by the company (organisation) for KM management as an important activity, with dedicated to staff within the organisation.
- Procedure and policies to handle KM within the organisation to be provided by the organisation.

## Action/interactions
- Participate in committee of LL approval, supervise the KM in projects, supervise the LL system, and communicate with HR and ICT to provide a supportive adequate environment that accelerates KM related activity within the organisation.
- Integrate LL into existing work practices: make LL practices part of people’s daily work supported by organisational procedures.
- Provide time and resources for the project team to be committed to the LL system.
- Locating the right expert for the K needed.
- Allocation of incentives for project team members committed to the LL system.
- Align existing project management activities with LL practices: meetings, reporting, tendering and contract procedures, and quality assessment and performance appraisals.

<table>
<thead>
<tr>
<th>Consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Improvement of the efficiency of LL practices.</td>
</tr>
<tr>
<td>- Contribute to organisational learning.</td>
</tr>
<tr>
<td>- Improvement of projects department success.</td>
</tr>
</tbody>
</table>
Paradigm 4: Role of LPE(s)

**Phenomenon**

Senior engineers play the role of K capturing and validation

**Causal conditions**

- K created by members should be captured
- K created should be verified to validate the context
- K created should be evaluated because it may not be applicable

**Context**

Senior engineers played a very important role in project KM involved in two main structures: project team and expert team. In the project team, they presented the middle management line, middle manager (lead engineer), and they played the role of K keeper. In the expert team, they played the role of K validation with multi-discipline senior engineers with long experience and important tacit K gained from their long careers.

**Intervening conditions**

- The two crossing roles of seniors within the projects department facilitate the K capture and the K validation.

**Action/interactions**

- K created should be checked at early stages by experts, not to be left to the end of the project activity.
- K created is to be reviewed at each development phase to facilitate its validation.
- The context of created K is verified and released for information within the organisation.
- K created is evaluated and endorsed by the expert team (comprising multi-disciplinary lead project engineers from different project teams) before endorsement and release for implementation.
Consequences

- Improvement of the effectiveness of K capture
- Improvement of the implementation of K created
- Support the management department in decision making
- Improvement of the value of the K created
- Contribute to the organisational learning by pushing dissemination of K
**PARADIGM 5: ROLE OF HR DEPARTMENT**

### Phenomenon

HR plays a central role in facilitating the dissemination and the use of available K.

### Causal conditions

- Need for push dissemination as users may not have the time or skills to retrieve and interpret textual lessons, and subsequently apply them.
- Need to develop and maintain expert team.

### Context

- HR management can be a member of the management committee in approving the K created.
- HR can provide and evaluate the needed K via the coordination with projects department.
- Network of relationship support and facilitating practices of LL system especially and with KM generally.

### Intervening conditions

- Problems with seminars, including the timing and location, delivery, relevance and experience of those in attendance.
- Communication and linguistic problems.

### Action/interactions

- Encourage individuals to submit LL themselves (Kartam, 1996), which ‘will only be as successful as the amount of information posted by people…it's all about the input really’.
- Enhancing informal K sharing: as demonstrated in project meetings both official pre-scheduled meetings to discuss particular defined subjects or non-official that can take place during coffee breaks, offer the main opportunities for sharing K within the project team before, during and after the completion of the project.
Thus, K sharing within the project team is highly influenced by the specific project circumstances which seem quite unique for the EPC propjet type in the oil and gas industry in Libya, one of the major factors within this context is the time constraints, with project teams always stating that time is short in achieving the project’s pre-defined target.

- Regular K sharing focus groups between projects.
- HR can push the dissemination to deliver the LL directly to the user based on their role, interests, training and experience.
- ‘Push’ lessons to relevant people: while a number of interviewees acknowledged that they do not use the LL system, there is the potential to ‘push’ relevant LL to them via email or print format, based on their role, interests, training and experience.
- Provide training: deliver regular refresher training on the use and benefit of LL practices.
- Guarantee job security and satisfactory conditions for professionals.

**Consequences**

- Contribute to organisational learning by supporting the informal K sharing
- Developing skills of individuals and improving their capacity for progression
- Retention of staff
- Enhancing the credibility and trust between professionals
- Improving recruitment effectiveness
PARADIGM 6: ROLE OF ICT DEPARTMENT

**Phenomenon**
- The ICT plays an important role in facilitating the KM within the Libyan oil and gas companies.

**Causal conditions**
- Need to facilitate access and dissemination of the LL stored

**Context**
- ICT infrastructure: hardware, software and network
- ICT manager can be a member of the committee of management approval

**Intervening conditions**
- Fragmentation of organisation, offshore inshore, office visits, etc.

**Action/interactions**
- ICT store LL on the organisation archive in a server which can be accessed from all offices and sites by logging into the company’s network, the use of which is not measured or tracked by management
- Regular email alerts and notification
- Regular updating of archive

**Consequences**
- Contribute to organisational learning by supporting the K sharing and transfer (LL dissemination)
- Improving the effectiveness of LL system
Appendix 8

Development Project - Chart - EPC Organisations
Typical EPC project development – organisation chart
EPC Project Development – chart Company A
Development project – chart Company B
EPC Project Development – organisation chart Company C