Modelling the Relationship between Client Activities and Construction Procurement Performance in Oman

BY

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ABSTRACT
Construction delays and cost overruns continue to receive attention from both academia and the industry. Simultaneously, the client organisation has been consistently cited as a primary party that could significantly improve construction performance. However, limited research has been undertaken to bring together client activities and evaluate their effects on construction delays and cost overruns. Thus, this research aims to define the client activities that substantially affect construction delays and cost overruns. It began with a review of the literature on client procurement activities throughout the procurement lifecycle and knowledge from other industries. Then a questionnaire survey method was adopted to explore how public clients' project engineers and managers have involved in and have managed construction procurement in the past projects. The interrelationship between 75 client activities was investigated through principal component analysis, which resulted in the identification of 14 essential client activity components. Multiple regression analysis revealed that construction delays are substantially affected by six client activity components: collaboration, construction efficiency, accuracy of objectives and requirements, difficulties with project planning and permits, contractor difficulties, and requirement modifications by the client. Likewise, construction cost overruns is greatly associated with eight client activity components, namely design efficiency, collaboration, multiphase involvement of stakeholders, objective and requirement changes, client team development, the availability of a construction workforce, contractor difficulties, and requirement modifications by the client.

These activity components can help client organisations to easily recognise those activities that greatly contribute to the improvement of construction performance. Clients can then ensure that these activities receive careful and continued attention from the client team. Simultaneously, recognising the effect of these activities on construction performance allows a precise measurement of the competency level that must be attained by the client team and the reduction of costly training in areas that are not necessary. While the research focuses on Oman, there is the potential for these activities to be adopted for use in other developing countries to aid the enhancement of construction procurement performance.
ACKNOWLEDGEMENT

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TABLE OF CONTENT

CERTIFICATE OF ORIGINALITY ......................................................................................................................... I
ABSTRACT ............................................................................................................................................................... III
ACKNOWLEDGEMENT ................................................................................................................................................ IV
TABLE OF CONTENT ................................................................................................................................................. V
LIST OF TABLES ....................................................................................................................................................... XI
LIST OF FIGURES ...................................................................................................................................................... XIII
LIST OF ABBREVIATIONS ........................................................................................................................................ XV

1 CHAPTER ONE: INTRODUCTION .......................................................................................................................... 1

1.1 BACKGROUND ................................................................................................................................................... 1
1.2 RESEARCH PROBLEM STATEMENT ...................................................................................................................... 3
1.3 KEY RESEARCH QUESTIONS ............................................................................................................................... 4
1.4 RESEARCH AIM AND OBJECTIVES ..................................................................................................................... 5
1.5 OUTLINE OF RESEARCH METHODOLOGY ......................................................................................................... 6
1.6 SUMMARY OF MAIN FINDINGS ......................................................................................................................... 9
1.7 CONTRIBUTION OF THE RESEARCH ................................................................................................................ 11
1.8 THESIS STRUCTURE .......................................................................................................................................... 11

2 CHAPTER TWO: CLIENT ACTIVITIES THROUGHOUT THE PROCUREMENT LIFECYCLE ........................................................................................................................................................................... 14

2.1 INTRODUCTION .................................................................................................................................................. 14
2.2 CLIENTS IN CONSTRUCTION PROCUREMENT .................................................................................................... 14
   2.2.1 Categorisation of clients ............................................................................................................................... 14
   2.2.2 Differences Between Public and Private Clients .......................................................................................... 15
2.3 CONSTRUCTION PROCUREMENT ...................................................................................................................... 16
2.4 PLANNING STAGE OF CONSTRUCTION PROCUREMENT ....................................................................................... 17
   2.4.1 Procurement Objectives .................................................................................................................................. 18
   2.4.2 Project Requirements ...................................................................................................................................... 19
   2.4.3 Establishment of Project Team ........................................................................................................................ 21
   2.4.4 Consultants and Contractors Selection ........................................................................................................... 24
   2.4.5 Stakeholders Involvement ............................................................................................................................... 29
   2.4.6 Selection of Payment Method ........................................................................................................................ 33
   2.4.7 Risk Management ........................................................................................................................................ 35
   2.4.8 Key Performance Indicators (KPIs) ................................................................................................................. 37
   2.4.9 Construction Procurement Systems ............................................................................................................... 38
   2.4.10 Separated Procurement System .................................................................................................................... 40
   2.4.11 Management-oriented Procurement ............................................................................................................ 48
   2.4.12 Management Contracting ............................................................................................................................. 49
   2.4.13 Construction Management .......................................................................................................................... 51
   2.4.14 Design and Manage ..................................................................................................................................... 51
   2.4.15 Advantages and Disadvantages of Management-oriented Procurement Systems ...................................... 53
   2.4.16 Public Private Partnership (PPP) Procurement System .................................................................................... 53
2.5 DESIGN STAGE .................................................................................................................................................... 58
   2.5.1 Scope of Consultancy Services and Deliverables ............................................................................................ 60
   2.5.2 Design Parties ............................................................................................................................................... 61
2.6 CONSTRUCTION STAGE ...................................................................................................................................... 62
CHAPTER THREE: CLIENT ORGANISATIONAL SUCCESS ACTIVITIES .................................................. 69

3.1 INTRODUCTION .................................................................................................................... 69

3.2 PROCUREMENT PERFORMANCE .................................................................................. 69

3.2.1 Performance Parameters ...................................................................................... 69

3.2.2 Performance Situation ....................................................................................... 71

3.2.3 Success Factors .................................................................................................. 72

3.3 KNOWLEDGE DEVELOPMENT ................................................................................. 75

3.3.1 Knowledge Management .................................................................................. 75

3.3.2 Learning from Experience .............................................................................. 76

3.3.3 Innovation ......................................................................................................... 78

3.4 INFORMATION, COMMUNICATION AND TECHNOLOGY ............................................. 81

3.4.1 Information ......................................................................................................... 81

3.4.2 Communication .................................................................................................. 82

3.4.3 Information and Communication Technology .................................................. 83

3.4.4 E-procurement .................................................................................................. 84

3.5 QUALITY MANAGEMENT ......................................................................................... 86

3.5.1 Performance Evaluation .................................................................................. 86

3.5.2 Process Management ......................................................................................... 88

3.5.3 Procurement Control ......................................................................................... 90

3.5.4 Cross Organisation Management .................................................................... 91

3.5.5 Standardisation .................................................................................................. 92

3.5.6 Planning and Permits Approvals ...................................................................... 94

3.5.7 Top Management Support ............................................................................... 95

3.6 SMALL AND MEDIUM ENTERPRISES ........................................................................ 96

3.6.1 Public Sector and SMEs .................................................................................... 96

3.6.2 Involvement of SMEs in Public Procurement ..................................................... 96

3.7 FINANCIAL MANAGEMENT ...................................................................................... 97

3.7.1 Best Value .......................................................................................................... 98

3.7.2 Cash Flow and Funding ..................................................................................... 100

3.8 LEARNING FROM OTHER INDUSTRIES ..................................................................... 100

3.9 AUTOMOTIVE INDUSTRY ......................................................................................... 101

3.9.1 Lean Manufacturing .......................................................................................... 102

3.9.2 Just-in-Time ......................................................................................................... 103

3.9.3 Modularisation .................................................................................................... 104

3.9.4 Global Outsourcing ........................................................................................... 104

3.9.5 Supplier Parks ..................................................................................................... 105

3.9.6 Supply Chain Collaboration ............................................................................. 105

3.9.7 Quality Control .................................................................................................. 106

3.10 AEROSPACE INDUSTRY .......................................................................................... 107

3.10.1 Lean Manufacturing .......................................................................................... 107

3.10.2 Outsourcing ......................................................................................................... 107

3.10.3 Supply Chain Collaboration ............................................................................. 108

3.10.4 Information and Knowledge Exchange ........................................................... 108

3.11 SUMMARY .................................................................................................................... 109

CHAPTER FOUR: PUBLIC CONSTRUCTION PROCUREMENT IN OMAN ................................................. 111

4.1 INTRODUCTION ............................................................................................................ 111

4.2 GEOGRAPHY .................................................................................................................. 111
### 5.17 PRINCIPAL COMPONENT ANALYSIS

- **5.17.1 Sample Size and Component Loading** .................................................. 159
- **5.17.2 Correlation Matrix** ............................................................................ 160
- **5.17.3 Extraction of Components** ............................................................... 160
- **5.17.4 Component Rotation** ....................................................................... 160
- **5.17.5 Component Score and Naming** ......................................................... 161

### 5.18 MULTIPLE REGRESSION ANALYSIS

- **5.18.1 Major Methods of Multiple Regression** ........................................... 162
- **5.18.2 Assumptions of Multiple Regression** ............................................... 163
- **5.18.3 Reducing Bias** ............................................................................... 165

### 5.19 SUMMARY

**6 CHAPTER SIX: DATA PREPARATION AND DESCRIPTIVE ANALYSIS**

- **6.1 INTRODUCTION** .................................................................................. 167
- **6.2 QUESTIONNAIRE ADMINISTRATION AND RESPONSE RATE** ......... 167
  - **6.2.1 Questionnaire Administration** .......................................................... 167
  - **6.2.2 Missing Values and Analysis** ............................................................. 168
- **6.3 RELIABILITY** ..................................................................................... 168
- **6.4 CONSTRUCTION SCHEDULE DELAYS** ............................................ 169
- **6.5 CONSTRUCTION COST OVERRUNS** ............................................... 169
- **6.6 DESIGN EFFICIENCY** ....................................................................... 170
- **6.7 COLLABORATION** .......................................................................... 173
- **6.8 CONSTRUCTION EFFICIENCY** ......................................................... 175
- **6.9 SITE MANAGEMENT** ......................................................................... 177
- **6.10 MULTIPHASE INVOLVEMENT OF STAKEHOLDERS** ..................... 179
- **6.11 REVIEW OF LEARNING FROM PAST PROJECTS** ............................. 181
- **6.12 ACCURACY OF PROJECT OBJECTIVES AND REQUIREMENTS** .... 181
- **6.13 RESOURCE OPTIMISATION** ............................................................. 183
- **6.14 PLANNING AND PERMIT APPROVALS** .......................................... 185
- **6.15 DECISION-MAKING AND INFORMATION COORDINATION** ...... 185
- **6.16 SUMMARY** ..................................................................................... 187

### 7 CHAPTER SEVEN: PRIMARY DATA ANALYSIS

- **7.1 INTRODUCTION** .................................................................................. 188
- **7.2 DATA RE-CODING** .......................................................................... 188
- **7.3 PRINCIPAL COMPONENT ANALYSIS** ............................................... 189
  - **7.3.1 Appropriateness of the Analysis** ....................................................... 189
  - **7.3.2 Principal Component Analysis Results** ......................................... 189
  - **7.3.3 Design Efficiency (Component 1)** ............................................... 191
  - **7.3.4 Collaboration (Component 2)** ....................................................... 193
  - **7.3.5 Construction Efficiency (Component 3)** ....................................... 194
  - **7.3.6 Site Management (Component 4)** ................................................. 195
  - **7.3.7 Multiphase Involvement of Stakeholders (Component 5)** ............ 196
  - **7.3.8 Review of Learning from Past Projects (Component 6)** .............. 197
  - **7.3.9 Accuracy of Projects Objectives and Requirements (Component 7)** 198
  - **7.3.10 Client Team Development (Component 8)** ................................ 198
  - **7.3.11 Project Planning and Permits Approvals (Component 9)** ............ 199
9.6 Site Management...................................................................................................................... 249
9.7 Multiphase Involvement of Stakeholders.............................................................................. 250
9.8 Review of Past Project Difficulties......................................................................................... 253
9.9 Change Control ...................................................................................................................... 253
  9.9.1 Accuracy of Objective and Requirements........................................................................ 253
  9.9.2 Requirement Modifications Initiated by the Client.......................................................... 254
  9.9.3 Difficulties in Project Planning and Permit Approvals....................................................... 255
9.10 Human Resources Optimisation ........................................................................................... 255
  9.10.1 Client Team Development (Training)................................................................................ 255
  9.10.2 Availability of Construction workforce........................................................................... 256
  9.10.3 Contractor Difficulties.................................................................................................... 258
9.11 Decision-Making During Construction ................................................................................ 259
9.12 Information Coordination Process ....................................................................................... 260
9.13 Implication of Research Findings .......................................................................................... 260
10 Chapter Ten: Conclusion and Recommendations .................................................................. 263
10.1 Introduction .......................................................................................................................... 263
10.2 Achievement of Research Aim and Objectives ................................................................... 263
  10.2.1 Objective 1: To Identify Client Activities throughout the Procurement Lifecycle 263
  10.2.2 Objective 2: To Identify Client Organisational Success Activities and Learning from Other Industries............................................................................................................ 264
  10.2.3 Objective 3: To identify features of construction procurement in Oman..................... 265
  10.2.4 Objective 4: To Identify the Important Client Activities................................................ 265
  10.2.5 Objective 5: To Model the Relationship between the Important Client Activity Components and Delays and Cost Overruns............................................................................... 266
  10.2.6 Objective 6: To Validate the Findings............................................................................ 266
10.3 Contribution of the Research ............................................................................................... 267
  10.3.1 Contribution to the Industry .......................................................................................... 267
  10.3.2 Contribution to Knowledge............................................................................................. 268
10.4 Research Limitations ............................................................................................................ 269
10.5 Recommendations ............................................................................................................... 269
  10.5.1 Clients .......................................................................................................................... 270
  10.5.2 Policy Makers ............................................................................................................. 271
10.6 Further Research .................................................................................................................. 272
References ..................................................................................................................................... 274
Appendix 1: Publication ............................................................................................................... 317
Appendix 2: Questionnaire Survey ............................................................................................. 319
Appendix 3 List of Variables with Commonality Values ............................................................. 327
Appendix 4: Validation Interview ............................................................................................... 330
LIST OF TABLES
TABLE 2.1 QUALITY/PRICE RATIO FOR EVALUATION OF CONSULTANCY SERVICES .... 25
TABLE 2.2 QUALITY SELECTION PARAMETERS FOR CONSULTANTS .................................. 26
TABLE 2.3 QUALITY/PRICE RATIO FOR EVALUATION OF CONTRACTORS’ PROPOSALS27
TABLE 2.4 QUALITY EVALUATION PARAMETERS OF CONTRACTOR ................................ 28
TABLE 2.5 CLASSIFICATION OF CONTRACT TYPES ..................................................................... 34
TABLE 2.6 OVERVIEW OF THE PRE-CONSTRUCTION AND CONSTRUCTION SERVICES PROV
TABLE 2.7 KEY DESIGN PHases AND MAIN ACTIVITIES......................................................... 59
TABLE 3.1 PROCUREMENT PERFORMANCE MEASUREMENT PARAMETERS ......................... 70
TABLE 3.2 : CLIENT SUCCESS ELEMENTS IN CONSTRUCTION PROCUREMENT ............ 73
TABLE 3.3 : CLIENT SUCCESS ELEMENTS IN CONSTRUCTION PROCUREMENT ............ 74
TABLE 4.1 KEY FACTS ABOUT OMAN’S ECONOMY............................................................... 116
TABLE 4.2 OMAN POPULATION GROWTH ............................................................................ 118
TABLE 4.3 CHALLENGES TO PERFORMANCE IMPROVEMENT IN CONSTRUCTION 
TABLE 4.4 CAUSES OF DELAYS AND COST OVERRUNS IN OMANI CONSTRUCTION 
TABLE 6.1 QUESTIONNAIRE SURVEY ADMINISTRATION .................................................. 167
TABLE 6.2 CONSTRUCTION DELAYS ..................................................................................... 169
TABLE 6.3 CONSTRUCTION COST OVERRUNS ...................................................................... 170
TABLE 6.4 DESIGN EFFICIENCY ACTIVITIES ........................................................................ 172
TABLE 6.5 COLLABORATION ACTIVITIES ............................................................................. 174
TABLE 6.6 CONSTRUCTION EFFICIENCY ACTIVITIES .......................................................... 176
TABLE 6.7 SITE MANAGEMENT ACTIVITIES .......................................................................... 178
TABLE 6.8 MULTIPHASE INVOLVEMENT OF STAKEHOLDERS ACTIVITIES ...................... 180
TABLE 6.9 REVIEWS OF PAST PROJECTS’ ISSUES ............................................................... 182
TABLE 6.10 ACCURACY OF PROJECT OBJECTIVES AND REQUIREMENTS ...................... 182
TABLE 6.11 RESOURCES OPTIMISATION ACTIVITIES .......................................................... 184
TABLE 6.12 PLANNING AND PERMIT APPROVAL ACTIVITIES ......................................... 186
TABLE 6.13 DECISION MAKING AND INFORMATION COORDINATION ACTIVITIES ........ 186
TABLE 7.1 KMO AND BARTLETT’S TEST .............................................................................. 189
TABLE 7.2 VARIANCE EXPLAINED BY EXTRACTED COMPONENTS ................................ 191
TABLE 7.3 PUBLIC CLIENT ACTIVITIES IN COMPONENT 1 ................................................. 192
TABLE 7.4 PUBLIC CLIENT ACTIVITIES IN COMPONENT 2 ................................................. 194
TABLE 7.5 PUBLIC CLIENT ACTIVITIES IN COMPONENT 3 ................................................. 195
TABLE 7.6 PUBLIC CLIENT ACTIVITIES IN COMPONENT 4 ................................................. 196
TABLE 7.7 PUBLIC CLIENT ACTIVITIES IN COMPONENT 5 ................................................. 197
TABLE 7.8 PUBLIC CLIENT ACTIVITIES IN COMPONENT 6 ................................................. 198
TABLE 7.9 PUBLIC CLIENT ACTIVITIES IN COMPONENTS 7 AND 8 ................................. 199
TABLE 7.10 PUBLIC CLIENT ACTIVITIES IN COMPONENTS 9 AND 10 ............................. 200
TABLE 7.11 PUBLIC CLIENT ACTIVITIES IN COMPONENTS 11 AND 12 ......................... 201
TABLE 7.12 PUBLIC CLIENT ACTIVITIES IN COMPONENTS 13 AND 14 ......................... 202
TABLE 7.13 DBB DELAYS MODEL SUMMARY ................................................................. 204
LIST OF FIGURES

FIGURE 1.1 RESEARCH PROCESS, STAGES, ANALYSIS METHODS AND OUTCOME ...... 8
FIGURE 2.1 CATEGORISATION OF CLIENTS......................................................... 15
FIGURE 2.2 CONSTRUCTION PROCUREMENT LIFECYCLE............................... 17
FIGURE 2.3 CLIENT PRIORITIES OPTIONS.......................................................... 19
FIGURE 2.4 PROCUREMENT WORKING TEAM.................................................. 22
FIGURE 2.5 RELATIONSHIP BETWEEN THE CLIENT TEAM AND PROCUREMENT PERFORMANCE ............................................................................................................... 23
FIGURE 2.6 TENDERING PROCESS FLOW CHART ............................................ 29
FIGURE 2.7 INTERNAL AND EXTERNAL STAKEHOLDERS IN CONSTRUCTION PROCUREMENT ............................................................................................................... 31
FIGURE 2.8 SIMPLIFIED METHOD FOR SELECTING A PROCUREMENT SYSTEM .... 40
FIGURE 2.9 PARTIES’ RELATIONSHIPS IN A SEPARATE PROCUREMENT SYSTEM... 42
FIGURE 2.10 DESIGN AND BUILD PROCUREMENT PROCESS ................................ 46
FIGURE 2.11 RELATIONSHIP BETWEEN PARTIES IN DESIGN-BUILD PROCUREMENT ... 47
FIGURE 2.12 PARTIES’ RELATIONSHIPS IN MANAGEMENT CONTRACTING PROCUREMENT ............................................................................................................... 50
FIGURE 2.13 PARTIES’ RELATIONSHIPS IN CONSTRUCTION MANAGEMENT PROCUREMENT ............................................................................................................... 51
FIGURE 2.14 PARTIES’ RELATIONSHIPS IN DESIGN AND MANAGE (CONTRACTOR-LED) ............................................................................................................................................ 52
FIGURE 2.15 PARTIES’ RELATIONSHIPS IN DESIGN AND MANAGE (CONSULTANT-LED) ............................................................................................................................................ 52
FIGURE 2.16 PROCUREMENT PROCESS IN PPP ................................................ 55
FIGURE 2.17 RELATIONSHIPS BETWEEN PARTIES IN THE PPP PROCUREMENT SYSTEM ............................................................................................................... 56
FIGURE 2.18 CONSTRUCTION STAGE: CONTRACTUAL AND FUNCTIONAL RELATIONSHIPS ............................................................................................................... 63
FIGURE 2.19 RELATIONSHIP BETWEEN FACILITY MANAGEMENT STAGE AND OTHER STAGES ............................................................................................................... 66
FIGURE 2.20 VERIFICATION AND VALIDATION CHECKING AT VARIOUS STAGES OF THE PROCUREMENT LIFECYCLE ............................................................................................................... 67
FIGURE 3.1 LEARNING THROUGH PERFORMANCE EVALUATION GATES............. 78
FIGURE 3.2 MAIN ELEMENTS TO BE CONSIDERED FOR PUBLIC PROCUREMENT INNOVATION ............................................................................................................... 79
FIGURE 3.3 PROCUREMENT ACTIVITIES EXPECTED TO BE COVERED BY E-PROCUREMENT SOLUTIONS............................................................................................................... 86
FIGURE 3.4 CONSTRUCTION PERFORMANCE ASSESSMENT MODEL.................... 87
FIGURE 3.5 RELATIONSHIP BETWEEN PERFORMANCE EVALUATION AND LEARNING. 88
FIGURE 3.6 AREAS TO STANDARDISE IN PUBLIC CONSTRUCTION PROCUREMENT .... 94
FIGURE 3.7 RELATIONSHIP BETWEEN COMPETITION AND PERFORMANCE .......... 99
FIGURE 3.8 TOYOTA’S WORKING MODEL .......................................................... 103
FIGURE 4.1 GEOGRAPHICAL LOCATION OF OMAN ........................................... 112
FIGURE 4.2 LEGISLATION PROCESS IN OMAN .................................................. 115
FIGURE 4.3 OMAN’S GDP BETWEEN 1995 AND 2015 ......................................... 117
FIGURE 4.4 ADMINISTRATIVE GOVERNORATES ................................................. 119
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
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<tbody>
<tr>
<td>BOO</td>
<td>Build Own Operate</td>
</tr>
<tr>
<td>BOOT</td>
<td>Build Own Operate Transfer</td>
</tr>
<tr>
<td>CAPEX</td>
<td>Capital Expenditure</td>
</tr>
<tr>
<td>CSF</td>
<td>Critical success factors</td>
</tr>
<tr>
<td>DBB</td>
<td>Design Bid Build</td>
</tr>
<tr>
<td>DB</td>
<td>Design Build</td>
</tr>
<tr>
<td>ICE</td>
<td>Institute of Civil Engineers</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
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<td>ICT</td>
<td>Information Communication Technology</td>
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<td>FM</td>
<td>Facilities Management</td>
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<td>Kaiser-Mayer Olkin</td>
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<td>Office of Government Commerce (UK)</td>
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<td>OMR</td>
<td>Omani Rial</td>
</tr>
<tr>
<td>OPEX</td>
<td>Operating Expenditure</td>
</tr>
<tr>
<td>PMBOK</td>
<td>Project Management Body of Knowledge</td>
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<tr>
<td>PPP</td>
<td>Public Private Partnership</td>
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<tr>
<td>PCA</td>
<td>Principal Components Analysis</td>
</tr>
<tr>
<td>RAMS</td>
<td>Reliability, Availability, Maintainability, and Safety</td>
</tr>
<tr>
<td>RIBA</td>
<td>Royal Institute of British Architects</td>
</tr>
<tr>
<td>SMEs</td>
<td>Small and Medium enterprises</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Science</td>
</tr>
<tr>
<td>SPV</td>
<td>Special Purpose Vehicle</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>USA</td>
<td>United State of America</td>
</tr>
<tr>
<td>VIF</td>
<td>Variance Inflation Factor</td>
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1 CHAPTER ONE: INTRODUCTION

1.1 Background
Clients in the public sector are held accountable by a wider community of stakeholders with more conflicting goals and a greater variety of interests than those in the private sector (Hooijberg and Choi, 2001; Feldman, 2005). Specifically, public construction clients are responsible for best utilisation of public funds. Delays and cost overruns are two persisting problems in construction projects. Delays in construction completion of public projects compromises the level and availability of services for the public and incurs the nation additional cost that could be better utilised for developing new or better services.

The dynamic nature of the construction industry increases uncertainties, budgets constraints, and delivery processes have made construction projects very complicated (Chan et al., 2004). While outsourcing some client activities to other organisations becomes necessary to overcome the limited resources within the client team, Mitchell et al. (2011) argued that these organisations have separate objectives and priorities. Thus, diversity in construction partners’ objectives and priorities can result in inefficient integration between all these organisations, inhibiting performance improvement in the construction industry (Bankvall et al., 2010). Therefore, to improve construction performance, Cohen and Eimicke (2008) argued that the public client manager should learn to work within a multi-organisation network and to identify the most critical interaction elements in their relationships. Similarly, Watermeyer (2012b) indicated that the client organisation is required to update the traditional procurement planning approaches by enabling different responsibility allocation, the use of cost-based strategies, early contractor involvement and the adoption of systematic and strategic working practices. Moreover, Kashiwagi (2008) argues that “the best-value concepts and principles of efficiency, accountability and appropriate transfer of risk and control, not alternative delivery systems, are key to maximising construction value and construction industry sustainability.” Additionally, Masterman (2002) highlighted the fact that the
client organisation’s characteristics and culture are key factors in developing a sound procurement strategy.

Therefore, past research had stressed the criticality of effective client involvement in the construction project delivery. More specifically, Knutsson and Thomasson (2013) argued that the public sector is a major procurer and can affect construction performance and drive innovation. Similarly, Rolfstam et al. (2011) highlighted that the public sector commands a powerful procurement party that, if managed appropriately, could promote innovation. Moreover, strategic working approaches by the public client need to promote sustainable procurement development, which provides the catalyst for converting stress into effective practices (Meehan and Bryde, 2011). However, researchers in construction procurement have been primarily focusing on investigating construction project success factors, and it does not appear they have been successful in developing a procurement model that paves the way for construction procurement improvement (Plane and Green, 2012). Furthermore, to date, there is very little research investigating the various aspects that help the public sector act efficiently to enhance construction procurement performance in Oman. A better understanding of the public procurement working environment in Oman can support the development of a more efficient way of working for public clients.

In Oman, the public sector is the largest construction client (Hamilton & Barton, 2014). The increasing demand for public services to sustain the population growth in Oman requires efficient public procurement approaches to deliver required services at the optimum times and costs and of the required quality. At present, public clients in Oman are mainly developing and maintaining these facilities through two main procurement routes: the traditional procurement system and integrated procurement systems, including public-private partnerships. In both systems, the public sector acts as the main controlling party in developing, operating and maintaining all public facilities. Meanwhile, the construction sector is criticised for its poor performance and not delivering value for money. More than
other parties, construction clients in Oman can play a primary role in enhancing procurement performance (Alnuaimi et al., 2010; Alnuaimi and Mohsin, 2013). However, this does not mean the client is the sole party responsible for the enhancement of construction procurement performance; other parties, such as consultants and contractors, are equally involved. For example, a survey conducted by Abu Bakar et al. (2011) showed that none of the participating contractors had any formal quality management training, and only about 64% had a plan for implementing a quality management system. Similarly, Alkalbani et al. (2013) noted that the construction industry is lagging behind the government’s plan for Information and Communications Technology (ICT). This situation puts high stress on the public sector to improve working environments in the construction industry and drive the sector toward the establishment of an innovative procurement strategy. In fact, Egan’s report (1998) recommended that the UK government should lead the construction sector toward best practices.

Aiming to facilitate more efficient client involvement in construction procurement in Oman, this research focuses on defining key public client activities to enable the fulfilment of the client’s objectives and project aspirations during the schemes delivery stage.

1.2 Research Problem Statement
While the importance of client involvement in attaining construction performance has been renewed, recent attempts to improve procurement performance have unfortunately given limited attention to supporting the success of client in construction procurement. In contrast, the direction toward integrated procurement systems focused attempts of performance improvement to outsourcing most of the procurement activities to the contractors. However, the integration of design and construction activities under the contractor still remains one part of procurement systems that is greatly dependent on the client’s decisions in the planning stage and effective involvement at later stages. In other words, success at each stage depends on contributions from more than one party, and the client is the single most important component in initiating the procurement process, defining project
objectives and requirements, and even selecting other parties. Comparison of DBB vs DB procurement performance revealed critical issues in public project deliveries, stressing the need for more comprehensive studies and re-evaluation of public procurement both in academia and in practice (Park and Kwak, 2016).

While the level of involvement of clients varies based on each organisation’s capabilities, public clients are responsible for the best utilisation of public funds and the protection of public interest. Furthermore, unlike private clients, public procurement goals and objectives must ensure wider users’ interests and social and economic interests. Hence, success in the development of a construction scheme depends largely on the collective participation of stakeholders.

Recognising that practices vary across geographical regions, the strategic and regulatory position gives public clients in Oman the power to contribute efficiently to the procurement process, not only improving construction procurement performance but equally improving the whole construction industry. According to Ling et al. (2013) there are differences between public and private sectors, thus different procurement approaches are recommended for places that have different planning and economic systems so as to help public projects achieve better project performance. Therefore, lack of recognition and embedment of key public client activities throughout the project lifecycle has the potential to threaten construction performance in many aspects, including causing failure to deliver the intended objectives and increasing risks of delays and cost overruns. Thus, this research emphasises the need for a thorough investigation to bring together important client activities and practices to understand key public client activity components that affect construction performance in terms of delays and cost overruns, which are the focus of this research.

1.3 Key Research Questions
The key research question that addresses the research problem is: What impact do the client activities have on construction procurement performance?

The main question is further broken down into four sub-questions to aid the research:
1. What are the main client activities at each stage of the procurement lifecycle that can influence the construction performance?

2. What are the client organisational success activities across the procurement lifecycle that influence the construction performance?

3. What are the important client activities in construction procurement?

4. What is the nature of the relationship between client activity components and construction delays and cost overruns?

Answering these questions will help to define how the client’s activities affect delays and cost overruns in construction procurement in Oman.

1.4 Research Aim and Objectives

The aim of this research is to establish the relationship between the client activities and construction procurement performance in terms of delays and cost overruns by developing multiple regression models. Establishing the relationship between the client activity components and construction performance can quantitatively evaluate the relative effect of individual client activity components on construction performance. Thus, the nature of these components’ effect on construction delays and cost overruns can inform future intervention strategies by the client organisation.

Consequently, the following six objectives are considered:

**Objective 1:** undertake a critical review of the literature on construction procurement to identify key client activities at each stage of the procurement lifecycle that affect construction delays and cost overruns.

**Objective 2:** undertake a critical review of the literature on construction procurement to identify client organisational success activities that affect construction delays and cost overruns.

**Objective 3:** undertake a critical review of the literature on the construction industry in Oman to identify key characteristic that affect construction delays and cost overruns.
Objective 4: Explore the interrelationships (correlations) among the client activities to define a set of common underlying activity components.

Objective 5: Develop multiple modelling of the relationship between the client activity components and construction procurement performance to explain the nature of the client activities effect on construction delays and cost overruns.

Objective 6: Define and evaluate the highly influential client activities to engendering construction procurement performance in term of delays and cost overruns.

1.5 Outline of Research Methodology

In addressing the research questions identified in Section 1.3, positivism was adopted as a research position to reflect the philosophical approach involved in and guiding the study in the data collection. Subsequently, quantitative research strategy and survey design was used to elicit data from public clients in Oman. The data collection technique adopted enabled multivariate statistical tools, such principal components analysis and regression analysis, to be used for data interpretation and discussion. Figure 1.1 illustrates a summary of the research stages: the adopted research methods, data collection, and data analysis.

The research commenced with a literature review (stage 1) covering three main aspects: client activities throughout the procurement lifecycle, client organisational success practices, and construction procurement in Oman. This led to the identification of 75 client activities (presented in Appendix 2), which were then scrutinised and verified through series of interviews with three industrial practitioners possessing renowned experience in public procurement in Oman. Comments made during the interviews were taken in the pilot study questionnaire before the distribution of the final set of surveys (stage 3). Subsequently, the data collected were subjected to principal component analysis and regression analysis to identify and group important public client success activities/practices and their impacts on construction delays and cost overruns (stage 4). Finally, analysis
findings were validated via interviews with experts from the construction industry in Oman (stage 5) and concluded with the discussion of the results, which led to the suggestion of action by the public client to minimise risks of construction delays and cost overruns.
Client activities throughout the Procurement lifecycle

Organisational success practices in construction procurement

Construction procurement in Oman

Important client success activities and practices

Research methodology
Identify research philosophy, strategy, design, data collection approach, data analysis

Data collection
Questionnaire survey

Principal components analysis
Investigation of interrelationship within client activities and organisational practices (identification of the important public client activities)

Multivariate regression analysis
Modelling the relationship between public client activity components and construction delay and cost overrun

Interviews
Validation of findings

Discussion of findings

Figure 1.1 Research process, stages, analysis methods and outcome
1.6 Summary of Main Findings
The key findings of the research are as follows:

1. The client organisation is expected to be involved to a different extent at each stage of the procurement lifecycle. The activities of the planning stage belong solely to the client. Other activities, mainly design, construction and technical matters of facility management, are often candidates for outsourcing to other parties.

2. Client involvement after the appointment of the consultants, and more particularly the contractor, is not well established. This is because the client is seen to lack the knowledge and skills that can add value.

3. The organisational success activities indicated these activities could be integral elements throughout the procurement lifecycle. In fact, learning and knowledge gained by effective participation could facilitate innovative decisions and practices. The volume and continuity of public client construction procurement should enable client organisations to accumulate a wealth of technical and non-technical knowledge about the procurement lifecycle.

4. Other industries, such as automotive and aerospace, have managed to develop working models that increase their market competitiveness. The learning from the automotive and aerospace industries stresses the importance of embedding the success activities identified by researchers in the construction industry day to day practices.

5. The review of the client success activities revealed that client activities are interrelated. For example interaction, collaboration and knowledge management seem to complement each other. Therefore, establishing relationships among the client-related activities can support clients in recognising and understanding the set of elements that affect construction performance.

6. The Omani community has a very strong social structure where people like to be involved, however, such an environment is not well utilised in public sector day to day working practices.
7. Project strategies, project planning, design efficiency, effective site management, collaboration, construction efficiency, and social environment set of activities are considered as the potential client activities that need further investigation to understand their effect on construction delays and cost overruns.

8. The average delays in traditional procurement (54.44%) is much higher than the average delays in design-build procurement (34.62%). However, highest delays recorded (252%) was in the design-build procurement, which can be seen as indicative of higher delays risks associated with design-build procurement.

9. Approximately 55% of the projects in both traditional and design-build procurement were completed beyond the project cost contingency limit (5%). The average cost overruns in traditional procurement (14.51%) is higher than the average cost overruns in design-build procurement (10.07%). Furthermore, the highest cost overruns (316%) in traditional procurement is much higher than highest recorded cost overruns in design-build (86%). These recorders indicate higher cost overruns risk is associated with traditional procurement system.

10. In accord with modelling and validation results the client can reduce construction delays in five ways: enhancing collaboration, enhancing construction efficiency, the accuracy of projects objectives and requirements, resolving planning and permits approval difficulties, handling major contractors' difficulties.

Similarly, the client can reduce cost overruns in eight ways: enhancing design efficiency, enhancing collaboration, multiphase involvement of stakeholders, enhancing the accuracy of project’s objectives and requirements, resolving issues related to the availability of construction workforce, and handling major contractors difficulties.
1.7 Contribution of the Research
This study has explored the relationship between public client procurement activities, thereby defining client activities affecting construction delays and cost overruns. These client activities must receive close attention from client organisations when developing construction projects. The specific contributions of this study are as follows:

1. Defining client activities affecting construction delays and cost overruns helps client organisations to recognise easily those activities that contribute substantially to the improvement of construction project performance. Hence, client organisations can ensure that these activities receive close and continuous scrutiny, which they might otherwise not receive.
2. Defining client activities allows a clear and early characterisation of the client team competency level that must be attained by the client organisation and limits costly training to only those areas that are necessary.
3. The research findings provide empirical evidence for organisations seeking information on the development and implementation of construction procurement guidelines, policies, and strategies.
4. The research findings provide the basis for future research on client involvement during the procurement lifecycle. Each of the client components could be the subject of a more in-depth investigation.

1.8 Thesis Structure
The thesis comprises 10 chapters, organised as follows:

Chapter One is an introduction to the research, presenting the research background and stating the research problem, questions, aim, and objectives. Subsequently, the chapter provides a guide to the structure of the thesis.

Chapter Two presents client procurement activities throughout the project delivery lifecycle. The chapter compromises four main sections, covering client
activities during the planning stage, design stage, construction stage and finally
the operation and maintenance stage.

**Chapter Three** presents organisational procurement success activities and
learning from other industries that can benefit public clients. The chapter
covers success activities related to knowledge management, performance
assessment, and financial management, learning from the automotive industry,
and finally learning from the aerospace industry.

**Chapter Four** recognises the importance of local context, presenting some
important features of Oman and public construction in Oman and issues
affecting construction performance.

**Chapter Five** presents the research methodology used in achieving the
objectives of the research. The choice of the research’s philosophy, strategy
and design are explained and then the methods of data collection and analysis
are presented.

**Chapter Six** presents the results of the questionnaire survey. The chapter
overviews current trends in construction procurement practices and potential
improvement. The chapter also gives a summary of delays and cost overruns
in the most common procurement systems used in Oman.

**Chapter Seven** first presents the principal component analysis results,
including the grouping of the important public client procurement activities into
components which are subsequently used in regression analysis. The second
part of the chapter presents the results of this regression analysis and
validation.

**Chapter Eight** discusses the validation process followed in this research and
the results of the validation interviews.

**Chapter Nine** focuses on a discussion of the analysis results and links them to
the body of literature. Through this discussion, the research questions are
answered, and the research aim is achieved.
Chapter Ten concludes the thesis with a summary of the research findings and highlights the contribution that this study makes to both theory and industry. Finally, the chapter acknowledges the limitations of the research, addresses recommendations to industry and policy makers and suggests future research.
CHAPTER TWO: CLIENT ACTIVITIES THROUGHOUT THE PROCUREMENT LIFECYCLE

2.1 Introduction
Construction procurement is a lengthy process and runs through multiple stages which commence when a client identifies the need for services or facilities. While the client is the only party that exists at the earliest stage of the project procurement process, other participants get involved over time based on a plan the client establishes for the development of the project. This research focuses on the public client procurement activities and practices influencing construction delays and cost overruns. Accordingly, this chapter focuses on public client procurement activities throughout the procurement lifecycle. Thus, it is important to initially understand the general differences between public and private clients. The first section of this chapter highlights the differences between the public and private clients; then the other sections cover construction procurement activities over the project lifecycle, which will be considered in four main stages: planning, design, construction and facility management. Finally, the chapter address the importance of the client’s involvement at each stage of the procurement lifecycle and highlights key activities for further investigation.

2.2 Clients in Construction Procurement

2.2.1 Categorisation of clients
Clients in the construction industry play a strategic role by setting objectives. The client initiates the procurement process and sets the objectives of the project then works with other project team members to transfer those objectives into reality (Rowlinson and McDermott, 1999). The Institution of Civil Engineers (ICE) defines the client as “the organisational entity or individual within the public or private sector organisation that commissions the project” (ICE, 2009). This means that clients in the construction industry can be categorised mainly as public or private organisations. Masterman (2002), as shown in Figure 2.1, provided a more detailed breakdown classification of public and private clients in the construction industry. The diagram further categorises public clients as experienced clients, but in contrast, private clients may vary between
experienced and inexperienced clients. Even though some departments within the public sector might not carry out the number of projects that would enable them to accumulate good experience, others, such as highways, water, electricity, education and health departments, are continuously involved in construction projects. These departments are expected to have better capabilities than some private clients, if not all.

![Figure 2.1 Categorisation of clients (Masterman 2002)](image)

### 2.2.2 Differences Between Public and Private Clients

The public and private sectors in construction procurement may share some common features, but they differ in key aspects. For instance, the procurement expenditure of the public sector is higher than that of the private sector (Arlbjørn and Freytag, 2012). However, the common features of both the public and private sectors include teams’ accountability, expertise, reliability, efficiency, and effectiveness, which are key elements in construction procurement (Wal et al., 2008). Another common feature is that securing value for money in procurement is the optimum objective of both the public and private sectors (Burnes and Anastasiadis, 2003). However, the two sectors might have different views on defining value for money. In the private sector, profit is a fundamental factor because it is the reason for an organisation’s existence and its value is determined by the returns on investment (Hooijberg and Choi, 2001; Burnes and Anastasiadis, 2003). In contrast, in the public sector, the best value is determined by the community or end users’ satisfaction, which means the
best utilisation of public funds and quality of services. Thus, the public sector is held accountable by a wider community of stakeholders with more conflicting goals and a greater variety of interests than the private sector (Hooijberg and Choi, 2001; Feldman, 2005). This means public procurement goals and objectives vary from project to project across locations. Accordingly, public client teams need to have the capability to deal with wider procurement goals and objectives, which are not only limited to technical elements, but also include social aspects such as providing support to small and medium enterprises. In fact, the Rethinking Construction (Egan report, 1998), recommended among other aspects that the UK government lead the construction sector toward best practices.

2.3 Construction Procurement

Construction procurement has been defined in different ways by various professional organisations. For example, the International Commission of Building defined procurement as “a strategy to satisfy client’s development and/or operational needs with respect to the provision of constructed facilities for a discrete life-cycle” (Lenard and Mohsini, 1998:79). Similarly, the International Society of Standardisation defines procurement as “the process which creates, manages and fulfils contracts relating to the provision of goods, services, engineering and construction works or disposals, or any combination” (International Society of Standardisation, 2010:4).

The International Commission of Building’s definition is almost completely concerned with the outcome of procurement, without giving much attention to the procurement activities. In contrast, the ISO provides a more comprehensive description of the activities associated with the procurement lifecycle. Looking at the construction industry, major procurement activities involve four main stages: planning, design, construction, and operation. Figure 2.2 illustrates an overall procurement lifecycle, which, according to Watermeyer (2011), commences when the client identifies the need and continues until decommission or abandonment of the facilities. However, decommission does not always mean the end of the cycle; instead, it can be the commencement of a new project, that again follows the main stages.
Figure 2.2 Construction procurement lifecycle

2.4 Planning Stage of Construction Procurement

Construction projects are mostly initiated as a response to a need or a business opportunity. The RIBA work plan (2013) includes the involvement of no other external parties at this stage of the procurement lifecycle, which means the client is the sole party responsible for developing all deliverables for the next stages. The client information developed at this stage must demonstrate the key stakeholders’ understanding of outcomes and benefits (BSI, 2011; McIvor et al., 2011). The main outputs of this stage of construction procurement include the identification of the procurement goals and objectives, a procurement strategy, the identification of project requirements, the selection of a procurement system, the selection of a payment method, and the selection of contract terms and conditions (International Organisation for Standardisation, 2011; Watermeyer, 2011). Similarly, Pesämaa et al. (2009) and RIBA (2013) have stated that in this stage of construction procurement, the client is required to develop a procurement strategy, a strategic brief and identify the core project scope for consultancy services.

The aim of the public procurement strategy is to ensure procurement activities at various stages of the procurement lifecycle are undertaken efficiently and economically whilst contributing to the realisation of the economic, social and
environmental objectives. Unlike in the private sector, the public procurement of construction and infrastructure projects is a major part of a country’s economy and has great potential to drive economic growth (Cabinet Office UK, 2011). In addition to the above aspects, the procurement strategy should take into consideration the project’s objectives, the need for stakeholder involvement, budget constraints, the project’s time frame, the project team, the procurement system, the scope of consultancy services, consultant and contractor selection criteria, payment methods, tendering, and risk assessment (International Organisation for Standardisation, 2011a). Despite decades of individual and collective experience, there is widespread acknowledgement in recent studies that the public sector fails to efficiently handle these activities. More details of each of these activities and their interrelationship will be covered in the following sections of this chapter.

2.4.1 Procurement Objectives
Project objectives generally vary from client to client, and they are normally identified on an individual project basis. Furthermore, a project may have just one objective or multiple objectives, as seen in Sections 2.2.2 and 2.3. Public sector projects involve more than one objective; for example, the outcome of the project should achieve a set level of performance for the minimum cost and in the minimum time possible. Although the primary objective of most projects is achieving the project outcomes for the minimum cost and in the minimum time, other objectives can be equally important, such as good operation performance (de Wit, 1988). Past research shows that there is a trade-off between project objectives, especially time, cost and performance (Patanakul and Milosevic, 2009; Watt et al., 2009; de Wit, 1988). Therefore, it is the client’s responsibility to identify project objectives and priorities between the three main objectives (cost, time and performance level) (Toor and Ogunlana, 2008a). As can be seen from Figure 2.3, various elements can affect the client’s decisions (Walker, 2002). For example, in the case of cost, the client's focus may be only on the construction cost, without much consideration to the whole project’s lifetime costs. Another important point highlighted in the figure is time and cost certainty, which is mostly related to the importance of completing the project without construction time and cost being increased. These parameters show
that decisions by the client in the early stages of the procurement lifecycle influence the project’s outcome; this influence could appear immediately, during the construction stage, if it affects construction time or construction cost, while performance problems appear more clearly during the operation stage. Additionally, Balson et al. (2012), Chapman and Ward (2003) and Doloi (2012) argue that the failure to identify objectives or issues at the planning stage of the procurement process causes serious difficulties at later stages of the project.

2.4.2 Project Requirements
Requirement management continues to be one of the most challenging problems in construction procurement. Some requirements may not be well understood by the client team during the initial briefing. In practice, clients’ awareness of requirements improve with time, as the project progresses (Thomson, 2011). Moreover, multi-stakeholder clients such as public clients can face more difficulties in identifying the project requirements at the outset, because actual requirements highly depend on the interaction between the client team and other stakeholders. Therefore changes in the initial requirements can become necessary to satisfy the emergent needs of the client.
and other stakeholders (Thomson, 2011; Yu and Shen, 2013). Consequently, changes during the construction stage may incur additional costs and delays the progress of the project. According to Winch and Kelsey (2005) and Yu and Shen (2013), clients always recommend improving the requirements of management competency in order to produce an inclusive project brief during the project’s initial stage.

The requirements of each project define what the stakeholders need from the project and also what criteria the end product must meet in order to satisfy those needs (Yu et al., 2010). These requirements can be defined in terms of specific size, shape, appearance and quality. However, according to Ibrahim et al. (2013), development and control of construction project requirements and end users’ expectations is a challenging task. Misinterpretation of requirements, difficulties in identifying requirements, complex client organisations, and team communication problems are some of the most challenging tasks (Yu and Shen, 2013). To help the client overcome these challenges, the Strategic Forum for Construction (2003) recommends the establishment of a client team at the early stage of the procurement process as a proactive action to manage project requirements and end users’ expectations. However, with time, procurement requirement management is becoming more complex due to the increase in construction project complexity, which requires project clients to develop and practice systematic approaches and continuously develop their capabilities to meet performance expectations (Yu and Shen, 2013). Otherwise, failure by the client team to appropriately manage project requirements can lead to changes during the construction stage and subsequently poor performance (Love and Smith, 2004).

Not all clients have the capabilities or the resources that would enable them to develop clear requirements and briefings (International Organisation for Standardisation, 2010). This forces some clients to seek professional advice from external parties to overcome the shortages in their internal capabilities. Therefore, the involvement of external parties in the development of a construction project may arise from the early stages of the procurement process. However, the most commonly used process guideline, the RIBA Plan, does not show third parties’ involvement before the concept design stage. This
 CLIENT ACTIVITIES THROUGHOUT THE PROCUREMENT LIFECYCLE  

indicates that the client team is solely responsible for the development of the procurement strategy and project brief. The client mainly gets the support of its private sector partner/s only after establishing the project strategy. Yu et al. (2004); Aritua et al. (2011); Berry and McCarthy (2011) and Balson et al. (2012) argued that the public client should establish its requirements and select a competent private partner to fulfil the successful delivery of the construction scheme and maximise value. This does not mean the client is relieved of its responsibilities by outsourcing part of the work to this private partner; in fact, clients can maximise project value only if they have the capability to manage their relationships with their private partners. But in practice, the public sector may lack the capability to manage private partners (Akintoye et al., 2003). Such weakness in the public client could be caused by the lack of the unique set of skills needed to overcome the challenges facing them in project delivery (Britua et al., 2009). Another reason could be a lack of clarity about those client components that significantly influence procurement outcomes. Thus, better understanding these components will enable clients to develop the required skills and efficiently handle their relationships with other parties, so all parties in the project can work as a team. In other words, understanding client success components and the development of client teams can lead to more accurate project requirements and subsequently mitigate costly changes during the construction stage.

2.4.3 Establishment of Project Team  
The client, when developing a specific scheme, needs to bring in multidisciplinary members at various stages of the procurement lifecycle. Based on information from the UK (Office of Government Commerce, 2003), a working team includes the client team, consultants, contractors and specialist sub-contractors and suppliers. Figure 2.4 establishes the key members of a construction project; they are mainly classified into three groups, namely the client team, the procurement team, and stakeholders. In practice, building this team may take a long time and members get involved in the project at various stages of the procurement lifecycle. Looking at Figure 2.4, the project sponsor and project managers hold the responsibilities of integrating the team members’ efforts towards project delivery. Both the project sponsor and the project
manager hold the role of managing all procurement activities and interacting with other members, such as the contractors, the consultants, the suppliers, or as they may be called, sub-contractors, and finally stakeholders. Specific attention should be given to end users' requirements early in the project lifecycle (Ling and Poh, 2008; Toor and Ogunlana, 2008a). In fact, careful consideration should be given to the wider stakeholders, as will be discussed in Section 2.4.5.

![Diagram of procurement working team](image)

Figure 2.4 Procurement working team

Diverse end user goals and the involvement of multidisciplinary parties over the lifecycle of a project increases the complexity of the construction project, especially with the conflicting objectives of each of them (Howes and Robinson, 2005). With the exception of the client, the majority, if not all, of the parties have a temporary interest in the project which ends on the date the project is handed over to the client. The client is the party that continues on the project to the end of its lifecycle. Therefore, it is in the interest of the client to ensure the integration of the parties involved in the project and initiate new ways of working to achieve the set objectives (Rahman et al., 2008). Research by Scott-Young and Samson (2008) found a significant relationship between clients' ability to manage a project team and project performance. They found that effective
client teams have a direct influence on procurement cost, time and quality. Based on Figure 2.5, elements like client team context, team design, team leadership and the team working process are the main drivers that affect procurement performance. However, there are no well-defined client activities which, when implemented by the client, result in integrated procurement. In fact, more attention is given to the integration of activities rather than integrating the team in an effort to efficiently handle these activities. It is the client team that is required to update the team selection criteria to match each project’s context, objectives, and goals.

<table>
<thead>
<tr>
<th>Client Organizational context</th>
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<tbody>
<tr>
<td>Clear project goals</td>
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<tr>
<td>Senior management support</td>
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<table>
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<tr>
<th>Team design</th>
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<tbody>
<tr>
<td>Cross-functional integration</td>
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<tr>
<td>Autonomous project team structure</td>
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<td>Team experience</td>
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<td>Team continuity</td>
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<td>Co-location</td>
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<tr>
<td>Virtual office usage</td>
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<td>Office designed for communication</td>
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<tr>
<th>Team leadership</th>
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<tbody>
<tr>
<td>Project manager continuity</td>
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<tr>
<td>Project Manager's incentives linked to project objectives</td>
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<table>
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<tr>
<th>Team processes</th>
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<tbody>
<tr>
<td>Problem solving</td>
<td></td>
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<tr>
<td>Team potency/efficacy</td>
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</table>

![Figure 2.5 Relationship between the client team and procurement performance (Source: Cheng, 2003).](image)

In fact, project team integration can be influenced by various elements. According to Ahmad et al. (2011), the factors that influence the performance of the client team during the initiation stage can be classified into three main groups:

- Client team’s experience and knowledge.
- Client’s efforts at brief management. Clear documentation and communication of client’s needs within the client organisation team and
amongst other stakeholders significantly influences procurement performance.

- Client organisation commitment. Top management’s support in decision making and effectiveness of communication between client team members enhances the chances of success of the procurement process. These attributes show that various factors can influence the client’s ability to build a project team. To support a better working environment, the client team needs to possess management skills and technical knowledge that support better performance at various stages of the procurement lifecycle. Not only do they need these skills and knowledge; they also need the sound capability to provide guidance to other members, especially at the procurement initiation stage (Smith and Love, 2001). While client team commitment appears to be an essential factor, other stakeholders’ commitment is equally important for success in project delivery. Therefore, encouraging collaborative working approaches can greatly benefit the client team.

2.4.4 Consultants and Contractors Selection
The public sector plays a vital role in the construction procurement industry and the contracting process is governed by laws and procedures. Public regulations restrict the use of informal information, such as past relationship experience, in selecting consultants and contractors (Sporrong, 2011). However, at present it is not necessary to select the lowest price, and there is increasing use of project-specific criteria (PSC) (Wong et al., 2001). For example, EU procurement directives require public contracts to be awarded to the lowest bidder or the most economically advantageous bidder (Bergman and Lundberg, 2013).

The technical capabilities of all parties are important for the successful completion of a construction project (Rahman and Kumaraswamy, 2005). Therefore, public clients should formulate selection criteria to match the project’s objectives (Kumaraswamy et al., 2000; Chow and Ng, 2005). Many clients use a scoring system to evaluate the bidders’ proposals, where the final rank of the technically qualified bidders is generated by aggregating the technical and price scores of each bidder (Bosché et al., 2012). This allows the client to select the most economically advantageous bidder. More specific
selection criteria can be further developed for consultant and contractor selection, as will be discussed in Sections 2.4.4.1 and 2.4.4.2 respectively.

2.4.4.1 Consultant Selection
Depending on the selected procurement arrangement, the client may appoint one consultant to provide the required services or appoint separate firms for each of the specialised activities involved in the procurement of the construction scheme. The client avoids administrative and communication difficulties by giving the responsibility of the design to a single firm, where the appointment of firms from separate disciplines gives the client the chance to get the best firms in each discipline (Morledge et al., 2006). According to Morledge et al. (2006), the main objective of the client should be value for money and not the lowest price, thus the price is not the only selection criteria (Cheung et al., 2002). Both the International Organisation for Standardisation (2011) and the Construction Industry Board (1996) have provided general guidelines of quality/price ratio (Table 2.1).

Table 2.1 Quality/price ratio for evaluation of consultancy services

<table>
<thead>
<tr>
<th>Characteristic of the project</th>
<th>Quality/price ratio</th>
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<tbody>
<tr>
<td>Feasibility studies</td>
<td>80/20 to 90/10</td>
</tr>
<tr>
<td>Innovative projects</td>
<td>70/30 to 85/15</td>
</tr>
<tr>
<td>Complex projects</td>
<td>60/40 to 80/20</td>
</tr>
<tr>
<td>Straightforward projects</td>
<td>30/70 to 60/40</td>
</tr>
<tr>
<td>Repeated projects</td>
<td>10/90 to 30/70</td>
</tr>
</tbody>
</table>

It can be seen from Table 2.1 that the feasibility studies assigned the highest quality score without any link to the selected procurement system. The remaining distribution of the quality/price ratio is linked with the complexity of the project; the more complex the project the higher the quality score. There is no major difference between the BSI standard and the Construction Industry Board ranking when it comes to project complexity. The use of a quality/price ratio offers the client the flexibility of selecting the most appropriate consultants.
for the required services, because only consultants who achieve the minimum quality threshold can be considered for the award.

Before the invitation to bid, the client has the option to assign the quality score to a set of various parameters and a minimum cumulative score is defined to enable a proposal to be further considered for the price evaluation. As cited earlier, Wong et al. (2001) clarified that parameters can vary from project to project; here, Table 2.2 presents two examples of consultants’ quality assessment parameters. A common important point that can be noted from the two examples is the criticality of the consultant’s technical and management personnel’s abilities. Additionally, the client best practice guide by ICE (2009) emphasises the importance of these two elements in consultant selection, along with the consultant’s reputation. Even if the same parameters are used in more than one project, the score allocated for each parameter may vary based on the client’s judgement. Therefore, the client’s knowledge, skills, and understanding of the scope of the project are critical in defining the parameters, scoring each parameter, the evaluation of bids and finally the selection of the best consultant. Accordingly, the consultant’s technical and managerial abilities’ effects on the procurement might vary from project to project.

<table>
<thead>
<tr>
<th>(Ng and Chow, 2004)</th>
<th>(Cheung et al., 2002)</th>
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</thead>
<tbody>
<tr>
<td>Past experience</td>
<td>Firm’s background includes past experience in providing services for projects of a similar nature</td>
</tr>
<tr>
<td>Resource</td>
<td>Firm’s reputation</td>
</tr>
<tr>
<td>Creative and innovative ability</td>
<td>Past performance</td>
</tr>
<tr>
<td>Management staff</td>
<td>Professional qualifications and experience of firm’s team</td>
</tr>
<tr>
<td>Service delivery</td>
<td>Project approach methodology and time</td>
</tr>
<tr>
<td>Financial soundness</td>
<td>Present workload</td>
</tr>
<tr>
<td>Professional indemnity insurance</td>
<td>Quality control</td>
</tr>
<tr>
<td>Quality attitude</td>
<td></td>
</tr>
</tbody>
</table>
2.4.4.2 Contractor Selection

Selecting the most competent contractor is another crucial part of the procurement process. One of the client key roles is to make sure all contractors are qualified to complete the project successfully. The qualification of the contractors depends on the contractor selection method, decided on a project-by-project basis or based on a pre-qualified shortlist for multiple projects during a specific period of time (Morledge et al., 2006). Similar to consultant selection, contractor selection is no longer based on lowest price. The client’s main objective when procuring a construction project is achieving the best value (Palaneeswaran et al., 2003). The quality/price ratio developed by the International Organisation for Standardisation (2011), provide construction clients with a guide to value-based procurement processes (Table 2.3).

Table 2.3 Quality/price ratio for evaluation of contractors’ proposals

<table>
<thead>
<tr>
<th>Characteristics of the project</th>
<th>Quality/price ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>B S I Standards (2011)</td>
<td></td>
</tr>
<tr>
<td>Innovative projects</td>
<td>20/80 to 40/60</td>
</tr>
<tr>
<td>Complex projects</td>
<td>15/85 to 35/65</td>
</tr>
<tr>
<td>Straightforward projects</td>
<td>10/90 to 25/75</td>
</tr>
<tr>
<td>Repeated projects</td>
<td>5/95 to 10/90</td>
</tr>
</tbody>
</table>

Furthermore, researchers have identified different selection criteria parameters for the selection of the project contractor; some examples are shown in Table 2.4. Wong et al. (2001) argued that multi-criteria evaluation increases the likelihood of the project’s success. However, there is no agreement on specific parameters that are considered to lead to project success; in fact, both the client’s and the contractor’s understanding of the challenges associated with the project could be more important, not only in developing a construction strategy but also in working collaboratively to solve the difficulties the project may face during the construction stage. Furthermore, a good understanding of the project features on the part of the contractor can ensure better resource management, and workshops before awarding the contract provide the client with the opportunity to scrutinise the contractor’s ability to deploy the required
resources and act proactively to mitigate any risks that might affect the project’s performance.

Table 2.4 Quality evaluation parameters of contractor

<table>
<thead>
<tr>
<th>(Wong et al., 2001)</th>
<th>(Watt et al., 2010)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manpower resources</td>
<td>Past performance on projects</td>
</tr>
<tr>
<td>Plant and equipment resources</td>
<td>Technical expertise</td>
</tr>
<tr>
<td>Project management capabilities</td>
<td>Tender price</td>
</tr>
<tr>
<td>Geographical location of knowledge</td>
<td>Project management expertise</td>
</tr>
<tr>
<td>Location of home office</td>
<td>Workload/capacity</td>
</tr>
<tr>
<td>Contractor’s capacity</td>
<td>Client tenderer relation</td>
</tr>
<tr>
<td>Project execution capabilities</td>
<td>Method and technical solution</td>
</tr>
<tr>
<td>Technical-economic analysis</td>
<td>Company standing</td>
</tr>
<tr>
<td>Other for particular project</td>
<td>Organisational experience</td>
</tr>
</tbody>
</table>

2.4.4.3 Tendering

Tendering is more frequently used in public procurement, which is mandatory in some countries. However, the public tendering procedure shows private clients good practice for tendering processes (Cooke and Williams, 2009). Clients use tendering as an indication of genuine and fair competition (Ballesteros-Pérez et al., 2013). The tendering process may differ from one country to another but the general tendering process is illustrated in Figure 2.6 (Mohemad et al., 2010). Even though the flow chart provided by Mohemad et al. (2010) characterises all tendering activities as taking place between the client and the contractor, with no involvement from the consultant, the actual situation may differ and the consultant could be the actual party to assess the tenderer’s quality, with the client then scrutinising the shortlisted tenders.

Construction project tender documents normally include instructions to tenderers, information to be provided by tenderers, evaluation criteria, contract terms, specifications, drawings, and a bill of quantities (Yan and Zhang 2010; Mohemad et al., 2010). However, in practice, tender documents are not always precise or sufficient for contractors’ understanding or price estimation (Laryea, 2011). Tenderers address ambiguities in the tender documents either by raising queries seeking client clarification or by qualifying the tender.
submissions for post-tender negotiations (Laryea and Hughes, 2009). Qualifying the tender submission might complicate the tender evaluation process and leave the client and the contractor with high transaction costs. A report issued by the treasury (2012) shows that the average period of the procurement tendering phase, from issuing the tender notice to award, when using PFI is about 35 months, and this period can go up to 60 months (HM Treasury, 2012). Parties spend this time clarifying issues related to the information provided in the tender documents and the risks which might affect construction time and cost. Furthermore, during the evaluation period, the client gets the opportunity to scrutinise the contractor’s ability to deliver the project’s scope.

<table>
<thead>
<tr>
<th>Client</th>
<th>Consultant</th>
<th>Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiate Project</td>
<td>Develop Tender Documents (TD)</td>
<td>View Tender</td>
</tr>
<tr>
<td>Tender Notice</td>
<td>Assess tender Quality</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Pass threshold</td>
<td>Interested</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Combine Quality/price score</td>
<td>Collect (TD)</td>
</tr>
<tr>
<td></td>
<td>Award</td>
<td>Prepare Bid</td>
</tr>
<tr>
<td></td>
<td>End</td>
<td>Submit Tender</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End</td>
</tr>
</tbody>
</table>

Figure 2.6 Tendering process flow chart (Source: Mohemad and Hamdan, 2011)

### 2.4.5 Stakeholders Involvement
As seen in Section 2.4.3, stakeholders can significantly affect the outcome of construction projects. Freeman (2010) defines stakeholders as parties who
affect, or are affected by, the achievements of an organisation. Considering the influence of stakeholders on project development, Mitchell et al. (1997) define stakeholders as any parties having possession of at least one of the following: power, legitimacy or urgency. As long as stakeholders might be affected by the project and have at least one of these three, their involvement becomes an essential part of the construction procurement process. Public client policy and practice can show the client’s commitment to stakeholder involvement, and the more the client engages with its stakeholders, the more accountable and responsible towards these stakeholders it will be (Greenwood, 2007; Nguyen et al., 2004).

Freeman (2010); Manowong and Ogunlana (2010) and Ward and Chapman (2008) classified stakeholders into two main groups: internal stakeholders and external stakeholders. But the critical step is identifying the potential stakeholders who are most likely to impact or be impacted when developing a construction scheme. Figure 2.7 provides a general overview of the parties that can form the two groups of stakeholders. The illustration shows that internal stakeholders are clearly identified as: the project client/owner, contractors, suppliers, and consultants. In contrast, general terms have been used to point to a group of unknown individuals and organisations, like local and national authorities, which might differ from project to project within the same country. Even though the stakeholders change from one project to another, the same client, consultants, and contractors could work together in multiple projects, but it is rare for all external stakeholders to be the same for more than one project. This is because normally, projects are constructed in different locations, unless the same project is constructed in different phases, in case which the same stakeholders continue throughout the project’s phases. The situation might be much clearer in the case of private clients, but, in contrast, other public services departments, local and national authorities are an integral part of the public sector. Thus they are not external parties and collaboration between all public stakeholders is very crucial to the client’s success.
Stakeholders remain a major source of uncertainty in project development and giving attention to them is very important for the successful completion of the project (Ward and Chapman, 2008). The concept of stakeholder management has not been developed in a way that makes using them practical (Ackermann and Eden, 2011). For example, conflict is observed between stakeholders at different phases of the project lifecycle due to miscommunication and mismanagement of stakeholders’ concerns (Olander, 2006). Even though clients may outsource stakeholder management to other parties via any contractual form, they retain overall control (Ward and Chapman, 2008). Therefore, client organisations, specifically public sector clients, have to get stakeholders involved as early as possible in the procurement process (Wihlborg and Laurell, 2012). Furthermore, it is the client organisation’s responsibility to ensure that associated stakeholders’ interests are considered in project development (Shen et al., 2006).

Stakeholder involvement is generally associated with two key issues: identifying and reaching a wide range of stakeholders, and achieving consensus on
expectations from a range of potentially mutually exclusive views held by the stakeholders (Unerman and Bennett, 2004). Clarity about stakeholders’ responsibilities and obligations can be another critical issue in construction procurement. According to Cooper and Owen (2007), corporate responsibility and accountability have not been well established and corporate governance is required for stakeholder accountability to be established in the construction industry. However, in practice, client performance can be influenced by any other stakeholder throughout the procurement lifecycle. This is because the client is not working in isolation from the other stakeholders; in fact, some stakeholders may affect clients’ decisions regarding the project.

To resolve the issue of stakeholder management, research has given great attention to the influence and collaboration between stakeholders in the development of construction projects. For example, Phua and Rowlinson (2004) found a significant relationship between collaboration and the procurement success. More interestingly, they pointed out that intra-organisational collaboration is more important than inter-organisational. Therefore, in addition to the technical aspects, these findings highlight the importance of other soft aspects of procurement system, such as collaboration. These soft aspects are not just limited to a single department within one organisation, but in fact involve a wider working environment which does not practically fit within the present procurement context. A better understanding of aspects such as team communication, teamwork, respect for each other’s needs, involvement, and openness is important for the overall procurement system (Boes and Doree, 2013; Eriksson, 2010; Walker and Hampson, 2003).

Problems arise due to difficulties in the management of the complex and dynamic relationship between the client and the contractors’ teams (Bresnen, 2007; Rose and Manley, 2010; Laan et al., 2011). Such dynamic and complex relationships require the client to continuously improve its practices to efficiently handle their influence on procurement performance (Chan and Ho, 2003).

Overall, the research stresses the importance of stakeholder management, while involving the stakeholders helps to get their contributions and enhance project performance. Therefore, it is important to look at stakeholders as valuable parties that can help in solving issues, rather than just parties requiring
effective management. In other words, the client organisation can engage stakeholders in various tasks, such as performance assessment and problem solving.

2.4.6 Selection of Payment Method
Payment methods are related to the selected procurement system, and the client has many payment options to choose from. Examples of payment methods are fixed-price contracts, cost-reimbursable contracts and target cost contracts (Kumaraswamy and Dissanayaka, 1998; Wamuziri, 2012). Therefore, the selected procurement system and the contract’s terms and conditions establish the basis for contractor payment; the contractor could be paid on a work progress basis, or based on milestones or activity/service delivery. However, in traditional procurement systems, such as design bid build and design and build, delays in payment by the client can cause severe delays to the project schedule (Ayudhya, 2011).

Recent development in procurement systems has led to the implementation of the Public Private Partnership (PPP), where the construction scheme’s development is let to a consortium collectively named Special Purpose Vehicle (SPV) which takes care of the project’s design, construction, operation, and finances. In such cases, the client enters into a long-term commitment with the SPV, where the client might pay the consortium a fixed lump sum amount periodically for the availability of the facilities, in addition to a variable fee for the utilisation of the facilities. Adopting PPP procurement provides the client organisation with an alternative source of project funding for a limited capital cost, but at the same time, creates a long-term financial commitment for the client (Akbıyıklı, 2013).
Table 2.5 Classification of contract types

<table>
<thead>
<tr>
<th>Contract</th>
<th>Description (Watermeyer, 2011:4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price based</td>
<td></td>
</tr>
<tr>
<td><strong>Lump sum</strong></td>
<td>Contract in which a contractor is paid a lump sum to perform the work. (Interim payments which reflect the progress made towards the completion of the works may be made.)</td>
</tr>
<tr>
<td><strong>Bill of quantities</strong></td>
<td>Contract in which a bill of quantities lists the items of work and the estimated/measured quantities and rates associated with each item to allow contractors to be paid, at regular intervals, amount equals to the agreed rate for the work multiplied by the quantity of work actually completed.</td>
</tr>
<tr>
<td><strong>Price list/price schedule</strong></td>
<td>Contract in which a contractor is paid the price for each lump sum item in the price list/schedule that has been completed and, where a quantity is stated in the price list/schedule, an amount is calculated by multiplying the quantity which the contractor has completed by the rate.</td>
</tr>
<tr>
<td><strong>Activity schedule</strong></td>
<td>Contract in which the contractor breaks the scope of work down into activities which are linked to a program, method statements and resources, and prices each activity as a lump sum, which he is paid on completion of the activity. The total of the activity prices is the lump sum price for the contract work.</td>
</tr>
<tr>
<td>Cost Based</td>
<td></td>
</tr>
<tr>
<td><strong>Cost reimbursable</strong></td>
<td>Contract in which the contractor is paid for his actual expenditure plus a percentage or fee target.</td>
</tr>
<tr>
<td><strong>Target cost</strong></td>
<td>Cost reimbursable contract in which a target price is estimated and on completion of the work, the difference between the target price and the actual cost is apportioned between the client and contractor on an agreed basis.</td>
</tr>
</tbody>
</table>

Generally, construction procurement systems involve separate contracts between the client and the consultancy firm and the client and contractors. With separate procurement systems, the client mainly follows a sequential process: design development, tender, contract award and construction delivery (Walker and Hampson, 2003). In contracts, integrated procurement systems combine the design and development solely under the main contractor. Irrespective of the procurement method selected by the client, Wamuziri (2012) and Watermeyer (2011) classified contract types into price- and cost-based, as detailed in Table 2.5. These pricing strategies can be used with both separated and integrated procurement systems, except the PPP procurement system,
where bespoke terms and conditions are more frequently used. However, the general issue most frequently reported is contractors’ cash flow difficulties due to delays in payment from the client. Investigations of a client perspective on this issue have not been well represented, because the majority of studies consider the collective view of all participants, with a lower response rate from clients (see for example Doloi, 2012; Kaliba et al., 2009; Yong and Mustaffa, 2013).

2.4.7 Risk Management
Construction risks are generally perceived as events that influence project objectives of cost, time and quality. Construction project delivery is usually subject to more risk than other business activities because of the complexity of coordinating a wide range of disparate and interrelated activities. Complexity is even more associated with public sector construction procurement, where multiple objectives are expected by a wide range of stakeholders (Shen et al., 2006).

Risk analysis and management in construction projects depend mainly on individual judgement and the experience of the parties involved (Akintoye and MacLeod, 1997). This means the identification of risks is a significant task for all major procurement parties across all stages. However, it is in the client’s interest to know which risks will generate significant impacts on the project’s success (Chan et al., 2011). In additional to risk identification, and according to Al-Jibouri and Ogink (2009) and Edwards and Bowen (1998), risk management typically comprises the establishment of context, risk identification, risk analysis, risk evaluation and risk response. The adequacy of an organisation’s knowledge and risk management plan is considered a key success factor in construction projects (Cooke-Davies, 2002).

Sources of risk in construction procurement are wide and not confined to potential events; they include lack of information, uncertainty, the characteristics of parties to the project, trade-offs between trust and control mechanisms, and the varying agendas of parties in different stages of the project lifecycle (Akintoye and MacLeod, 1997). Other procurement risks can include lack of clear specification of what is required; lack of experience, and inter-
dependencies between parties (Ward and Chapman, 2003). Therefore, from the client’s perspective, risks can cover a wide range of issues, some of which might be beyond the client’s own capabilities to deal with. Even important sources of risk are not well defined enough to enable the development of the client team’s competency. Thus, the client team, in association with other parties, can use judgement and experience to work collaboratively and manage risks throughout the procurement lifecycle.

While the private sector can effectively handle industrial action, design and construction risks, it is more effective to allocate site acquisition risks and legal risks to the public sector (Shen et al., 2006). In fact, it is not sufficient to acquire a project site without giving attention to the logistical aspects of the project, such as site access and ease of resource transportation (Javernick-Will and Scott, 2010). Also, other risks, such as financial risks, market condition risks and force majeure risks can be shared between the public and private partners (Shen et al., 2006). In fact, the client can be a source of risk when delaying contractor payments. A study by Frimpong, Oluwoye and Crawford (2003) identified monthly payment difficulties on the part of clients as the most significant cause of delays, and difficulties in sourcing construction materials as the second most significant cause of delays and cost overruns.

Unforeseen ground conditions can also be another source of risk in construction projects. In addition to the geotechnical condition of the project site, a number of man-made obstructions, such as pipes and cables installed by other stakeholders, can constitute major causes of changes in project scope (Chan and Kumaraswamy, 1997; Chan et al., 2011; Shen et al., 2006). Public stakeholders can play a critical role in mitigating risks associated with underground conditions by providing accurate information about their underground assets such as pipes and cables.

Various individual recommendations have been provided to help in managing risks in construction projects. For example, a change of the public client’s focus, from the single role of just a project manager to multiple roles as customer, project manager, inspector and partner, may mitigate public client-related risks during the construction phase (Shen et al., 2006). Furthermore, the
involvement of stakeholders through brainstorming and workshops is a very useful technique for identifying possible issues and solutions. Brainstorming sessions during the initial stage of the project can be very significant for the development of the project briefing (Osipova and Eriksson, 2011; Shen et al., 2007). Similarly, workshops with stakeholders during tendering are a good opportunity for the client, consultants, and contractors to identify potential issues and debate possible solutions. Furthermore, individual clarification workshops with potential contractors are a last chance for the client to amend the tender documents with minimum impact on cost and time. According to Asenova et al. (2002), construction companies are keen to be involved in well-organised brainstorming sessions and workshops to help with risk identification. Thus, further empirical investigation of these recommendations will provide concrete evidence and clarification of ways for clients not just to reduce risks, but more importantly, to simultaneously improve construction performance. This leads to the conclusion that identifying important client success activities will allow a better understanding of areas that constitute high risks to clients, thus deserve more attention when delivering these activities and developing client teams’ knowledge and skills.

2.4.8 Key Performance Indicators (KPIs)
The purpose of KPIs is to “enable measurement of the project and organisational performance throughout the construction industry” (KPI Group, 2000). Even though Cooke-Davies (2002) limited the effect of performance assessment to cost, a client could use KPIs as general indicators of performance, focusing on the assessment of the critical objectives of construction projects, which are basically cost, time and quality (Chan and Chan, 2004). These groups of critical objectives are associated with performance indicators that provide information as to whether the upstream objectives are being met or not. The identification of critical issues inhibiting the achievement of the set objectives (KPIs) can enable project teams to make improvements in particular areas and recover deviations from the set objectives. According to Lam et al. (2004), if the critical success factors of projects are identified and properly addressed, benchmarking techniques can be developed for improving project performance. Benchmarking for overall procurement needs to involve
cross-functional teams, the high hierarchical positioning of the procurement functions, strong cooperation with other stakeholders, and the provision of training and development for its team (Brandmeier and Rupp, 2010). Therefore, there is indeed a need to identify the components that make a procurement system a success, and client teams can use these components and work collaboratively with other stakeholders to evaluate various aspects of the procurement system.

### 2.4.9 Construction Procurement Systems

The client’s relationship with other procurement participants, mainly the consultants and the contractors, has seen significant changes in the last three decades (Masterman, 2002). These changes are associated with changes in the procurement systems used to develop construction projects in the last few decades (Chan et al., 2001). The client’s decision about the type of procurement system to be adopted for the development of the project determines the line of relationships among the main participants: the client, the consultant, and the contractor. In general, there are four main procurement arrangements clients use in delivering construction projects (Masterman, 2002; Morledge and Smith, 2013; Palaneeswaran et al., 2001; Tookey et al., 2001) which are:

- Separated procurement system, which is also called traditional or design bid build.
- Integrated procurement system.
- Management-oriented procurement systems.
- Public private partnership.

It is argued that the chances of procurement success are influenced by the client’s ability to select an appropriate procurement type (Kumaraswamy and Dissanayaka, 1998). However, to date, no single method is applicable or adaptable to all situations, and the selection of the procurement system varies from project to project and from client to client (Lloyd-Walker and Walker, 2012). The existing procurement selection methods were developed to provide
construction clients with a general mechanism for assessing procurement systems against the project aims and objectives (Chan, 2007). For example, Figure 2.8 illustrates a simplified method of selecting a procurement system (Hughes and Murdoch, 2007). A key difference between the various procurement systems is the split of the responsibility for activities between the client and the contractors, or the investor, as the case may be with PPP projects.

Integrated procurement systems combine two elements of the project, design and construction, in one package. According to Masterman (2002) and Tookey et al. (2001), the responsibility for these two basic elements lies solely with the contractor. Design and build, management-oriented, and public private partnerships are the most common forms of this system. Therefore, the following sections will cover construction procurement systems, identifying client-related activities within each system.
2.4.10 Separated Procurement System
The separated procurement system is the traditional contracting method that separates the responsibility for the design from the construction. Apart from separating design and construction responsibility, the separated procurement system has the following basic features:

- Sequential project delivery (Masterman, 2002), which means the client commences the process by appointing a designer first, then after completing the design appoints a contractor; after construction, the client becomes responsible for the operation and maintenance of the facilities.

Figure 2.8 Simplified method for selecting a procurement system
(Source: Hughes and Murdoch, 2007)
- The client specifies in detail the scope of the project before inviting construction contractors (Morledge et al., 2006). The complete design of the project is provided to the contractor, with limited input by the contractor on the design and project specifications.

- Project management responsibility is divided between the client’s consultant and the contractor, who have limited involvement in each other’s activities (Masterman, 2002).

- Rectifying design errors during the course of construction affects the project’s progress and requires great attention from the client team (Love et al., 2013).

- The client has a direct contract with the designers, cost consultants, and project management.

Thus, the separate procurement approach involves three main phases: design development, construction tender, and finally construction delivery. The client initially appoints independent consultants to design and prepare the construction tender document and then supervise the contractor work. Then the contractors utilise the tender document to evaluate the project and submit their competitive prices, allowing the successful bidder to enter into a contract with the client. Following the appointment of the contractor, the relationship between the parties, as illustrated in Figure 2.9, can be divided into two aspects: functional and contractual. Even though the client has a contractual relationship with the two parties, the functional relationship with the contractor is generally left to the consultant. The client’s interaction is more with the consultants, rather than the main contractor, so the client’s involvement in site activities is very limited. This is because the construction stage of design bid build procurement is just translating the sketches and specifications developed by the design consultant into a physical asset.
Considering the whole procurement lifecycle, construction project delivery in design bid build can be classified into three separate main stages: the design stage, the construction stage and the operation stage (Lloyd-Walker and Walker, 2012). Each of these stages involves various activities. Like any other procurement system, the client initially needs to establish the project requirements and identify the need for professional consultancy services. Accordingly, after deciding to select a separate procurement system, the client follows a sequence of activities to develop the construction project. These activities start with the development of the project brief and the appointment of one or more consultants to develop the project design and a detailed scope of the construction work.

The client normally seeks consultancy services to plan, develop the scope of work, assess alternative solutions, develop the design, produce construction documents, and confirm implementation of the design during construction (Watermeyer, 2012a). Based on Yu and Shen's (2013) research, this phase of the project creates the foundation for a successful relationship between the client and the construction industry. Furthermore, innovation at the design stage is considered a critical source of creativity and greatly influences the competitiveness of construction package proposals (Salter and Gann, 2003). Both Turner (2002) and Walker and Rowlinson (2008) stress that success at the design stage depends on establishing a good understanding and
relationship between the public client and the consultancy firm. For a long time, Salter and Gann (2003), Turner (2002) and Walker and Rowlinson (2008) and Yu and Shen (2013) have stressed that the design stage is one of the most important stages and affects all the subsequent stages of the project lifecycle. These researchers provide indications of the criticality of this stage, and at the same time indicate a lack of performance by both design consultant and clients in satisfying the functional and qualitative objectives before awarding construction packages. However, Walker and Rowlinson (2008) argue that responsibility for managing the design services agreement remains with the public client. More specifically, clients’ failure to review and clarify the design will lead to expensive changes during the construction phase (Masterman, 2002).

To improve design performance, the public sector in the Netherlands is encouraging the use of RAMS (reliability, availability, maintainability, and safety) and lifecycle costing at the design stage of infrastructure projects (Al-Jibouri and Ogink, 2009). Even though RAMS is not well known in the construction industry, it has been very effective in other industries, such as telecommunications and aerospace, and it is thought that the consideration of RAMS at the design stage could minimise construction and operational phase problems (Al-Jibouri and Ogink, 2009). These findings by Al-Jibouri and Ogink indicate that the construction sector could learn good practices from other sectors such as aerospace. More specific elements related to the design stage will be highlighted in Section 2.5, and learning from other industries in Chapter 3. This is because the need for design efficiency is not just limited to the traditional procurement system, but also applies to other procurement systems.

2.4.10.1 Advantages and Disadvantages of Design Bid Build
The studies identified various advantages and disadvantages of design bid build procurement systems. As will be seen in the discussion of other procurement systems later on, each procurement system has some advantages and disadvantages. With regard to design bid build procurement, the main advantages include:
- The system is well established and understood by all participants in the construction industry (Masterman, 2002; Morledge et al., 2006; Bogus et al., 2013).

- Full development of the project design before the construction tender results in lower costs compared with other procurement methods (Hampton, Baldwin and Holt, 2012; Masterman, 2002).

- The availability of rates makes change valuation easier and quicker (Masterman 2002; Morledge et al., 2006; Cooke and Williams, 2009).

- The system provides greater certainty of achieving quality and functional standards (Masterman, 2002; Cooke and Williams, 2009; Hampton et al., 2012; Lupton et al., 2012).

- Full development of the design and scope establish a fair competition between all bidders (Morledge et al., 2006).

In contrast, the main disadvantages include:

- The client is not encouraging designers and contractors to improve time, cost and quality performance (Masterman, 2002; Morledge et al., 2006).

- Obtaining construction based on an incomplete design could result in financial claims from the contractor (Masterman, 2002; Morledge et al., 2006; Lupton et al., 2012).

- The separation of design and construction can result in delays, lack of communication between parties and problems of buildability (Masterman, 2002; Morledge et al., 2006).

- Changes can result in project delays and cost increases (Masterman 2002; Hampton et al., 2012).

The design risk lies with the client (Cooke and Williams, 2009). The contractor relies on the design developed by the client’s designer at the bidding stage and the construction stage, and any ambiguities in design are the client’s responsibility.
2.4.10.2 Design-Build

Optimum delivery time and cost are the main reasons for selecting the design-build procurement system (Gransberg and Windel, 2008; Masterman, 2002). The design-build procurement system process tends to be shorter than the traditional design bid build system, especially the pre-contract stage. Furthermore, the public client has more than one option for expediting the process at this stage, for example:

Option 1: The client could tender the project by providing the construction tenderers with the requirements and performance level; this is the traditional design and build system (Kumaraswamy et al. 2000; Masterman 2002).

Option 2: The client could appoint a consultant to develop the conceptual design, which would then be included in the tender document along with project requirements and performance level. Then the design consultant’s agreement is assigned to the construction contract, where the design team acts as consultants to the contractor. Sometimes the client novates the design team to the successful bidder, as it is expected that the client will have more influence on the project’s detailed design, and also ensures consistent design standards (Kumaraswamy et al., 2000; Masterman, 2002; Walker and Rowlinson, 2008).

Following the client’s decision to go down the design-build route, the procurement process consists mainly of client requirement identification, obtaining tenders, tender evaluation, and project implementation (Masterman, 2002). As can be seen from Figure 2.10, in design-build, the client organisation remains directly responsible for three out of five activities. Furthermore, the contractor is the main partner of the client organisation in the development scheme; both design and construction are integrated and under the contractor’s responsibility. It is argued that integrating design and construction under the contractor gives the contractor organisation more flexibility to define the project details and the scope and reduces the client’s involvement in design activities. However, it is critical that the client provides the contractor with sufficient and comprehensive information about the project requirements in order to achieve clarity and avoid misunderstanding (Masterman, 2002).
In working toward professional project design, the client normally appoints a design consultant to prepare a concept design and compile the design and construction tender documents for the project (Smith et al., 2004; Walker and Rowlinson, 2008). Therefore, the services included in the contractor’s scope of work are for a detailed design, while a very important portion of the design still remains the responsibility of the client organisation. Following the contract award, the contractor takes the key role in both the detailed design and construction (Walker and Rowlinson, 2008). The prospective contractor mainly depends on the information provided in the tender document to estimate the project’s cost and develop a detailed design, which means inaccurate information from the client could lead to delays and cost overruns.

With the involvement of a design consultant by the client, the functional and contractual relationship between the main parties (the client, the consultant and the contractor) look quite similar to those in design bid build. The client’s
functional relationship with the contractor is very limited and takes place mainly through consultancy parties. Thus, the client is less exposed to both the detailed design and construction issues. The early involvement of the contractor at the design stage allows the contractor team to reflect on their learning from previous projects and avoid repeating errors or mistakes. However, the quality of the contractor’s work depends on the individuals’ skills and knowledge more than the contractor’s overall experience. This means the design team appointed by the contractor plays a critical role in developing a quality design.

2.4.10.3 Advantages and Disadvantages of Design-Build
Similar to other procurement routes, design-build procurement has its advantages and disadvantages. The common advantages of the design-build procurement system include:

- Responsibility for the detailed design and project construction lies on the contractor (Smith et al., 2004; Lupton et al., 2012).
- Accurate specification of the client’s requirements increases the chance of achieving lower construction cost compared with other procurement routes (Masterman, 2002; Walker and Hampson, 2003; Bogus et al., 2010; Lupton et al., 2012).
- The overlap of design and construction enables a shorter project development period and improves management efficiency (Vogelsang and Ernzen, 2001; Masterman, 2002; Morledge et al., 2006; Lupton et al., 2012).

In contrast, design and build procurement is associated with the following disadvantages:

- Lack of precision in the client brief results in cost overruns and adversely impacts the project quality (Balson et al., 2012).
- Difficulty in evaluating tenders due to diversity in contractors’ design proposals (Morledge et al., 2006). Each contractor has his own view about the best solution to meet the client’s requirements which requires detailed review before awarding the contract.
- There is only limited involvement of the client with the design and construction teams and design control is left to the contractor. Limited client involvement may result in unexpected outcomes for the end users.
- The client makes a commitment before design finalisation, and changes of client requirements at later stages become very expensive (Morledge et al., 2006).
- Price may drive the procurement process on the account of quality.

Compared with the design bid build route, the design build route seems to release the client from some activities, mainly design management. However, whether this is the case or not is the subject of any further investigation. Although the design build route seems to be a viable option for expediting project delivery, the disadvantages highlight some critical risks, mainly related to the clarity of the client’s requirements in the early stages and difficulties in selecting an appropriate contractor. These two difficulties indicate the need of additional effort from the client in order to achieve the desired objectives, especially the delivery period.

2.4.11 Management-oriented Procurement
The management-oriented procurement system is distinguished by the involvement of the contractor in the early stages of the project to provide advisory and management services under the client’s directions. These
procurement systems include management contracting, construction management and design and manage (Masterman, 2002).

2.4.12 Management Contracting
Management contracting involves the selection of a contractor at an early stage of the project based on a brief description, timescale and estimated cost of the project (Masterman, 2002). A management contracting agreement may include providing services during the design phase of the project and the construction phase. Table 2.6 presents key services provided by the management contractor in the design and construction stages of the procurement lifecycle. The main objective of appointing a managing contractor is utilising its experience, skills, and knowledge to ensure the buildability of the project design.

<table>
<thead>
<tr>
<th>Pre-construction services</th>
<th>Construction services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall project programmer</td>
<td>Manage, organise and supervise the project’s implementation.</td>
</tr>
<tr>
<td>Project component scheduling</td>
<td>Receive work payments from the client and reimburse trade sub-contractors.</td>
</tr>
<tr>
<td>Advice on design and specification practicality</td>
<td>Assist in cost monitoring and control.</td>
</tr>
<tr>
<td>Agree with the client on the construction method</td>
<td>Ensure project completion on time.</td>
</tr>
<tr>
<td>Breakdown of the project work into packages and identification of potential tenderers</td>
<td>Ensure that all work is completed to the specified standards.</td>
</tr>
<tr>
<td>Tendering and selection of trade contractors who should carry out the construction work of the project</td>
<td>Single point of responsibility for project documentation and construction work liability.</td>
</tr>
</tbody>
</table>
Management contracting agreements normally provide the client with the option to abort the services after the design stage, in which case the contractor is paid the agreed fee, or to continue with the construction phase, in which case the management contractor becomes liable for completing the project on the agreed date (Masterman, 2002).

Management contracting allows the expedition of project delivery, as the client divides the project into packages and starts the procurement of some packages before completing the overall design of the work (Morledge et al., 2006). However, all construction work should be carried out by sub-contracting these construction packages to trade sub-contractors that are not related to the management contractor, thus avoiding conflicts of interest between the client and the managing contractor. Furthermore, all trade sub-contractors are jointly evaluated and selected by the client, the consultants, and the management contractor. It is worth noting that the management contractor bears the full responsibility if he appoints the work package sub-contracts directly (Gan, 2011). Figure 2.12 shows the organisational structure of management contracting. The diagram shows that the client does not have a direct contractual relationship with the package contractors; instead, the client’s contractual relationship is with the management contractor. Although the management contractor is providing consultancy services to the client, another consultant is still appointed by the client to manage the functional relationship between the client and the management contractor.

![Diagram showing parties' relationships in management contracting procurement](image_url)
2.4.13 Construction Management
The construction management procurement system is generally similar to management contracting, except that the trade contractors are appointed by the client directly, so the construction management contractor does not enter into a contractual relationship with these contractors. The construction management contractor acts as a consultant, coordinating and supervising all clients’ contacts and providing advice to the client on cost control, construction planning, and operational work (Walker and Rowlinson, 2008).

In construction management procurement systems, the client can involve multidisciplinary contractors, which impose additional management and administration activities. However, splitting the project work into small packages increases competition and the project becomes more manageable (Masterman, 2002). Figure 2.13 shows the project network and the relationship between parties in the construction management procurement system. Unlike contracting management, the client has a direct contractual relationship with the trade contractors and the construction manager provides only consultancy services to the client, without having a contractual relationship with the trade contractors.

![Figure 2.13 Parties’ relationships in construction management procurement](image)

2.4.14 Design and Manage
In design and manage procurement, one organisation is appointed for both design and construction, and the client has contact only with this organisation. The client can appoint either a consultant or a contractor to provide consultancy
and management services, and package contractors carry out the actual construction work. These package contractors enter into a direct contract with the client in cases where a consultant is providing the design and management (consultant-led), and are sub-contractors when a contractor (contractor-led) is in the design and management position (Masterman, 2002). Figures 2.14 and 2.15 illustrate the relationship between parties in consultant-led and contractor-led design and manage procurement systems respectively.

**Figure 2.14 Parties’ relationships in design and manage (contractor-led)**

**Figure 2.15 Parties’ relationships in design and manage (consultant-led)**
Advantages and Disadvantages of Management-oriented Procurement Systems

The main advantages of the management-oriented procurement system include:

- Overlap of design and construction enables a shorter project development period and improves management efficiency (Morledge et al., 2006; Cooke and Williams, 2009; Lupton et al., 2012). Site work commencement is made possible by splitting the project into packages.

- Work packaging allows better price competition (Morledge et al., 2006).

- Involvement of the management contractor in the early stages of the project ensures buildability and improves the quality and time of the project (Lupton et al., 2012). The client utilises the contractor’s construction experience and skills to avoid construction issues and better project management is allowed by the fact that two firms of the same character are involved in the procurement process: the management contractor and the construction contractor.

In contrast, management-oriented procurement is associated with the following disadvantages:

- The project will not be completed unless the client provides clear requirements and brief (Morledge et al., 2006).

- No price certainty until all work packages are awarded to trade contractors (Morledge et al., 2006; Cooke and Williams, 2009).

- Changes in one package may affect other work packages, which leads to excessive cost increases and delays (Cooke and Williams, 2009).

Overall, the accuracy of clients’ requirements appears to be a crucial aspect in all the discussed procurement systems. The argument for the advantages of the private sector enabling the achievement of better performance does not seem to be practical without high client team capabilities.

Public Private Partnership (PPP) Procurement System

Based on Grimsey and Lewis (2005), the term “PPP”:

“can cover a variety of transactions where the private sector is given the right to operate, for an extended period, a service traditionally the
responsibility of the public sector alone, ranging from relatively short term management contracts (with little or no capital expenditure), through concession contracts (which may encompass the design and build of substantial capital assets along with the provision of a range of services and the financing of the entire construction and operation), to joint ventures where there is a sharing of ownership between the public and private sectors.”

In the last three decades, the PPP procurement method has been used to develop facilities by transferring financing, design, construction and operation to the private sector for a long-term concession (Robinson and Scott, 2009). Public clients consider PPP a good chance for utilising the private sector’s funding in the development of public services (Akintoye et al., 2003). Thus, the PPP procurement system mainly focuses on utilising private finance rather than public funds in delivering services. In recent years, the public sector has selected public private partnerships (PPP) for delivering infrastructure projects such as power generation, water supply, wastewater treatment, hospitals, and schools. It is claimed that PPP provides a number of benefits to the public sector by transferring risk to the private sector and securing value for money. Generally, the PPP agreement gives great attention to the performance level, where the private investor is paid for the service delivered, with limited risk to the public sector (Grimsey and Lewis, 2005).

2.4.16.1 PPP Procurement Process
Public private procurement goes through several stages, as illustrated in Figure 2.16. The pre-award process is very complicated and incurs the public client and interested parties high preparation and consultancy costs. According to information from HM Treasury (2012), the pre-award stage may involve six years of discussion.
There is more than one form of contractual relationship between a client and the private sector, for example, build own and operate (BOO) and build own operate and transfer (BOOT); in both examples the client or the end users pay the private sector service charges periodically to cover the cost of procuring and operating the facilities. With the BOOT procurement option, the facilities are transferred to the client by the end of the concession period, and in the case of the BOO option, the private sector is required to remove the facilities by the end of the concession period and keep the site in an acceptable condition (Walker and Rowlinson, 2008). The contractual duration (concession period) normally ranges between 20 and 30 years; however, the client may specify a concession beyond this range. During the period between tendering and the end of the concession period, various parties may get involved at various times. Figure 2.17 provides a simple representation of parties that could be involved in the PPP procurement system. Either directly or indirectly, parties that get involved
in PPP procurement cover multidisciplinary specialisations, for example technical and non-technical consultants, such as legal and financial. Other parties include debt providers, construction contractors and operation contractors.

According to the studies of Akintoye et al. (2003) and Robinson and Scott (2009), many public clients are on the learning curve and should acquire sufficient skills and knowledge to achieve value for money. Furthermore, all stakeholders believe that PPP could be further improved by a better understanding of risk allocation, standardisation and skill development (Akintoye et al., 2003; Robinson and Scott, 2009). Carrillo et al. (2008) highlighted several issues that need to be addressed by both public clients and the private sector:

- High bidding costs.
- Lengthy process.
- Lack of knowledge and experience in the public sector.
- Exploring previous projects’ lessons.
- Lack of knowledge transfer between projects.
- Assurance that PPP delivers value for money and creates innovation.

### 2.4.16.2 Advantages and Disadvantages of PPP

The main advantages of public private partnerships are as follows:

- Transfer of risk to the private sector (Grimsey and Lewis, 2005), which is an element frequently put forward in favour of PPP procurement.
- It solves the problem of public sector budget constraints. The public sector can overcome budget limitations by financing the project through the SPV. Then the SPV is refunded by the client or customers based on service utilisation over a long period of time.
- Provides better lifecycle cost certainty. All payable fees are well known when making the services agreement.
- The client organisation avoids construction issues and gives greater attention to the performance of services provided by the SPV.

The disadvantages of adopting public-private partnerships include:

- A great deal of management time needed for contract transaction, which involves high participation costs.
- Lengthy delays in negotiations.
- Value for money cannot be assessed due to lack of information about different phases of the procurement lifecycle (Walls et al., 2006).
- They are too complex, and costly, for many small projects (Grimsey and Lewis, 2005).

Clients’ skills and knowledge persist as the cornerstones not only of better performance, but also of a better understanding of the PPP procurement system. Therefore, the client should not be put aside when targeting performance improvement in construction projects. Understanding key areas in public procurement could help clients to direct attention to these areas when thinking about building their knowledge and skills.
2.5 Design Stage
Design is a process of balancing needs and functional requirements against various constraints, whether technological, functional, operational or economic (Pahl and Beitz, 1996; Voland, 1999). Thus, project design aims to produce economically useful information by efficiently generating a complete tender document for the construction stage, or a detailed design and construction in the case of the design-build procurement system. According to Chua et al. (2003), efficient management of the project’s design is critical to the time, cost and quality of the entire project.

Whatever the selected procurement system, the design stage is the foundation of all subsequent stages. This stage of the project creates the basic information for the foundation of a successful relationship between the client and the construction industry (Yu and Shen, 2013). The innovation and accuracy of the output of this stage greatly influence the competitiveness of the construction package proposals (Salter and Gann, 2003). Therefore, efficiency in handling project design in construction can enhance projects’ outcomes. Achieving this objective, according to Turner (2002) and Walker and Rowlinson (2008), requires a good understanding between the public client and consultancy firms. While the output of this stage creates the foundation for the construction phase, clear client requirements, objectives, and the scope of consultancy services are the basis for efficient design. Furthermore, the client must ensure the consultancy deliverables satisfy the functional and qualitative objectives before obtaining and awarding the construction package. Clients’ failure to review and clarify the design deliverables may lead to expensive changes during the construction phase (Masterman, 2002).

The RIBA plan of work (2013) breaks down the design stage of construction projects into three phases: concept design, schematic design, and technical design. As can be seen from Table 2.7, the concept design phase forms the skeleton, while the next phases continue to build on this phase over the design lifecycle. For example, the client’s decision about operation maintenance may be a huge scope for the consultant in the case of the PPP procurement system, while it is a minor scope for the consultant in the case of the design bid build procurement system. Another point to be clarified is that in design-build
procurement, the three phases’ activities might be separated between the client and the contractor. In fact, the contractor might only be assigned the detailed design, while the other two phases are completed by the client before requesting design-build bids from potential construction bidders.

Table 2.7 Key design phases and main activities

<table>
<thead>
<tr>
<th>Concept design</th>
<th>Developed design</th>
<th>Technical design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outline proposals for facilities design, structural design and specifications</td>
<td>Update facilitates design, structural design and specification proposals</td>
<td>Prepare detail technical design and specifications</td>
</tr>
<tr>
<td>Risk assessment</td>
<td>Update risk assessment</td>
<td>Update risk assessment</td>
</tr>
<tr>
<td>Operation and Maintenance strategy</td>
<td>Update Operation and Maintenance strategy</td>
<td>Update Operation and Maintenance strategy</td>
</tr>
<tr>
<td>Project Plan</td>
<td>Update project plan</td>
<td>Update project plan</td>
</tr>
<tr>
<td>Preliminary cost estimate</td>
<td>Update cost estimate</td>
<td>Update cost estimate</td>
</tr>
</tbody>
</table>

Both the ICE and RIBA guidelines stress the importance of the client’s involvement throughout the project lifecycle, and according to Stuart (1991), involvement means clients’ collaboration with experts in activities in the acquisition process, including decision making, leading best option decisions, and satisfying short- and long-term end users’ needs along with clients’ strategic objectives. In addition, innovation and problem solving in the design stage, especially at the concept and schematic design stages, greatly depend on face-to-face interaction between the project team members (Salter and Gann, 2003). Moreover, allocating appropriate time for the project team to diagnose client problems allows them to develop a well-argued and justified scope of work (Elinwa and Joshua, 2001; Molenaar and Songer, 1998; Nikolova et al., 2009; Zwikael and Sadeh, 2007). Overall, the quality of the design stage impacts on project time, cost and performance, not only in the traditional procurement system but also other procurement routes. Both the client and the consultants are main parties who are expected to ensure the quality of the design stage deliverables before moving on to the construction stage. While
the consultants hold the responsibility for developing the project design, the client plays a critical role in defining the project’s requirements, defining the scope of consultancy, selecting competent consultants and ensuring the quality of the design deliverables. The RIBA plan of work identifies five general design deliverables: detailed technical design and specifications, an updated risk assessment, an updated operation and maintenance strategy, an updated project plan and an updated cost estimate. Therefore, recognising and studying which of these success elements affects project performance will support better utilisation of client resources and more importantly direct client focus to the design activities that contribute most to construction success and performance improvement.

2.5.1 Scope of Consultancy Services and Deliverables

Identifying the need for external parties’ advice services is one of the primary client tasks in the planning stage of a construction project. Good decisions by the client team about both the scope and selection of the consultants can lead to good project performance, and poor decisions to poor performance (Soriano, 2001; West, 1997).

Consulting services are most generally contracted to organisations that have professional personnel and experts who can help the client identify problems, analyse these problems, develop solutions to them and in some cases help in the execution of the proposed solutions. Within the public sector, consultants can provide consulting advice concerning training, the provision of public services, overall project planning, environmental studies, engineering, communication with stakeholders, construction supervision, and other services when requested to do so by the client (Schiele and McCue, 2006). In other words, consultancy services are not limited to just technical aspects of projects, but can also cover other, non-technical services such as obtaining permit approval and handling communication with other stakeholders.

The involvement of experienced stakeholder personnel in the design stage can ensure that construction factors are considered in such a way as to achieve the overall project’s objectives (Song et al., 2009). Thus, the design stage must cover all activities that enable the client to generate the information of the
greatest value and produce economically useful information for the construction stage (Reinertsen, 1997). For project objectives to be achieved, the tender document, including drawings and specifications, should provide the contractor with clearly defined information for estimating the project’s cost and planning the resource needs of construction (Chan and Kumaraswamy, 1997). Here, a review of these documents by the client team to ensure their accuracy may be very important and significantly improve construction performance. Thus, recognising the other activities linked to the accuracy of the tender document will help the client to give more attention to activities that could significantly improve construction performance.

2.5.2 Design Parties
The parties in the project design vary based on the procurement system selected by the client at the planning stage. For example, if the separated procurement system is selected, the client directly appoints the design firm, and then the client team and the design firm team work together in developing the project design within the brief developed by the client at the planning stage. Another option is integrating design and build under one contract, where design development is shifted to the contractor, who then goes on to complete the design internally using its capabilities or outsources it to a third party.

The structure of the design team has evolved with the various changes in the procurement systems and contractors are no longer left just to carry out construction activities. Instead, they are frequently involved in the early design stages, which enables them to build a good understanding of the design as it develops (RIBA, 2013). The early involvement of contractors in the planning and design stages offers the client the opportunity to get their feedback about possible risks that might affect project performance. In all cases, establishing good communication between parties is a critical element of ensuring quality design deliverables. Poor communication between the parties leads to deficiencies in the development of the design (Elliman and Orange, 2003).

Studies and guidelines have stressed the importance of communication to the procurement success. ICE, in the Client Best Practice Guide, for example, ranked communication as the second most important role the client should play
in construction procurement (ICE, 2009). Similarly, RIBA (2013), in the Guide to Using the RIBA Plan of Work 2013, specified client involvement as a very crucial element in the development of any construction project. These two guides indicate that better integration of the design team increases the possibility of good design performance.

The effectiveness of design team integration depends on several attributes, namely: value identification, project delivery framework, the planning of delivery process knowledge and skills and local context (Jørgensen and Emmitt, 2009). According to Sturdy et al. (2009) consultants’ members have shown to have the expertise that could help the client; however, client team members are frequently seen to lack skills and knowledge. Therefore, client involvement in construction design activities requires the development of a high level of skill and knowledge (Schiele and McCue, 2006). This raises two important aspects: first, the need for client involvement and second, the gap in knowledge and skills between the consultants and the client team. These two aspects give an indication of the possible relationship between the efficiency of the client’s involvement and the development of the client’s knowledge and skills. Further investigation of this relationship and identification of its positive effect on project performance could guide clients to acquire the competencies that enable their teams to have meaningful involvement in the design stage.

2.6 Construction Stage
The construction stage is when the client’s contractor starts transferring sketches and specifications to a physical product on the project’s site. Based on the RIBA Plan of Work, this stage of a construction project consists of two main activities, off-site manufacturing and on-site construction (RIBA, 2013). Both activities involve extensive coordination and management, which are mainly handled by the main contractor. Therefore, the client is required to have an appropriate understanding of specific complexity of the project and take these aspects into consideration when defining the contractor selection criteria. During the course of the project’s construction stage, the contractor focuses mainly on managing project cost, time and internal organisational performance. Depending on the project’s complexity and the main contractor’s capabilities,
other parties such as sub-contractors or suppliers may get involved in the project. Again referring back to the client procurement strategy, the appointment of these sub-contractors and suppliers may be left as part of the construction contractor’s responsibilities or they may be appointed by the client and then assigned to the main contractor to manage. In general, more parties get involved in the project during the construction stage and the project organisation structure, as shown in Figure 2.18, gets more complex. Unlike design stage relationships, the client gets less involved during the construction stage and interaction is mainly between the client’s consultants and the project contractors.

![Diagram of contractual and functional relationships](image)

**Figure 2.18 Construction stage: contractual and functional relationships**

The recognition of the interdependence of all parties, shown in Figure 2.18, in a procurement network appears to be an important aspect of effective integration. Thus, the integration of these parties and the improvement of relationships are critical to addressing the perceived problems of the sectors that are underperforming, inefficient, and wasteful (Assaf et al., 1995; London and Kenley, 2001). Although there might not be a direct operational dependence between parties, the failure of one party can affect the whole project’s performance. Accordingly, attention needs to be paid to all of the procurement activities that feed into project delivery at the site (Bankvall et al., 2010; Walker,
The RIBA Plan of Work stresses the critical role of regular site inspection and reviews of work progress (RIBA, 2013). Taking into account the various parties’ and their respective logic may help to advance the understanding of how the performance can be enhanced by balancing the different logics (Bygballe and Jahre, 2009).

Overall client involvement during the construction stage is not well established, and more focus is directed toward other parties. Clients’ ability to work within the project team could help them to better understand issues and work collaboratively with the other stakeholders to have a better understanding and take the right decisions. Furthermore, the higher involvement of the client allows its team members to recognise practical issues and participate efficiently in developing solutions that serve long-term national interest as well as the immediate project benefits.

### 2.7 Facility Management
Moore and Finch (2004) defined FM as a professional discipline that involves "the development, coordination, and management of all of the non-core specialist services of an organisation, together with the buildings and their systems, plant, IT equipment, fittings and furnishings, with the overall aim of assisting any given Organisation in achieving its strategic objectives".

According to Barrett and Baldry (2009), the future of facility management lies in two main areas:

- Organisations’ integrated role is directed toward management matters rather than technical issues.
- Facility management services are oriented toward making a positive contribution to the core business.

Generally, facilities management tasks commence immediately after the handing over of the facilities and operations takes place, and continue throughout the project lifecycle. The role of the client in traditional working practices is to ensure the facilities meet its strategic business goals and objectives (Jensen, 2009; Mohammed and Hassanain, 2010). However, in order for constructed facilities to meet the set goals and objectives, Vanlande et al. (2008) emphasise that a successful client organisation needs a range of
skills to be able to develop innovative operation and maintenance strategies. Still, client organisation requires tools to organise the knowledge and information generated throughout the entire operation stage. According to Barrett and Baldry (2009), facility management continues to expand in terms of volume and multiplicity, and the construction industry still faces a significant deficiency of knowledge.

There is a growing realisation of the need to consider operational aspects in the early design process; however, this is not fully executed in actual practice except in PPP projects (Jensen, 2009). The involvement of facility managers in the early stages of a project provides the project team with the special needs that have been accumulated from daily contact with end users and the operation of the existing facilities. Therefore, the involvement of the facility management team is a valuable aid to proper requirement identification, execution and facilities’ performance (Jensen, 2009). Furthermore, Mohammed and Hassanain (2010) argue that the involvement of the facilities management team in the early stages has the potential to reduce maintainability problems and the operation costs of the facility.

The interrelation between construction project stages stresses the importance of integrating the teams involved in the three stages (design, construction and facility) from the early stages of the procurement lifecycle. As shown in Figure 2.19, the FM stage can provide useful feedback about learning from the operation stage (Kamara, 2012). The figure shows the interrelation between the project initiation stage and the other two stages (the design and construction stage and the facility management stage). Furthermore, the role of the client organisation mainly focuses on the initiation and facility management stages. This does not necessarily mean the client performs all its activities in isolation from other parties. For example, the general concept of the role of the client organisation is that management matters predominate over technical issues when developing a facility management strategy. Therefore, technical issues within facility management could be outsourced to other parties and the client organisation retain management matters. In contrast, the AEC industry holds the primary role at the design and management stages.
Each stage of the procurement lifecycle involves a great deal of information being exchanged among various participants. These participants are involved only at either the planning, development, and implementation stages or the operation, maintenance, and decommissioning stages. The way in which information and knowledge is assembled and used is a very important aspect of controlling procurement outcomes, e.g. by providing feedback on lessons learned for new developments. Figure 2.20 shows the verification and validation checking at various stages of the procurement lifecycle. Good management of information and knowledge at the operation, maintenance and decommission stages can provide the decision makers with on-going feedback on facilities performance and highlights areas for future improvement.

Therefore, ensuring full records of the procurement lifecycle is an activity client organisations should consider at the stage of project initiation. However, the core driver of performance is the involvement of team members from both the client and contractors, acknowledging the relationship between different stages of the project lifecycle and overall performance (Kershaw and Hutchison, 2009).

These authors further clarified that there is no point in developing systems unless the team members understand the importance of procurement lifecycle information to procurement performance. Therefore, building team members’ capabilities and interest is a prerequisite element for the successful implementation of a system or a process.
2.8 Chapter Summary
In this chapter, the procurement lifecycle’s main stages and the role of the client have been discussed. The literature review revealed that the procurement stages are interrelated and interdependent. The client organisation gets involved to a different extent at each stage of the procurement activities chain. The activities of the procurement initiation and development of the procurement strategy belong solely to the client organisation. Other activities, mainly design, construction and technical matters of facility management, are often candidates for outsourcing to other parties. However, client involvement after the appointment of the consultants, and more particularly the contractor, is not well established. This is because the client is seen to lack the knowledge and skills that can add value. Therefore, the client organisation is required to build appropriate capabilities to satisfy its roles throughout the procurement lifecycle. Furthermore, the review has shown that facility management has a better understanding of post-occupancy performance because of their daily involvement in the operation and maintenance stage. The involvement of
facility management at the early stages of procurement is critical for incorporating new learning and mitigating operational issues.

Overall, the client organisation is the hub of the construction delivery process and client decisions on project strategy determine procurement performance. At the same time, the development of an effective procurement strategy requires a good understanding of the relationship between the procurement lifecycle activities. Different models have been developed explaining each stage’s activities; however, building the client team’s capabilities is a challenging task that is necessary for the successful implementation of these models. The theoretical models will remain useless without building the appropriate capabilities to transfer these models to practice. The review highlights important questions about client involvement throughout the procurement lifecycle. Answering these questions will provide a better understanding of the most important client activities in the procurement process and inform decision makers about further actions for the improvement of construction procurement.
3 CHAPTER THREE: CLIENT ORGANISATIONAL SUCCESS ACTIVITIES

3.1 Introduction
There are day-to-day elements which must be carried out by the client organisation to enhance the performance of a project over its lifecycle. The capture and integration of these activities by the client organisation, along with other procurement activities, do not only increase the chances of success in the project, but also allow the client organisation to establish a basis for sustainable procurement approaches.

Various performance parameters have been addressed over time and similarly, more than one factor has been argued to influence procurement performance. This chapter will look into the parameters consistently addressed as critical for the success of construction projects. Then it will cover those success factors that have been argued to influence construction procurement, and more importantly identify the practical ways of integrating these elements within procurement systems. This approach has been deployed in other sectors, such as automotive. Thus, the possibilities of learning from other sectors must not be ignored when looking for ways of improving construction procurement. This led to the review of the automotive and aerospace industries and a discussion of possible learning for public construction clients.

3.2 Procurement Performance

3.2.1 Performance Parameters
Clients are now facing more complications in identifying the performance of procurement systems such as public-private partnerships with the limited amount of information they get from the construction and operation phase. A good number of researchers have investigated procurement performance; examples of these studies are covered in Table 3.1. The general observation is that most of these studies do not consider lifecycle performance. For example, when comparing the performance of the traditional procurement system with PPP procurement, procurement performance measurement focuses on the cost and time certainty of the construction phase of the project. This might be justifiable, because construction time and cost changes are facts, while
obtaining the lifecycle cost might be very complicated and time-consuming. Another important point is that the parameters focus on the project performance, which might not be the first priority of all parties, especially the contractors.

Projects’ clients and contractors could have diverse perspectives about project success; for example, the client gives higher attention to satisfying stakeholders’ needs, while the contractors’ emphasis is on reducing construction cost and duration (Bryde and Robinson, 2005). Failure to agree success criteria between the client and the contractor leads to project failure and adversely affects the parties’ relationship. In contrast, construction projects involve a high degree of interdependence between the client and the contractor. Therefore, a better understanding of each other’s perspectives is important when identifying project success, and even when time and cost are used to measure project success, assessment criteria should be agreed by both parties.

The literature review, as shown in Table 3.1, reveals that cost, time and quality have been known for a long time as the main construction performance parameters. To a lesser extent, other performance parameters such as safety and stakeholders’ satisfaction have been highlighted in the literature. This research focuses on procurement-related parameters, which mainly cover time, cost, and quality or performance. Delays and cost overruns were used to measure deviation from the initial agreed time and cost, while project quality is benchmarked with the specifications set by the client in the construction tender document; changes in quality requirements can affect project time and cost, thus leading to either delays or cost overruns, or even both of them.

Table 3.1 Procurement performance measurement parameters

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameter</th>
<th>Author</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Cost</td>
<td>(Chao and Hsiao, 2012); (Chan and Chan, 2004); (Cox et al., 2003); (Lauras et al., 2010); (Hughes et al., 2004); (Atkinson, 1999); (Lam et al., 2008); (Chan et al., 2002); (Ng and Cheung, 2007); (Bryde and Robinson, 2005); (Cooper and Kagioglou, 1998)</td>
</tr>
<tr>
<td>2</td>
<td>Time</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Quality/performance</td>
<td>(Chao and Hsiao, 2012); (Chan and Chan, 2004); (Cox et al., 2003); (Cox et al., 2003)</td>
</tr>
<tr>
<td>4</td>
<td>Safety</td>
<td>(Chao and Hsiao, 2012); (Chan and Chan, 2004); (Cox et al., 2003)</td>
</tr>
<tr>
<td>5</td>
<td>Stakeholders’ satisfaction</td>
<td>(Chao and Hsiao, 2012); (Chan and Chan, 2004)</td>
</tr>
</tbody>
</table>
3.2.2 Performance Situation

Construction projects have noticed some performance improvement, but it has not been continuous (Smyth, 2010). Even though some studies have claimed that PPP procurement is showing better performance, Hughes (2003) and Raisbeck et al. (2010) have argued that no data is available to evaluate the performance of PPP procurement, and public clients still need to develop an appropriate database to inform future decisions. Therefore, the adoption of any particular procurement route does not mean better performance (Hughes, 2003). Furthermore, focus on short-term relationships and gains in both the public and private sectors inhibit the development of procurement performances over time (Eriksson, 2008).

Clients have been consistently addressed as one of the main constraints to performance improvement, because they cause projects delays and they lack knowledge and experience in handling construction projects. Other problems associated with client organisations include:

- The client places a greater emphasis on cost rather than value (Smyth, 2010).
- Knowledge transfer does not take place from one project to another (Smyth, 2010).
- The client may issue change orders during the construction phase (Al-Momani, 2000; Assaf and Al-Hejji, 2006; Alnuaimi et al., 2010).
- The client lacks knowledge and skills (Asenova et al., 2002; Toor and Ogunlana, 2008; Onosakponome et al., 2011).
- The client lacks data from previous projects to facilitate future decision making (Akintoye et al., 2003; Raisbeck et al., 2010). Based on Kashiwagi and Byfield (2002), any event can be predicted, and better performance could be achieved if the client had more information.
- Lack of communication between the client and other parties (Sambasivan and Soon, 2007; Mahamid et al., 2012).
- Incomplete contract documents and lack of decision from the client (Love et al., 2012; Mahamid et al., 2012).
- Inappropriate risk management (Ball et al., 2003; Heald, 2003).
- The client does not conduct a post-project review to address learning lessons for future decisions (Williams, 2004).

The above issues continued to appear for a long time, and a number of institutes and organisations have attempted to help the construction sector by developing guidelines for the development of construction projects. However, construction procurement has not managed to establish a sustainable procurement strategy. More specifically, public clients lag behind the private sector in developing the appropriate competencies (Akintoye et al., 2003).

Public clients are expected to achieve the best value in public construction by having the competency to implement proactive approaches (Akintoye et al., 2003). The development of client competencies is not limited to the procurement activities discussed in Chapter 2, but also includes other elements influencing construction procurement performance. Achieving this goal requires revisiting the procurement and delivery management system through the adoption of systematic and purposeful strategic approaches (Watermeyer, 2012a). The client’s purposeful strategic approaches or practices must emphasise more long-term objectives, such as learning for future projects and establishing a collaborative working environment. However, the client initially needs to have a better understanding of key aspects which, when efficiently carried out by the client, can lead to significant performance improvement.

3.2.3 Success Factors
Various views of defining success factors exist. Rowlinson and McDermott (1999) defined success factors as those day-to-day elements which must be carried out to maintain efficient and effective teamwork when developing a construction project. Therefore, successful completion of a construction project is a result of collective effort and interaction between the client team and other parties, such as consultants and contractors. On the other hand, Chan and Chan (2004) define success as “the set of principles or standards by which favourable outcomes can be completed within set targets”.

72
This chapter covers those success elements that are linked to the client organisation in general and more specifically to repeated construction clients. Table 3.2 provides a list of typical client-related success factors addressed in literature and argued to result in better construction procurement performance.

Table 3.2: Client success elements in construction procurement

<table>
<thead>
<tr>
<th>No.</th>
<th>Factor</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge management</td>
<td>Cooke-Davies, 2002; Akintoye et al., 2003; Shokri-Ghasabeh and Kavousi-Chabok, 2009; Scott-Young and Samson, 2008; Abraham and Chinowsky, 2003; Chan et al., 2004; Schindler and Eppler, 2003; Wong et al., 2009; Luu et al., 2008; Lam et al., 2008; Atkinson and Fulton, 2013; Yu et al., 2006; Schindler and Eppler, 2003; Ogden et al., 2007; Greiner and Ennsfellner, 2010</td>
</tr>
<tr>
<td>2</td>
<td>Innovation</td>
<td>Foray et al., 2012; Sofka and Aschhoff, 2009; Lam et al., 2008</td>
</tr>
<tr>
<td>3</td>
<td>Learning from past experience</td>
<td>Yu et al., 2006; Schindler and Eppler, 2003; Luu et al., 2008; Scott-Young and Samson, 2008</td>
</tr>
<tr>
<td>4</td>
<td>Information, communication and technology</td>
<td>Inayat et al., 2012; Akintoye et al., 2003; Zwikael and Globerson, 2006; Yu et al., 2006.</td>
</tr>
<tr>
<td>5</td>
<td>Performance evaluation</td>
<td>Cooke-Davies, 2002; Korde et al., 2005; Kenny, 2012; Gonzalez et al., 2008; Shokri-Ghasabeh and Kavousi-Chabok, 2009; Abraham and Chinowsky, 2003; Toor and Ogunlana, 2009; Porskrog, 2008; Leu and Lin, 2008</td>
</tr>
<tr>
<td>6</td>
<td>Process management</td>
<td>Cooke-Davies, 2002; Zwikael and Globerson, 2006; Chan et al., 2004; Toor and Ogunlana, 2009</td>
</tr>
<tr>
<td>7</td>
<td>Standardisation</td>
<td>Milosevic and Patanakul, 2005; Akintoye et al., 2003</td>
</tr>
<tr>
<td>8</td>
<td>Permits</td>
<td>Inayat et al., 2012</td>
</tr>
<tr>
<td>9</td>
<td>Top management support</td>
<td>Shokri-Ghasabeh and Kavousi-Chabok, 2009; Nguyen et al., 2004; Lam et al., 2008; Scott-Young and Samson, 2008; Ogden et al., 2007</td>
</tr>
<tr>
<td>10</td>
<td>SME support</td>
<td>Akintoye et al., 2003</td>
</tr>
<tr>
<td>11</td>
<td>Finance management</td>
<td>Inayat et al., 2012; Porskrog, 2008; Nguyen et al., 2004; Porskrog, 2008</td>
</tr>
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</table>
Table 3.3: Client success elements in construction procurement

<table>
<thead>
<tr>
<th>No.</th>
<th>Factor</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Procurement planning</td>
<td>(Akintoye et al., 2003); (Shokri-Ghasabeh and Kavousi-Chabok, 2009); (Chao and Hsiao, 2012); (Scott-Young and Samson, 2008); (Zwikael and Globerson, 2006); (Yu et al., 2006)</td>
</tr>
<tr>
<td>2</td>
<td>Procurement method</td>
<td>(Chao and Hsiao, 2012)</td>
</tr>
<tr>
<td>3</td>
<td>Organisation responsibilities</td>
<td>(Cooke-Davies, 2002)</td>
</tr>
<tr>
<td>4</td>
<td>Building project team</td>
<td>(Shokri-Ghasabeh and Kavousi-Chabok, 2009); (Scott-Young and Samson, 2008); (Abraham and Chinowsky, 2003); (Phua and Rowlinson, 2004); (Yu et al., 2006); (Toor and Ogunlana, 2009); (Nguyen et al., 2004); (Porskrog, 2008); (Pesämaa et al., 2009) (Cheng, 2003)</td>
</tr>
<tr>
<td>5</td>
<td>Clear and precise briefing documents</td>
<td>(Chan et al., 2004); (Yu et al., 2006); (Toor and Ogunlana, 2009); (Porskrog, 2008)</td>
</tr>
<tr>
<td>6</td>
<td>Contractor and consultant selection</td>
<td>(Chao and Hsiao, 2012); (Akintoye et al., 2003); (Chan et al., 2004); (Toor and Ogunlana, 2009)</td>
</tr>
<tr>
<td>7</td>
<td>Risk Management</td>
<td>(Shokri-Ghasabeh and Kavousi-Chabok, 2009); (Scott-Young and Samson, 2008)</td>
</tr>
<tr>
<td>9</td>
<td>Stakeholders involvement</td>
<td>(Yu et al., 2006); (Toor and Ogunlana, 2009)</td>
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While factors highlighted in Table 3.3 were covered in Chapter 2, the following sections of this chapter will look into elements included in Table 3.2, so investigation of the relationships between various client activities and success elements allow the establishment of the important client success components. Then a further investigation of the relationships between client success components and construction delays and cost overruns will identify the set of activities using which clients can attain significant performance improvement. The listed elements will be presented into five sections: knowledge management (section 3.3) will cover the first three elements, then section 3.4 will cover information, communication and technology, subsequently quality management (section 3.5) will discuss elements between 5 and 9, and finally section 3.6 will cover small and medium enterprise related elements followed by financial managements related elements in section 3.7.
3.3 Knowledge Development

3.3.1 Knowledge Management
The Oxford dictionary defines knowledge as the “facts, information, and skills acquired by a person through experience or education; the theoretical or practical understanding of a subject” (Oxford Encyclopedic English Dictionary, 2003). So knowledge is mostly associated with individual information and skills. Another key point that can be noticed is that knowledge can be acquired through two main streams: education, which is the theoretical stream, and experience, gained from practice.

Discussion in Chapter 2 and Section 3.2.2 indicates a lack of knowledge and skills within client organisations as one of the key issues in construction procurement. As can be seen from Table 3.2, various studies have stressed the importance of knowledge development as a key success factor in construction procurement. These studies indicate that client organisations need to develop their working practices to accumulate knowledge and consider it a very valuable asset alongside the physical deliverables of the project. Effective integration of previous construction learning in the development of new projects establishes the habit of continuous knowledge development. In contrast, lack of knowledge management in the construction industry could significantly hinder continuous improvement (Carrillo et al., 2013; Forcada et al., 2013; Kasvi et al., 2003).

The practice in construction procurement involves individuals from different disciplines interacting with each other, and the project can be moved forward by combining their knowledge in the delivery activities. Considering the long-term vision, improvement in the procurement performance of construction projects depends on individuals’ knowledge, developed over time. Thus, continuous learning and knowledge development become essential for enhancing the delivery process of construction facilities. The collective knowledge and experience of the construction industry’s technical and non-technical professionals are key attributes in the successful delivery of any construction procurement (Wall and Ahmed, 2008). In addition, knowledge sharing within the organisation’s team and across organisations helps in addressing the
sector’s challenges and developing innovative approaches to overcoming difficult problems.

The organisation’s structure should encourage knowledge sharing, because the integration of knowledge sharing within the organisational working team generates benefits to the organisation (Linderman et al., 2010; Peng, 2013; Ratcheva, 2009). Therefore, the effects of knowledge development in the client organisation cannot be ignored when thinking about better performance in construction procurement. Simultaneously, the absorption capacity of an organisation depends on its ability to acquire, incorporate, transform and apply knowledge to navigate challenging tasks (Phelps et al., 2007; Ruikar et al., 2009). In addition, levels of interaction, individual benefits, organisational support, and degrees of courage dramatically influence knowledge development (Amayah, 2013).

In summary, individuals can gain new knowledge through continued learning and interaction with other parties. Additionally, knowledge is spread among a wide range of organisations and what matters is the collective knowledge of these organisations and individual knowledge within these organisations. The evolvement of multidisciplinary parties within each project provides the public client team with access to a wide range of knowledge which might not be available to any other party. In addition to learning from practice, theoretical training allows the client team to clarify and have better understanding about new ways of doing things better. Also, using new ways of doing things could add to the knowledge of the client team. In other words, knowledge development can be achieved when the individual acquires and applies knowledge collaboratively to resolve challenging tasks. The following subsections provide more information on continuous learning and the adoption of new working ways (innovation).

3.3.2 Learning from Experience
The continuous changes in the construction industry require parallel knowledge development of the client’s human resources throughout all levels of the organisation. Therefore, it is vital for construction client organisations to emerge into a continuous learning process where knowledge enhancement and
improvement become core elements in its operations (Bessant et al., 2003; Chinowsky et al., 2007). The client can learn from experience in two ways: getting involved in the project during the procurement lifecycle and knowledge sharing between participants.

Integrating learning as part of performance evaluation is one way that enables the client team to acquire new knowledge. The performance evaluation model in Figure 3.1 illustrates the track of the construction project development phases and the performance evaluation gates throughout the procurement lifecycle. The model, when practised by client organisations, might enable client teams to acquire knowledge about various stages of construction procurement and subsequently affect the project’s outcomes. Additionally, the client team will get the opportunity of interacting with different stakeholders in each of the project’s stages. Furthermore, difficulties in projects generally become apparent during the performance review and debate about alternative solutions can be a valuable source of knowledge for client teams. However, according to Siva and London (2011), enabling the learning of new skills and overcoming difficulties is dependent on the level of collaboration between the involved parties.

A study by Arlbjørn and Freytag (2012) concluded that wider collaboration between the private and public sectors may increase knowledge sharing between the two sectors. Passing on experience among project team members is an important way of learning, but according to Schindler and Eppler (2003), client organisations lack a systematic approach to gathering learning from different construction projects and integrating it into their knowledge. An individual working in a project keeps their knowledge with them and seldom transfers their knowledge to other members within their organisation; hence the debriefing process within the client organisation requires significant improvement. Maqsood et al. (2006) argued that deficiency in learning from project histories is a result of lack management support and lack of integrating learning history into organisations’ operations.

Overall, human resources advancement and continuous learning are crucial elements in the manufacturing sector, and adopting a similar working environment within the construction industry requires embedding these
elements within client organisations throughout every project (Chinowsky et al., 2007). Furthermore, continuous improvement depends on the ability of an organisation to build knowledge and learning alongside other activities (Bessant et al., 2003). Although the need for knowledge development is well established, ways for clients to get involved, other than performance assessment and knowledge sharing, are not clear. Therefore, the challenge for client organisations is in incorporating a continuous learning and thinking culture, learning to share new ways of doing things within their daily operations and promoting a collaborative working environment in its procurement practices.

![Figure 3.1 Learning through performance evaluation gates](image)

(Source: Schindler and Eppler, 2003)

### 3.3.3 Innovation

Many researchers have emphasised the vital role the public sector could play in stimulating innovation (Hartmann et al. 2008; Uyarra and Flanagan 2010; Rolfstam 2009; Rolfstam et al. 2011). Innovation, according to Rogers (2003: 11), is “an idea, practice, or object that is perceived as new by an individual or another unit of adoption”. So, innovation has been differentiated from doing things in a regular way and delivering the repeated service by applying new ways to deliver a better level of service. The adoption of innovation within an
organisation depends on its working context and individual interests (Rogers, 2003). According to Rolfstam et al. (2011), innovation infusion is a social process influenced by the level of interaction and learning between organisations and individuals. Therefore, building a competent organisation in a changing environment is subject to the adoption of innovation as a way of corporate life (Bessant et al., 2005; Tushman and Nadler, 1986).

Repeated public clients have a greater potential to drive innovation compared with contractors and private clients (Barbosa and Faria, 2011; Manley, 2006). In working toward innovation in the public sector, three elements (Figure 3.2) need to be considered: political leadership, community and business leadership, managerial leadership.

![Figure 3.2 Main elements to be considered for public procurement innovation](Source: Hambleton, 2012)

A politician could support innovation in public services by encouraging a collaborative working environment, managing tension within their team, and explaining the value of innovation to other stakeholders (JRF, 2012; Rolfstam, 2009). Similarly, community and business involvement should be recognised as adding value to the client team (JRF, 2012). Additionally, professional
organisations can add useful ideas to public sector construction procurement (Barbosa and Faria, 2011; Hambleton, 2012; Prajogo and Sohal, 2001).

A key outcome of research on innovation is that the public sector has great opportunities for improving construction procurement by embedding innovative thinking culture in the day-to-day working environment. However, limited attention has been directed to practicing innovative thinking in the public sector (Rolfstam, 2009) and according to Uyarra (2012) innovation in the public sector is scarce.

According to Chandy and Tellis (2000), individuals who interact with end users and the market can have a better understanding of radical innovation. Furthermore, a dynamic organisational structure in a large organisation keeps it innovative (Chandy and Tellis, 2000). This can be achieved by looking at how an organisation is functioning and then applying analytical tools as a key element in the innovation system (Coriat and Weinstein, 2002). Freeman (2002) concluded that the capacity of using information and communication technology in the 21st century and political and cultural changes are essential elements in any innovation system. Developing a specific sector’s innovation mechanisms requires further investigation by focusing on one organisation, which could go through the process, eliminating any potential problems (Barbosa and Faria, 2011). Thus, the public organisation role should focus on promoting an innovative thinking culture across different level and organisations (Uyarra and Flanagan, 2010).

Generally, interaction, communication and collaboration between stakeholders appear to be key enablers for learning from experience and innovation in construction procurement. The client team’s interaction with other stakeholders is a vital method for solving problems and acquiring new knowledge. Thus, encouraging collaboration, knowledge sharing and innovative, thinking culture are the way to encourage knowledge development in public client organisations. Furthermore, interaction between stakeholders appears to be the cornerstone of knowledge development, learning, and innovation. This suggests clients could enhance their operations throughout the procurement lifecycle if they better
understood how to get benefits from other partners by efficiently engaging and not managing them.

3.4 Information, Communication and Technology

Procurement in the construction industry heavily relies on the quality of information and efficiency in communicating this information. At the same time, construction procurement is becoming more complex due to increases in projects’ complexity, an increase in the volume of information and technology developments. With all these changes, construction clients are still working to improve information management and to acquire the tools needed to improve information communication (Grilo et al., 2010).

Recognising the challenges facing different organisations, the IT sector is working on the development of technology tools that support enterprise management and create a suitable environment for better information communication. While these efforts have resulted in good achievement in other sectors, like the financial and automotive sectors, much less development is taking place in systems that support construction procurement. For example, supply chain management and inventory management modules are well implemented in the automotive industry and an integral part of the ERP systems which are becoming an essential element in organisations’ daily operations.

The use of IT systems could facilitate information sharing and the procurement process among participants throughout the automotive supply chain. Establishing a similar working environment in the construction sector could resolve deficiencies in decision-making that result from inadequate information or communication between the client and other participants in construction procurement (Quanjel and Zeiler, 2007).

The following sections discuss information, communication and technology in the construction industry and the role of the client in facilitating the development of these procurement success attributes.

3.4.1 Information

Construction projects go through long periods where several parties are brought together by construction clients for performing various tasks. Massive amounts of information are exchanged between these parties and according to
Chassiakos and Sakellaropoulos (2008), this information constitutes a component of the performance of the development of construction projects. This information includes technical standards, product-specific data, design specifications, project management information (including construction programming, financial control, and design management documents) and guidelines at both inter- and intra-organisational levels. Generally, this information is incorporated into a single document for the contractors to use to estimate the construction costs, develop construction schedules and plan resources. Issues in the tender documents can be transposed to issues during the construction stage (Balson et al., 2012; Gransberg and Windel, 2008).

The quality of the information provided in the tender documents determines the construction time, cost and quality. According to Titus and Bröchner (2005), appropriate management of information brings in value in construction procurement. Furthermore, according to Doloi (2012), success in construction procurement highly depends on the ability of the tenderers to estimate construction cost. Meanwhile, the tenderer’s estimation is mainly calculated based on the information provided in the tender documents, which, as stated by Kumaraswamy et al. (2004) and Laryea (2011), are not always clear or adequate. They added that the poor quality of tender documents is the main cause of disruption during the construction phase and can lead to claims and disputes. Therefore, the tender documents are seen as a valuable source of information and the clarity of this information narrows the bidding differential between entrants and incumbents in construction procurement (Silva et al., 2009). Furthermore, efficient information flow minimises procurement risk and mitigates delays and disputes (Cheung et al., 2013). Therefore, it might be worth client organisations giving more attention to the quality of the information provided within the tender document, and more specifically, ensuring a better understanding of this information by all partners through workshops or individual meetings with bidders during the contractor selection stage.

3.4.2 Communication
Information and communication are highly dependent; one will not function without the other. According to Bendoly and Swink (2007) and Kashiwagi (2002), it is individuals’ capabilities of processing information that create the
perception of lack of information, and not actual deficiency of information. This view stresses the importance of enhancing individuals’ capabilities within the client team as a tool for better information quality. In fact, efficient communication of information between team members also supports team working and increases collaboration. Zwikael and Globerson (2006) (Toor and Ogunlana, 2008a)suggested that communication planning has a great impact on procurement success.

It is becoming evident that information communication is a critical process in construction procurement. Better information communication could be achieved through the implementation of an appropriate IT platform (Bryde et al., 2013; Cheung et al., 2013; Nguyen et al., 2004; Yang et al., 2005). The implementation of information technology in construction will not only enhance information sharing, but also increase knowledge sharing and innovation (Amor et al., 2002). According to Titus and Bröchner (2005), having the right information at any time reduces procurement time and increases accountability. However, handling information in construction projects continues to be a challenging task for the construction industry. Issues such as the accuracy of communicated information and organisations’ ability to understand and utilise information are the main challenges facing construction parties (Lee and Whang, 2000).

Based on the above review, the accuracy of exchanged information and the ability of the parties to understand this information is vital in the communication process. The use of an efficient communication process could be an enabling tool for better information management, and provides easier and faster access to information.

3.4.3 Information and Communication Technology
Information communication technology (ICT) permeates every part of today’s practices. ICT can facilitate information sharing and communication between individuals and organisations. A study by Van Ark et al. (2003) showed that the US is well ahead of other countries in implementing ICT in different sectors. Looking at the ICT strategy in the US, the US federal government has played the leading role in developing standards and envisioned strong leadership for
the private sector in the standardisation arena (Guijarro, 2009). In 1998, the US government issued a circular directing all federal units to use the voluntary consensus standards in government procurement, in place of government-unique standards, and stating that any deviation from this direction should be justifiable (Guijarro, 2009). The results from the services sectors in the US shows that productivity has grown faster than in the EU because of the intensive use of ICT (Van Ark et al., 2003). In the UK, the government set a target for the use of Building Information Modelling, which indicates the strong role of the public sector in the deployment of ICT in the construction sector.

The directions taken in the US and UK stress the importance of the client’s commitment to utilising ICT to develop the construction industry. Furthermore, standardisation is the cornerstone of the efficient deployment of any ICT. However, success in utilising ICT solutions in the construction sector depends on its structure, along with the level of collaboration between organisations in both short- and long-term aspects (Kumaraswamy et al., 2004). Legris et al. (2003) and Henderson and Ruikar (2010) added that ICT implementation has to be integrated into a broad strategy that includes human and social change processes along with the adoption of the innovative model.

The review of ICT adoption in the construction sector identifies several elements that need to be taken into consideration for an ICT system to succeed. These elements include standardisation, system structure, organisational working practices, process changes, team involvement, and human and social change requirements.

3.4.4 E-procurement
E-procurement could facilitate information sharing and coordinate the procurement activities (Chang et al., 2013). E-procurement includes those technologies that facilitate procurement activities, such as information interchange, video conferencing, and auctions (Quesada et al., 2010). Presutti (2003) defined e-procurement as “a technology solution that facilitates corporate buying using the internet”. According to Lu et al. (2011), e-procurement provides both organisations and communities with better and more efficient services at reduced cost. Tran et al. (2011) noted three dominant
factors that play critical roles in the deployment of e-procurement: the government, the organisation, and technology. The government plays a critical role in the adoption of e-procurement with its regulation, policies, and support (Uzoka et al., 2007). The support of the government includes funding, planning, and implementation support so improvement occurs in a sustainable way (Tran et al., 2011).

An e-procurement system for the construction industry should cover the different procurement phases: the pre-contract activities and the delivery activities (Lu et al., 2011). Based on the process illustrated in Figure 3.3, e-procurement solutions should cover all processes from the identification of the project’s necessity up to payment. However, the adoption of e-procurement by construction clients is lagging behind other sectors, such as the manufacturing sector (Beauvallet et al., 2011; Ruddock, 2006; Uzoka et al., 2007). According to Chen and Rankin (2006) and Cheng et al. (2010), there are still no e-procurement solutions suitable for the construction industry. Issues such as what an e-procurement system should include and how success and assessment could be achieved need to be agreed first (Vaidya et al., 2006). Other challenges include the difficulty of structuring procurement information and transforming this information into a digital processing format (Lu et al., 2011). Therefore, future studies investigating the development of IT solutions for the construction industry should consider functional requirements, security issues and public policies (Lenin, 2011).

Similar to other elements of procurement systems, the implementation of e-procurement in construction requires the involvement and agreement of relevant parties. Thus, collaboration between these parties constitutes a cornerstone in implementing e-procurement. Achieving collaboration with the client organisation depends on implementing sound strategies and policies and continuous performance assessment (Pearcy and Giunipero, 2008).
3.5 Quality Management

3.5.1 Performance Evaluation
Based on the ICE client guide (ICE, 2009), one of the most critical client roles is keeping everything on track, which includes the following:

- Managing performance.
- Sharing results.
- Accountability for results.
- Performance measurement framework.
- Raising performance standards.
- Performance reviews.
- Taking responsibility for the end result.

The key element of the role of the client at the construction stage is performance measurement: implementing clear, well-defined, measurable and ultimately achievable key performance criteria (ICE, 2009). In fact, construction procurement performance evaluation is a continuous process that helps the client to link the goals and objectives developed at the planning stage to the overall procurement outcome at the implementation stage.

The construction performance assessment model in Figure 3.4 shows that performance assessment is not just limited to the construction stage, but covers...
all project stages, and more importantly, establishes a basis for a sustainable construction improvement process (refer to Section 2.4.8).

**Figure 3.4 Construction performance assessment model**
(Source: ICE, 2009)

Performance evaluation provides the client organisation with the opportunity to integrate the assessment of procurement performance and learning from practice (see Section 3.3.2). Utilising this opportunity requires the client team to adopt a dynamic performance evaluation strategy that meets changes in working practices (Kennerley and Neely, 2002). Neely (2005), after a literature review of performance measurements between 1981 and 2005, found that the development of dynamic measurement systems and the enhancement of flexibility are the two critical elements for organisations to cope with changes in the construction working environment. Liu et al. (2014) proposed a dynamic lifecycle performance measurement framework for PPP projects (Figure 3.5). The proposed framework integrates two elements: performance measurement and learning. Even though the framework was developed for the measurement of PPP project performance, in general, the same principles can be applied to any of the other procurement systems (refer to Section 3.3.2).
More specifically, Kagioglou et al. (2001) argued that construction performance evaluation falls into the three main categories:

- The financial perspective: how do the project’s financial stakeholders view the project? For example, use of cash flow forecasting and cost-benefit analysis.
- The internal business process perspective: how are we performing in our key process activities? For example, use of critical path analysis.
- The customer perspective: how do our existing and potential end users see it?

While benchmarking time, cost and quality with the initial set target is the central element for performance assessment, performance in key process activities seems to be unclear, especially in the case of the client, due to lack of clarity in defining these activities. Thus, recognising and understanding these key activities allows the public client to continuously assess its performance, proactively act to improve its operation within current projects and better prepare for future projects.

3.5.2 Process Management
Recent research has indicated that poor process performance in the construction industry is the main cause of delays, cost overruns and dissatisfied clients (Haponava and Al-Jibouri, 2010; Jin and Ling, 2006). Even though
several recommendations have been made to guide procurement process management improvement, they remain isolated from the day-to-day activities of the client organisation.

A process is a chain of logically interrelated actions performed in a definite way which is concluded by the completion of a predefined deliverable or the achievement of a milestone (Watermeyer, 2011). The construction procurement process includes actions such as procurement activity administration, risk management, negotiation, team building, award and termination (Kwak and Ibbs, 2002). Most of these actions could be identified at the planning stage of each project, and performance audit is integrated within all procurement stages. The PMBOK Guide (Project Management Institute, 2013) provided the basis for the project quality management process, which includes planning, executing, mentoring and control. This means that decisions made by the client at the planning stage should be closely monitored during the execution stage and changes should be controlled to minimise their effect on project performance. A key point in the process is that monitoring and control should be considered a method of performance improvement and positive factors in building a better relationship between participants.

The relationships between clients and other participants are established at multiple levels, as well as each stage of the procurement lifecycle (Kwak and Ibbs, 2002). Cox and Townsend (1999) argued that good management does not depend on the length or closeness of relationships, but is more about responding to challenges by initiating an innovative procurement management process. So it is more valuable to the construction client to give greater attention to its internal procurement process, and build its team members’ capabilities. It is evident that the procurement process can mainly be improved by the client having a competent team; otherwise the process and stages will not function. In fact, organisations implementing process improvement techniques, such as total quality management or performance measurement tools, enables knowledge creation and improves their performance (Linderman et al., 2010). Similarly, Haponava and Al-Jibouri (2010) concluded that using key performance indicators (KPIs) to control procurement process performance in the construction stage eventually influences procurement outcomes.
Furthermore, like other activities within construction procurement, process management requires the integration of all parties' efforts to be effective. Therefore, collaboration may be an additional element that influences construction procurement management.

3.5.3 Procurement Control
Rework has been identified as a major cause of construction organisations’ poor procurement performance (Love and Smith, 2004). Requirement management continues to be one of the most challenging problems in construction procurement. It is evident that the development and control of construction project procurement requirements and end users’ expectations are challenging tasks to the project team (Doloi, 2013; Hampton et al., 2012; Ibrahim et al., 2013; Toor and Ogunlana, 2008a). Current difficulties with requirement management include lack of a practical framework, misinterpretation of requirements, difficulties in identifying requirements, complex client organisations, and team communication problems (Yu and Shen, 2013). These difficulties can lead to requirement changes during construction, causing major cost increases, delays, and disputes. The Strategic Forum for Construction (2003) recommended the establishment of a client team at the early stages of the procurement process as a proactive activity to manage project requirements and end users’ expectations. Focus on the client continues to be the key element in construction projects. However, clients lack the systematic practice and approaches that would help them develop their teams’ capabilities to meet the performance expectations (Yu and Shen, 2013).

Procurement control aims to ensure completion of the construction project on time and within the initial contract value and to achieve other project objectives. According to Olawale and Sun (2010), key common factors inhibiting both time and cost control during construction include design changes, risks/uncertainties, inappropriate project time/duration, and the non-performance of subcontractors. However, according to Osipova and Eriksson (2013), control and flexibility are both necessary if a project is to be managed effectively. Therefore, organisations must balance these two contradictory approaches to achieve the set objectives (Raisch, 2008). This indicates that control is a continuous process and covers a wide range of activities throughout the procurement
lifecycle. In fact, it covers the control of all of the client’s activities and is not limited to specific ones. More importantly, control is not limited to the client organisation; other parties, namely consultants and contractors, can play equally important roles in controlling project outcomes. The client’s role is to make sure the consultants and contractors are using the client control systems with their suppliers to maintain continuous control over project delivery.

### 3.5.4 Cross Organisation Management

Procurement management is a continuous process that involves the management of activities at different stages of a construction project. The above sections have highlighted that the client organisation is the focal point at the initial stages of construction procurement: identifying the project’s necessity, building the project team, developing procurement strategies and requirement management. Similarly, change control is an on-going process that involves more than just the client team, especially after letting the construction packages, or design and construction packages, as the case may be. Thus, once more parties from different organisations get involved, the procurement team will have expanded in terms of size and professional disciplines. Consequently, the construction client’s ability to manage cross organisational cooperation could enhance the possibilities of better performance. Rowlison et al. (2011) concluded that the management of cross organisational operations and relational procurement enhances performance and competitiveness. They further clarified that cooperative approaches encourage information and knowledge sharing. Phua and Rowlinson (2004) studied the extent to which cooperation influences procurement success in comparison with other attributes, and found that cooperation is critical to construction procurement success. More specifically, intra-organisational cooperation was found to be more important than inter-organisational cooperation (Phua and Rowlinson, 2004).

So, procurement management runs in two directions: first, the management of the team within a single organisation, which could be the client organisation, the consultant organisation or the contractor organisation; second, the management of the inter-organisational team. For example, in this case, the client managing the consultant team or the consultant managing the contractor team and its
working environment does not practically fit within the present procurement context. In contrast, successful procurement depends on factors such as team communication, teamwork, respect for each other’s needs, involvement, and openness (Boes and Doree, 2013; Eriksson, 2010; Walker and Hampson, 2003). Another key attribute highlighted by Chan and Ho (2003) is regular monitoring of the collaborative working environment. These factors indicate that cooperation in procurement management heavily relies on the level of team integration and participant willingness. Even though construction procurement involves multiple, cross-functional organisations, the problem is in the management of the complex and dynamic relationships between the client and the contractor teams (Bresnen, 2007; Rose and Manley, 2010; Laan et al., 2011). Therefore, both the client and the contractor organisations are required to build the appropriate capabilities to fulfil their duties throughout the procurement lifecycle process. While the client has the option to select the contractor based on predefined criteria that suit the project’s needs, the client team must hold the capability to manage the overall procurement process and not manage other team members. A collaborative working environment should be the optimum objective of the client team, and can be enhanced by adopting better communication practices, respect for each other’s needs, involvement, and trust. More importantly, all parties’ focus should be directed toward the efficient management of procurement activities, not toward managing other team members.

3.5.5 Standardisation
Standardisation is a tool for organisations to ensure consistency and reduce unnecessary use of resources on repeated tasks (Santos et al., 2002; Ungan, 2006). Therefore, standardisation is a framework of agreements in an industry or organisation which all parties must follow to ensure that the processes associated with the goods and services are carried out in conformity with a set of guidelines.

Actions by individuals vary because of experience and skill differences, which can in turn lead to a lack of consistency in organisations’ operations and influence the overall performance (Ungan, 2006). In contrast, standardisation minimises variations between individuals and leads to better work quality (Roy
To achieve this in a way that supports the client’s objectives requires an understanding of the knowledge and skills needed to create a standard operating process or procedure (Lillrank and Liukko, 2004). Furthermore, standardisation is not a one-off task, but a continuous process that has the flexibility and dynamic structure that add value to the client organisation. Therefore, standardisation must be an integral part of an overall organisation’s working culture in order not to be an obstacle to achieving the desired outcome. In other words, the thinking in organisations needs to be directed toward the processes of both standardisation and improvement (Roy et al., 2005).

As shown in Figure 3.6 Watermeyer (2011) identified four main areas to standardise in public construction procurement: government arrangements, procurement documents, procedures and methods, and procurement policy. Thus, the literature provides client organisations with recommendations that support greater standardisation in construction procurement. However, building client organisations’ competencies is a prerequisite for a better understanding about how standardisation improves performance in the construction industry. At the same time, keeping standardisation as an optional element may adversely influence the development of other attributes such as ICT (Section 3.4). Therefore, standardisation can no longer be an optional element in construction procurement, and clients need to take further steps to move forward in the standardisation process and allow a certain level of flexibility to adapt to future changes in the industry.
Figure 3.6 Areas to standardise in public construction procurement
(Source: Watermeyer, 2011)

3.5.6 Planning and Permits Approvals
Researchers have identified obtaining the relevant authorities’ approval as one of the key risks that influence construction procurement performance (Lee et al., 2007; Long et al., 2004; Luu et al., 2009; Wang et al., 2004). Furthermore, investigation of the causes of delays and cost overruns has attributed them partially to the bureaucracy in government departments’ approval processes, which means that the permit and planning approval process extends beyond the main parties, the client and contractor, and its operation cost is not limited to the main stakeholders, but also extends to the other stakeholders associated with the process (Al-Hussein et al., 2006). Changes in the requirements or regulations of the planning and permit authorities may further complicate the approval process and even influence construction performance (Chao and Hsiao, 2012; Wilson et al., 2006).

Although permit acquisition has been raised as a problematic issue, clients are struggling to overcome these challenges. Like many other activities in construction procurement, permits require teamwork, as they may involve more than one organisation in a specific project. The relevant authorities may adopt, modify or reject all or part of the procurement documentation. Some decisions may even result in debate and numerous changes to the project’s development (Kagioglou et al., 2000). Therefore, it is becoming evident that obtaining permits is a serious issue that requires collaboration between the client and the
concerned authorities. Compared with private sector clients, public clients have more alternatives for the establishment of a collaborative environment, because generally, the permit authorities are also part of the public sector. Therefore, the client should take into account the planning and permit approval period from the planning stage (Frimpong et al., 2003; Ling and Poh, 2008). Evidence suggests that greater attention paid by the client to planning and permit issues could result in better project outcomes. Client organisations could include contractors’ relationships with the respective approval authorities as one of their selection criteria. While the availability of different options for overcoming permit challenges supports the client’s decisions, they also create a new area of pre-assessment and analysis for the selection of the best options at the planning stage of the project. The engagement of stakeholders early in the project lifecycle can set the basis for a better relationship with the planning and permit authorities.

3.5.7 Top Management Support
The client organisation’s support and commitment to the project team’s members is one of the factors that affect the construction procurement process (Bryde, 2008; Jang and Lee, 1998; Toor and Ogunlana, 2008a). Authors such as Young and Jordan (2008), Shokri-Ghasabeh and Kavousi-Chabok (2009) and Young and Poon (2013) have argued that top management support is the most important critical success factors for projects, not simply one of many.

The nature of top management support has been identified in various ways. A strategic view is that management’s support should focus on building the team’s capabilities as the primary and most critical condition for procurement success (Young and Jordan, 2008). After that, top management needs to be transparent in resolving issues and flexible in adjusting actions to achieve the desired procurement outcomes (Dong et al., 2009; Young and Jordan, 2008). Proactive actions by top management are to ensure similar issues are not repeated in future projects by translating these issues into managerial actions, such as changes in the organisation structure, establishing guidelines, and/or further development of team capabilities (Liang et al., 2007). Large organisations, such as repeat public clients, can adopt mechanisms to overcome procurement issues, but the fact is that the top management in client organisations rarely
considers projects to be of direct interest (Crawford, 2005; Thomas et al., 2002). This is because the construction sector is lacking the mechanisms needed to integrate top management support activities into their daily practice (Crawford, 2005; Thomas et al., 2002). Therefore, top management support needs to be integrated within the whole procurement system to be more effective. Top management can mainly support public construction procurement by translating issues into actions such as changes in organisation structure, establishing guidelines, and/or further development of team capabilities. Identifying the interrelationship between various client activities and practices provides empirical evidence about areas that merit greater attention from top management.

3.6 Small and Medium Enterprises

3.6.1 Public Sector and SMEs
The public sector has a statutory obligation to support the development of SMEs (Latham, 2012). In addition, small and medium enterprises play an important role in strengthening countries’ economic development and employment. For example, small and medium enterprises account for 60% of the Chinese GDP and absorb more than 75% of employment (Jinbo and Huayong, 2010). Furthermore, between 2006 and 2008, SMEs won 31% to 38% of the total public procurement value in the EU and their contribution to the EU economy consists of 52% of the total turnover or gross premium (GHK, 2010).

3.6.2 Involvement of SMEs in Public Procurement
With more than 99% of total enterprises being SMEs, the size of SMEs in Japan is the highest among the industrialised countries (Economist Intelligence Unit, 2010). According to Latham (2012), SMEs are a powerful engine for local economic growth. The data show that SMEs have high influence not only on specific sectors, like construction, but also on whole countries’ economies. More specifically, SMEs are in a better position than large enterprises to offer public clients wider economic and social benefits (Loader, 2013).

The public sector continues to stress the criterion of best value as the main tool on which contractor selection is based, but it is working toward establishing an
appropriate environment for large-scale construction procurement, such as that involved in PPP procurement. SMEs have proved to be important players in countries’ economies and their activities cover various sectors, including the construction industry. Even though their contribution to countries’ economies in terms of GDP and employment is higher than that of major contractors, their share in public procurement is less than that of major contractors. According to Latham (2012), greater involvement of SMEs in construction procurement will often bring the benefits of lower overheads than those of larger contractors and flexibility in terms of responsiveness to client requirements. Furthermore, SMEs have more potential to develop a collaborative relationship with clients beyond the contractual obligation (Latham, 2012). In contrast, collaboration with larger contractors is less effective due to the organisational complexity and diversity in disciplines involved in a specific project. Additionally, the smaller size of manpower of SMEs allows them to better utilise the automotive concept of multi-skill manpower rather than focus on developing specialists in each specific technical area.

A major proportion of construction projects are either awarded directly to SMEs or sub-contracted to smaller enterprises by major contractors. Therefore, greater attention to these enterprises’ performance and support will influence both overall procurement performance and major contractors’ performance. However, the effective involvement of SMEs in public procurement is inhibited by issues such as the complex tendering process, lack of information, lack of involvement at the early stages, and delays in payments (GHK, 2010). These issues are part of the wider range of construction procurement challenges highlighted in earlier sections in this chapter, therefore improvement in these areas is not limited to SMEs, but also impacts the overall procurement performance. But the key obstacle to innovation in construction by SMEs are based on granting public contracts and regulatory inefficiencies (Manley, 2008). Therefore, public clients need to give more attention to SMEs when planning procurement for construction projects.

3.7 Financial Management
The financial activities involved in procurement are a continuous process that starts at the early stages of construction procurement when the client analyses
the available funding options and runs throughout the procurement lifecycle
design, construction, and facility management. Securing the best value out of
the procurement process is one of the client’s main priorities; funding and cash
flow are two essential elements in the development of a client’s scheme.

3.7.1 Best Value
The best value procurement is defined as “a procurement process where price
and other key factors are considered in the evaluation and selection process to
enhance the long-term performance and value of construction” (Scott et al.
2006: 4). Therefore, price is one factor used in establishing the best value in
construction procurement. Other factors highlighted by Scott et al. (2006) are
time, performance, quality, and design alteration. More specific measures,
provided by Palaneeswaran et al. (2003) and Kelly (2007), include capital
expenditure (CAPEX), operating expenditure (OPEX), time, esteem,
environment, exchange, and politics/community. Capital cost has been ranked
as a major part of the delivery of best value in construction procurement and it
is one of the key elements that enable the client to determine the satisfactory
completion of construction procurement (Kelly, 2007; Molenaar and Songer,
1998). Competition in public procurement has been shown to have a positive
impact when working toward lowering procurement costs and achieving best
value for money. In contrast, a limited number of bidders when using PPP
procurement, negatively impacts the bid cost and subsequently limits the
possibility of the client obtaining the best possible value (Walls et al., 2006). On
the other hand, Kashiwagi et al. (2004), as shown in Figure 3.7, consider best
value to be a combination of high competition and high performance (Quadrant
II).
Professional bodies such as the BS Standard 2000 have developed guidelines for clients to follow in order to obtain the best value. However, it is important to note that clients face difficulties in specifying the quality of the required services (Akintoye et al., 2003).

It is argued that clients could resolve conflicting issues in delivering the best value in procurement by providing a clear brief and deploying a multidisciplinary, professional and skilled team (Johnson, 2013). Furthermore, the consideration of contractors’ past performance at the selection stage is a crucial factor in achieving best value (Elyamany and Abdelrahman, 2010). Therefore, achieving best value is a collaborative effort by all parties and importantly, requires accurate client requirements and competent private sector team members. Quality is what the client pays for and the balance between quality and cost is what establishes the value of any construction. Achieving the best value is an effort that requires a competent client that recognises and understands the key elements that support efficient project delivery.
3.7.2 Cash Flow and Funding

The financial management of a construction project involves procurement funding, cash flow, and market stability (Abdul-Rahman et al., 2009). Inappropriate management of financial activities could adversely affect procurement performance. For example, poor cash flow management and late payments are very significant causes of delays in construction projects (Abdul-Rahman et al., 2009; Luu et al., 2009). Normally contractors maintain a balance between the work schedule and the project’s cash flow, so delays in payment are likely to influence the project’s schedule, unless the contractor manages to source funding to maintain the work schedule (Elazouni and Gab-Allah, 2004; Görög, 2009).

Historical record of the contractor’s cash flow management can provide the client with indications about the contractor’s capabilities to overcome any cash flow problems during the course of construction. Therefore, consideration of procurement cash flow during the early stages of the project reduces the possibility of financial crisis at the construction stage. Ross et al. (2013) argued that procurement cash flow forecasting is of paramount importance to the client and the contractor. It is known that both the contractor’s historical cash flow and the forecast of possible procurement cash flow paths during the project are effective tools for assessing contractors’ financial capabilities at the selection stage (Huang et al., 2013; Singh and Tiong, 2006). Even though financial issues are a non-technical matter, it is important for the client team to understand these issues in order to mitigate the adverse impact on project performance. In fact, repeat clients in the public sector are in a better position to build capabilities that might positively influence procurement performance.

3.8 Learning from other Industries

Reviews of other industries’ procurement processes could be useful for understanding issues in the construction industry and learning and identifying better practices. The automotive and aerospace industries are two industries that involve extensive engineering and a network of suppliers. Both the procurement and the production process require the manufacturing lead to establish a strategy that enhances its competitiveness in the market. This section highlights the development that has taken place in these two industries
and the lessons that can be learned for the improvement of construction procurement.

### 3.9 Automotive Industry

The automotive industry is known to be very active in developing supply chain management (Pérez and Sánchez, 2001). Over time, competition between the main corporations has extended to the sub-levels of supply chains. Furthermore, supply chain management is a decisive element, not only for success but to a larger extent for the survival of automotive manufacturers. The global competition between the main corporations plays a critical role in driving the development of the automotive industry supply chain.

Similar to public construction, automotive customers are not limited to a specific geographic area; the industry is spread worldwide. This means the main corporations need to satisfy a wide range of end users’ wishes. Therefore, automotive production planning could be argued to be customer order production, which means identifying customers’ needs or wishes when designing and building (“pull”, build-to-order) instead of car makers’ possibilities (“push”, build-to-stock) (Miemczyk and Howard, 2008).

Enormous market competition has forced many automotive manufacturers and retailers to continuously improve their strategies to remain competitive and strengthen their market positions (Godlevskaja et al., 2011). Strengthening the market position implies the adoption of a production strategy that provides high-quality products and quick delivery times and lowers manufacturing costs (Lambrechts et al., 2010). The difficulties facing the main corporations in the production process lead to the expansion of their businesses to other supply levels to fuel new competitive business strategies (Godlevskaja et al., 2011). This means that the automotive industry’s business strategies are based on the operation lifecycle’s cost competitiveness, while the main corporations remain the leaders in the overall supply chain management process.

To overcome the challenges facing the automotive industry, various tools have been developed to enhance operation practices. These tools include lean manufacturing, just-in-sequence, modularisation, global outsourcing, supplier parks, collaboration, and quality control.
3.9.1 Lean Manufacturing

Lean manufacturing can be considered the elimination of waste from manufacturing operations, where waste includes (Taj and Berro, 2006):

- Motion: movement that does not add value.
- Waiting: unproductive time created when one element in the production process is not ready.
- Correction: rework because of defects, errors, mistakes or incomplete information.
- Over processing: effort that does not add value.
- Overproduction: production beyond the market need at the time.
- Knowledge: team members do not have knowledge about the best way of performing specific tasks.

The adoption of the lean manufacturing approach in the automotive industry aims to achieve rapid sales growth and reduced costs from a fixed quantity of resources. Toyota’s production operations are recognised as leading lean manufacturing, involving teamwork, standardised processes, just-in-time, zero inventory, automation, quick change-over, multi-skilled team members, and sequential operations (Emiliani and Seymour, 2011). Figure 3.8 shows that Toyota’s working model is based on 14 working principles that are classified into four categories: problem-solving, people and partners, process, and philosophy (Liker, 2004). The problem solving in Toyota’s working model has been critical in sustaining performance improvement (Gao and Low, 2014).
The lesson to be learned for construction procurement is to be clear about the working principles that establish a lean process by reducing waste, strengthening teamwork practices, developing skills, standardisation, and automation. Another key lesson is that the client team should be involved in solving problems in construction procurement when working to improve organisation performance.

3.9.2 Just-in-Time
The automotive industry has established a sequential manufacturing strategy in collaboration with its supply chain members. Therefore, materials are produced and delivered “just in time” to be assembled into the final product or sold on the market (Wiengarten et al., 2010). The just-in-time process is considered a strategic procurement practice in the automotive industry and has been a continuously important element in the automotive industry (Mackelprang and Nair, 2010; Matson and Matson, 2007).

The role of the client organisation in the construction industry is to establish a collaborative working environment so that all members work closely with each
The adoption of integrated procurement systems makes consultants, suppliers and sub-contractors deal directly with the main contractor, thus the main contractor holds a critical role in achieving a collaborative working environment, and the limited resources within the client organisation direct the client’s focus first to the contractor’s ability to perform the task effectively, and then to the continuous measurement of the contractor’s performance throughout the procurement lifecycle.

### 3.9.3 Modularisation
Modularisation is the process of building a product from smaller items that are designed independently (Baldwin and Clark, 1997). The main corporations do not entirely depend on their own skills and knowledge to develop modern automotive products; instead, major items are now designed and developed by suppliers (Morris et al., 2004). This strategy allows each member of the supply chain to focus on a specific component, and to compete in the automotive market, manufacturers and suppliers must work together in designing and producing modular products (Christensen et al., 2001). Furthermore, the production of a competitive product requires modules such as engines, transmissions, platforms and other parts that are interchangeable between different models (Morris et al., 2004). The main corporations have a substantial degree of collaboration between supply members at both the design and production phases of each element (Campagnolo and Camuffo, 2009; Morris et al., 2004). Furthermore, modularity is incorporated on a selective basis when moving to a build-to-order working model (Ro et al., 2007).

The learning point for client organisations is to have a clear outsourcing strategy that takes into consideration the criticality of collaboration between team members and respects other parties’ initiatives. This strategy should include collaboration between clients, contractors and suppliers at various stages of the procurement lifecycle. Modularity could be an effective tool for reducing construction time and the cost of construction procurement, but it should be selective, used when it is proven to be viable and practical.

### 3.9.4 Global Outsourcing
Globalisation has led the main corporations to react to market competition by developing a global supply chain network (Liao and Hong, 2007). Many
corporations have moved part of their manufacturing operations to low-cost countries. According to Xia and Tang (2011), a low-cost sourcing strategy is expected to penetrate more within the automotive industry, but there is no clear evidence that this strategy will generate long-term benefits. So the long-term relationship between the main corporations and suppliers is governed by low-cost production. However, the geographical distance between the assembly point and the supplier and the scale of services may involve higher levels of coordination cost (Handley and Benton, 2013). Therefore, the success of these relationships requires the main corporation to implement a balanced outsourcing strategy that focuses on both innovation and overall production cost. Outsourcing based on tasks close to the supplier’s core competencies supports innovation and coordination issues when the main corporation implements the appropriate control over suppliers (Roy and Sivakumar, 2012).

The learning point for construction clients is to implement a balanced outsourcing strategy with the appropriate innovation, cost and time. With the different natures of the two sectors in terms of item size and levels of customisation, the construction industry is required to give consideration to issues such as transportation, quality control, and communications.

### 3.9.5 Supplier Parks
Suppliers may work in a dedicated place aimed at reducing transport costs, reducing inventories, improving cooperation between suppliers, and providing flexibility in production (Pfohl and Gareis, 2005; Reichhart and Holweg, 2008). In contrast, supplier parks are based on high degrees of commitment between the main corporation and suppliers, which can limit an enterprise’s flexibility. Similar to global sourcing, the construction industry is required to give consideration to issues such as transportation, quality control, and communications.

### 3.9.6 Supply Chain Collaboration
The automotive industry’s supply chain strategy is directed towards establishing closer and longer-term relationships between the main corporations and suppliers (Cousins and Menguc, 2006; Wee and Wu, 2009). The lean production strategy creates a greater interdependency between the main corporations and suppliers, which makes integrating suppliers earlier in the
design a key success driver in the production process (Binder et al., 2008; Clifton, 2001; Primo and Amundson, 2002). However, the use of a long-term collaborative approach is relatively new and little is known about the relationship between this approach and success or failure in the automotive industry (Bennett and O'Kane, 2006). Binder et al. (2008) argue that the followings will add great value to the automotive supply chain:

- Early involvement of key suppliers.
- Open and intense sharing of know-how between members.
- Clarity regarding members’ responsibilities and cross-functional interfaces.
- Availability of competent management party who coordinates the interfaces between the members.

The learning point for construction clients is to implement a procurement strategy that integrates key members from the early stages of the project. Furthermore, attention must be given to know-how sharing and collaboration could be unitised to create an integrated team at the initiation phase of the construction project.

3.9.7 Quality Control
Suppliers struggle to win business from the main corporations unless their operations and products are certified to an approved quality standard (Bramorski et al., 2000). The quality management system in the automotive industry gives great attention to continuous improvement, end users' satisfaction, reduction of waste, defect prevention and reducing quality cost (Bennett and O'Kane, 2006). Bennett and O'Kane clarified that the implementation of a quality management system is not limited to first-tier suppliers, but has now cascaded down to lower-level suppliers, who are required to have an approved quality standard in place.

The learning point for the construction industry is to establish a quality control system that cascades the implementation and use of quality management and standards to various levels of suppliers and sub-contractors. The client organisation’s role is to make sure that contractors are using these systems with their suppliers to have continuous control over quality.
3.10 Aerospace Industry
The aerospace industry is characterised by relatively stable demand, small production, long lead items and severe competition (Bales et al., 2004; Gustavsson, 2008). Product performance, delivery time, availability and price are the main key industry competition elements. Aerospace production greatly depends on technological integration and the supply chain is very risky (Sinha et al., 2004). The manufacturing process in the aerospace industry is subject to strict regulations and standardisation. For example, suppliers have to comply with the certification authorities’ rules and regulations when inventing new products (Brusoni and Prencipe, 2001; Voordijk and Meijboom, 2005).

3.10.1 Lean Manufacturing
The aerospace industry has adopted lean thinking from the automotive industry to improve operation practices (Hines et al., 2004). The adoption of the lean practices of the automotive industry in the aerospace supply chain was an important action for being competitive (Rose-Anderssen et al., 2011). The lean thinking initiative in the aerospace industry has been linked with time, cost and quality performance. According to Michaels (1999), top management’s involvement is a major driver in transforming and learning in the aerospace industry.

The learning point for construction clients is that the adoption of lean thinking requires top management commitment. Furthermore, the adoption of the lean thinking approach requires the development of skills and an appropriate time frame.

3.10.2 Outsourcing
Many aerospace corporations have gone through a process of redefining their core competencies, which has led to the downsizing of internal teams and an increase in outsourcing (Saad and Gindy, 2007). Therefore, suppliers in the aerospace industry supply chain carry out a great amount of manufacturing work that is very complex in nature (Bales et al., 2004).

The learning point for construction clients is first to re-evaluate the roles of the client organisation and teams’ capabilities in order to develop an outsourcing
strategy. Secondly, outsourcing can be adopted to achieve better performance in terms of cost, quality and time.

3.10.3 Supply Chain Collaboration
A collaborative relationship is an important element when bringing two or more members of the supply chain together to develop any product (Rose-Anderssen et al., 2009). Openness and understanding of suppliers’ cost and quality systems establishes a long-term relationship between them. A collaborative relationship between the main corporation and suppliers integrates their capabilities, reducing cost and ensuring the quality of products.

It is worth noting that collaborative relationships in the aerospace industry are based on risk sharing, partnership and the financial capacity of suppliers to invest in new products (Rose-Anderssen et al., 2010). Similar to the automotive industry, Johnsen et al. (2009) argued that the development of collaborative relationships in the aerospace industry requires greater emphasis on openness, risk and reward sharing, lifecycle costing, and early supplier involvement.

The learning point for construction clients is to involve sub-contractors from the early stages of the project and share the risks and rewards of project development. Another crucial point is the emphasis on openness between procurement members, which seems to be a challenging element in all the three sectors, construction, automotive and aerospace. Openness can mean the exposure of important information and the transfer of know-how, which will most likely influence some members’ competitiveness. In other words, openness is more related to trust between the parties, which could be one of the key issues because of the competitive nature of all three sectors. Exposure of information could mean giving a counterparty the opportunity to become more competitive. However, public client departments are expected to share the same objectives, which increase the chances of achieving better collaboration between the client sector team’s members.

3.10.4 Information and Knowledge Exchange
Information exchange in the aerospace production process covers the whole lifecycle: the identification of requirements, design, manufacturing, testing and certification (Fan et al., 2000; Saad and Gindy, 2007). According to Voordijk
CLIENT ORGANISATIONAL SUCCESS ACTIVITIES

and Meijboom (2005), information exchange throughout the supply chain lifecycle can be improved by developing coordination strategies and information technology systems. However, time and effort are needed to integrate team members from different organisations, and this remains a challenging task within the aerospace supply chain (Voordijk and Meijboom, 2005). Individual organisations’ knowledge plays a key role in differentiating the quality and cost of the product (Fan et al., 2000). However, a weak relationship between organisations limits the know-how within individual organisations (Fan et al., 2000).

The learning point for construction clients is to improve parties’ relationships as a prerequisite for better information and knowledge sharing throughout the project lifecycle. Utilisation of information technology and acquisition of appropriate capabilities are two critical tools the client organisation can implement to enhance information and knowledge sharing in construction procurement.

3.11 Summary
Client organisational activities can be integral elements throughout the procurement lifecycle. Learning and knowledge gained by effective participation could facilitate innovative decisions and practices. The review shows a direct relationship between the ongoing client activities and client activities at various stages of the procurement lifecycle. The volume and continuity of public client construction procurement should enable client organisations to accumulate a wealth of technical and non-technical knowledge about the procurement lifecycle. Other industries, such as automotive and aerospace, have managed to develop working models that increase their market competitiveness. Competitiveness and long-term strategies in these two industries form important elements in their day-to-day operations. The learning from these two industries stresses the importance of developing key working practices for the implementation of the success attributes identified by researchers in the construction industry. The review in this chapter reveals that client activities are interrelated. For example interaction, collaboration and knowledge management seem to complement each other. Therefore, establishing relationships among the client-related activities can support clients...
in recognising and understanding the set of elements that affect construction performance.
4 CHAPTER FOUR: PUBLIC CONSTRUCTION PROCUREMENT IN OMAN

4.1 Introduction
Context plays an important role in the performance of construction procurement. The geographical, demographical and economical aspects are three factors that influence the cost and time of a construction project. When looking towards change or improvement, the solution must be devised to reflect the working environment in the targeted area. Public construction in Oman is one of the major economic sectors, and performance improvement in this sector has a positive influence on the entire construction supply chain, which covers manufacturing and retail. This chapter discusses the public construction context in Oman, highlights the challenges facing public procurement and identifies the need for new initiatives that provide the public sector with a procurement model that supports sustainable construction procurement improvement in Oman.

4.2 Geography
The Sultanate of Oman is an Arab state in south-west Asia, on the south-east coast of the Arabian Peninsula. Oman is one of the Arab Gulf Cooperation Council members, the others being Bahrain, Kuwait, Qatar, Saudi Arabia and the United Arab Emirates (Gani and Al Mawali, 2013). Figure 4.1 shows the geographical location of Oman and highlights its neighbour countries. Oman shares borders with three countries: Yemen to the South-West, Saudi Arabia to the West and UAE to the North West. Oman has a total area of 309 thousand square kilometres and a total coastal line of 3,165 kilometres (Shahalam, 2001).

The varying topographic areas (plains, wadis (dry riverbeds), deserts, and mountains) constitute a challenging working environment, especially for construction clients. The plain coastal area overlooking the Gulf of Oman and the Arabian Sea is the most important part of Oman, with an area of about 3% of the total land, and mountains ranges occupy almost 15% of the total area of Oman (Ministry of Information, 1997). The remaining part of the land is mainly wadis and desert (about 82% of the total area) and life in this area is very limited (Ministry of Information, 1997). However, the public sector is still obliged to provide services to these areas. Although the area is classified into three
main segments, the reality is that each part of the country includes a mixture of topographical terrain, so site surveys are fundamentally necessary for each project.

Figure 4.1 Geographical location of Oman
4.3 Climate
The temperature in Oman range between 15°C and 54°C, and generally during the daytime, the temperature can reach 50°C between May and September. Additionally, during this time of the year, wind in areas facing the Arabian Sea and desert areas often raises sandstorms and construction work is suspended at midday. In fact, on-shore work in the Arabian Sea can be totally suspended during the period between May and September.

There is very little rainfall in many parts, with the exception of the Dhofar area, which has a tropical climate and receives seasonal rainfall during the period from June to September as a result of the monsoon winds from the Indian Ocean. Similar to other parts of Oman, infrastructure construction is slowed down during this period of the year due to low visibility and high tides in the coastal area.

In general, the mountainous areas in Oman receive more rainfall, and annual rainfall on the country’s highest point Jabal Akhdar (3,000 metres above sea level) exceeds 400mm; drops in temperature in these areas result in snow cover once every few years. Working downstream of wadis is associated with risk because works can be dramatically damaged, if not totally washed out. Therefore, contractors’ understanding of the risks associated with a project site should be scrutinised by the client before the award of any construction project.

4.4 Socio-Cultural Context
Omani people are ethnically diverse; the population is composed of Arabs, Balochis, and Swahilis. The largest non-Arab Omani community is the Balochi people. At least 12 different languages are native to Omani citizens, and some languages are limited to specific geographical areas or families.

The Omani people accepted Islam peacefully during the prophet’s time, in the year 629, and the majority of people in Oman are now Muslims. During the confrontation between Muslims in Iraq and the development of the Sunni and Shiite schools, Oman decided not to follow any of them and remained independent, leading to the creation of the Ibadhi School. Over time and with immigration between different countries, at present, the Muslims in Oman
include members of all three schools of thought. Other faiths like Christianity, Hinduism and Sikhism are also found in Oman. Although the Omani community is split along social, ethnic and regional lines, the idea of the Omani nation is the collective framework of belonging.

In a multi-cultural construction industry, an understanding of cultural aspects can help in managing issues during project delivery. Looking at an issue highly related to this research, a study by Loosemore and Muslmani (1999) indicated that Arab culture was responsive, informal, flexible in resolving projects problems and tended to ignore schedules. This shows the sensitivity of cultural issues, which could influence construction project performance.

4.5 Political Stability and Legislation
According to the Economist Intelligence Unit (2012), the established structures of political power in Oman are expected to be stable over the period between 2012 and 2016. The Unit clarifies that Oman's ruler (Sultan) commands wide popular support and the country's traditional social structure is very strong. Internationally, Oman has preferred a very quiet political strategy, and for many years the country has maintained friendly relations with both western nations, notably the US and the UK, and its neighbours.

Since the implementation of the 2011 Basic Law of State, which is considered to be Oman's constitution, amendments so far suggest a desire to shift away from a system of absolute monarchy towards a constitution-based country (Economist Intelligence Unit, 2012). The most important amendment includes the granting of legislative powers to the Majlis Al-Shura and Majlis Al-Dawla (parliament). The 84 members of the Majlis Al-Dawla are appointed by the ruler for a four-year term, and members of the 84-seat of the Majlis Al-Shura are elected for a four-year term by universal voting. The Majlis Al-Shura is required to review and comment on all new legislation and amendments to existing legislation before they can be endorsed by the Sultan. Unlike the situation before 2011, this process (Figure 4.2) allows more involvement from the public in setting new laws or updating the existing ones, but this may lengthen the decision-making process.
4.6 Economy Overview

The government in Oman is undertaking various economic development projects to improve standards of living by attracting more international investment and increasing international trading. Oman has been a member of the World Trade Organisation since October 2000 (World Trade Organisation, 2013). The availability of airports and flexibility of travel between Oman and the UAE allow easy movement of professionals between the two countries. At the same time, this flexibility could lead to high manpower turnover.

Oman has two airports, one in Muscat and another in Salalah, the main city of Dhofar Governorate. In addition, there are other internal airports in Sohar, Al-Duqum, Adam, Khasab and Ras Al-Had. There are cargo ports in Muscat and Sohar, a large-scale modern container port at Salalah, and a dry dock and container post at Al-Duqum. A modern road network links the northern and southern cities.

The Omani Government is implementing a five-year plan to reduce the country’s dependence on oil revenue and expatriate labour. The plan generally focuses on developing sectors other than oil and gas, such as fisheries, tourism, re-export and manufacturing. The plan also gives great attention to job creation for Omanis in the private sector, and the development of interior cities. Oman’s 2020 economic vision is based on the following main goals (World Trade Organisation, 2014):
- Development of human resources and upgrading Omani skills and competencies.
- Establishment of a stable macroeconomic framework that increases private sector competitiveness by optimising the use of human and natural resources.
- Creation of an appropriate environment for the realisation of economic diversification.
- Reduction of inequality among cities and various income groups.
- Preservation of past achievements and their further development.

At present, the five-year plan is mainly based on oil revenue, which has been the main source of project funding in Oman over the past 40 years. In recent years, Oman has discovered more oil reserves than what has been produced during the past 40 years; however, the complex geology in Oman makes production expensive and challenging. Table 4.1 illustrates key facts about Oman’s economy during the period between 2009 and 2011. Increases in oil production and prices contribute heavily to the country’s review and revenue expenditure.

### Table 4.1 Key facts about the economy of Oman

<table>
<thead>
<tr>
<th>Description</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Government Revenue (Mn.R.O)</td>
<td>6,748.4</td>
<td>7,916.5</td>
<td>12,491.2</td>
</tr>
<tr>
<td>Oil &amp; Gas Revenue as a % of Total Government Revenue</td>
<td>77.4</td>
<td>80.9</td>
<td>86.8</td>
</tr>
<tr>
<td>Total Government Expenditure (Mn.R.O)</td>
<td>7,428.7</td>
<td>7,965.3</td>
<td>10,737.9</td>
</tr>
<tr>
<td>Average Daily Production of Oil (000 BBL)</td>
<td>813.0</td>
<td>864.6</td>
<td>884.9</td>
</tr>
<tr>
<td>Average Oil Price (US $)</td>
<td>102.95</td>
<td>76.64</td>
<td>56.67</td>
</tr>
<tr>
<td>Road Asphalted (Km)</td>
<td>25,926</td>
<td>28,903</td>
<td>29,685</td>
</tr>
<tr>
<td>Electricity production (GWH)</td>
<td>17,823</td>
<td>19,159</td>
<td>21,354</td>
</tr>
<tr>
<td>Water production (Mn. Gallon)</td>
<td>41,765</td>
<td>48,683</td>
<td>53,266</td>
</tr>
<tr>
<td>Inflation %</td>
<td>3.94</td>
<td>3.20</td>
<td>4.07</td>
</tr>
</tbody>
</table>
The International monetary fund is expecting Oman’s GDP to increase from 78.646 billion USD in 2013 to 81.550 billion USD in 2015. Figure 4.3 shows that Oman’s GDP has increased dramatically over the past 15 years. The share of the oil and gas sector in Oman’s GDP is about 52%, and of the services sector, about 35%.

![Figure 4.3 Oman’s GDP between 1995 and 2015](image)

4.7 Demography

Demand for public services increases with increases in population. Over the past 30 years, the population of Oman has risen dramatically. The total population has risen from 1.2 million (estimate) in 1980 to approximately 2.8 million in 2010 (2010 Census). The population forecast presented in Table 4.2 shows that the population of Oman is expected to keep on increasing up to 2050. Similarly, life expectancy at birth is expected to increase to reach 83.8 years in 2050. At the same time, it is important to note that non-nationals constitute about 30% of the total population and approximately 78% of these are male (United Nations Economic and Social Commission for Western Asia, 2011).

The data provided in Table 4.4 show that more than 55% of the population are concentrated in about 9% of the total area of Oman (Muscat and Al Bhatina). The remaining 45% are spread over a wide area, which makes the cost of development per capita very expensive.
Table 4.2 Oman population growth
(Source: United Nations Economic and Social Commission for Western Asia, 2011)

<table>
<thead>
<tr>
<th>Year</th>
<th>Population (thousands)</th>
<th>Population growth rate %</th>
<th>Life expectancy at birth (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
<td>Total</td>
</tr>
<tr>
<td>1980</td>
<td>608</td>
<td>546</td>
<td>1,154</td>
</tr>
<tr>
<td>1985</td>
<td>810</td>
<td>689</td>
<td>1,498</td>
</tr>
<tr>
<td>1990</td>
<td>1,008</td>
<td>802</td>
<td>1,810</td>
</tr>
<tr>
<td>1995</td>
<td>1,280</td>
<td>874</td>
<td>2,155</td>
</tr>
<tr>
<td>2000</td>
<td>1,228</td>
<td>965</td>
<td>2,193</td>
</tr>
<tr>
<td>2005</td>
<td>1,410</td>
<td>1,112</td>
<td>2,522</td>
</tr>
<tr>
<td>2010</td>
<td>1,645</td>
<td>1,158</td>
<td>2,803</td>
</tr>
<tr>
<td>2015</td>
<td>2,715</td>
<td>1,443</td>
<td>4,158</td>
</tr>
<tr>
<td>2020</td>
<td>2,904</td>
<td>1,610</td>
<td>4,514</td>
</tr>
<tr>
<td>2025</td>
<td>3,023</td>
<td>1,747</td>
<td>4,770</td>
</tr>
<tr>
<td>2030</td>
<td>3,068</td>
<td>1,852</td>
<td>4,920</td>
</tr>
<tr>
<td>2035</td>
<td>3,059</td>
<td>1,933</td>
<td>4,992</td>
</tr>
<tr>
<td>2040</td>
<td>3,008</td>
<td>1,999</td>
<td>5,007</td>
</tr>
<tr>
<td>2045</td>
<td>2,973</td>
<td>2,063</td>
<td>5,036</td>
</tr>
<tr>
<td>2050</td>
<td>2,942</td>
<td>2,123</td>
<td>5,065</td>
</tr>
</tbody>
</table>

4.8 Administrative Governorates
Royal Decree 114/2011 (MOLA, 2011) established 11 governorates (Figure 4.4):
Al Dakhiliyah, Al Dhahirah, North Al Batinah, South Al Batinah, Al Buraymi, Al Wusta, North Al Sharqiyah, South Al Sharqiyah, Dhofar, Musandam and Muscat.
According to Figure 5.4, each government has its own characteristics and administrative area. Local councils were established by Royal Decree 116/2011, which set the basis for the involvement of the community in the development of their local area. Each council consists of members from various government departments in addition to local community representatives, elected every four years. The establishment of these councils was considered a good initiative by the government to involve local communities in the services delivery process. However, these councils are still in their early stages and their influence on services delivery is not clear. Additionally, their role as per the royal decree is just to provide suggestions for new projects; then it is up to the
Supreme Council of Planning to decide to accept or reject these suggestions. The involvement of the councils after budget approval is not clear, and overall, the councils’ roles are limited to providing suggestions to others. In other words, it is a one-way communication stream and there is a lack of interaction between the council and other government departments.

### 4.9 Workforce Availability

Data from the National Centre of Statistics shows that, as of May 2015, the number of civil service employees, including expatriates, is about 200 thousand (National Centre for Statistics and Information, 2015). Omani employees make up 80% and the remaining 20% are non-Omanis. In contrast, a much higher number of expatriates compared with Omanis work in the private sector. The statistics in Figure 4.5 show that 1,763,710 expatriates work in the private sector, compared with only 210,074 Omanis (National Center for Statistics and Information, 2016). This indicates that the private sector is heavily reliant on

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Governorate</th>
<th>Percentage of total population</th>
<th>Number of cities</th>
<th>Area (Km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Al Dakhiliyah</td>
<td>11.78</td>
<td>8</td>
<td>31,900</td>
</tr>
<tr>
<td>2</td>
<td>Al Dhahirah</td>
<td>5.47</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Al Batinah</td>
<td>27.86</td>
<td>12</td>
<td>25,000</td>
</tr>
<tr>
<td>4</td>
<td>Al Buraymi</td>
<td>2.63</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Al Wusta</td>
<td>1.52</td>
<td>4</td>
<td>79,700</td>
</tr>
<tr>
<td>6</td>
<td>Al Sharqiyyah</td>
<td>12.64</td>
<td>11</td>
<td>72,800</td>
</tr>
<tr>
<td>7</td>
<td>Dhofar</td>
<td>9.00</td>
<td>10</td>
<td>99,000</td>
</tr>
<tr>
<td>8</td>
<td>Musandam</td>
<td>1.13</td>
<td>4</td>
<td>1,800</td>
</tr>
<tr>
<td>9</td>
<td>Muscat</td>
<td>27.97</td>
<td>6</td>
<td>3,900</td>
</tr>
</tbody>
</table>

Figure 4.4 Administrative governorates
expatriates. Therefore, expatriate play a big role in the private sector, as they represent the vast majority of the total workforce. More specific, the construction sector is a major employer of expatriates; they represent about 37% of the total private workforce (National Center for Statistics and Information, 2016). The statistics also show that about 75% of expatriates’ qualifications are lower than preparatory level.

Aycan et al. (2007: 13) suggest that Oman, “in common with other Middle Eastern states, has been heavily reliant on expatriate workers both for advanced technical and professional expertise and for manual labour”. In order to reduce the dependence on expatriates and create more opportunities for Omanis, the government has initiated the following measures (Al-Hamadi et al., 2007):

- Restricting expatriate labour coming into the private sector.
- Developed a manpower strategy to meet the needs of the private sector.
- Improving working conditions in the private sector. This includes the reduction of the working days per week from six to five.
- Support for willing Omanis to establish small and medium enterprises and encouragement for higher education graduate to become entrepreneurs in their own fields of interest by offering them financial incentives and guidelines.

4.10 Small and Medium Enterprises in Oman
A study by the Central Bank shows that SME contribution to GDP ranges between 15% and 20%, compared with 83% in Morocco and 40% in Dubai (Al Barwani et al., 2014). The total workforce in SMEs is estimated at about 40% of the total private sector workforce, and nationals working in the SME sector account for 2% of the total workforce (Al Barwani et al., 2014). In other words, the national workforce’s participation in the sector is negligible when compared with figures from developed or emerging economies, where over 80% of the workforce participate in SMEs. The limited participation of Omanis in SMEs could be argued to be due to negative attitudes towards the entrepreneurship market, fear of failure and the fact that the society’s mindset is focused on public sector employment (Al Shanfari et al., 2013).

Another prominent barrier to SMEs’ participation in government procurement is the negative impact of the governmental tendering and procurement processes, which generally exclude SMEs and give limited attention to corporate social values (Al Shanfari et al., 2013).

Given the key contribution of SMEs to the national economy, especially to employment and value addition, the government and the Central Bank introduced a number of initiatives in 2013 and 2014 to support and promote the SME sector (Al Barwani et al., 2014). In 2013, Royal Decree 36/2013 established the Public Authority for Development of SMEs in Oman to help SMEs become major contributors to the national economy. The authority is mandated to provide financial and technical support to SMEs to increase their ability to establish and develop their projects. Furthermore, a minimum of 10% of all government procurement contracts are required to be allocated to SMEs and similarly, large companies that win government contracts must sub-contract at least 10% of the contracts’ value to SMEs, with preference for those operating in the area of the project (Tender Board, 2013).
Overall, attention to SMEs’ participation in public procurement is in its early stages in Oman and the data are not available to assess the effect of the government initiatives intended to meet the set objectives of the SME sector. Additionally, action taken by the public sector to support SMEs lacks evidence.

4.11 Construction Procurement in Oman

Published research and information about the construction sector in Oman is very scarce. Furthermore, almost the entire public sector procurement process depends on physical communication within its own departments and between the public sector and the private sector. Therefore, getting information about construction procurement is very difficult, not only because of the document management methods, but also the confidentiality of the information. The following sections cover the main features of public construction procurement in Oman and highlight the main challenges causing time and cost increases. The chapter will be concluded with the elements that will be subjected to empirical investigation to identify those unique components which, when efficiently handled by public clients, can result in advantageous procurement outcomes in terms of time and cost.

4.11.1 Construction Procurement Strategies and Planning

Public construction in Oman is linked to a five-year plan which is validated on a yearly basis. At the beginning of each plan, each public department identifies its project’s needs and produces a report highlighting the initial scope and estimating the cost and key milestones before including the project in the five-year plan. Reports from all clients are reviewed by the Supreme Planning Council. The final list of projects and budgets is approved by the Council at the beginning of the five-year plan and then updated on a yearly basis to reflect the country’s economic position. However, none of the project prioritisation criteria used in the development of the five-year plan has been published. Recent changes in the Basic Law have made the plan a subject of conflict between clients and the Majlis Al-Shura, and the prioritisation approach applied by clients has become questionable. Even though the process flow, shown in Figure 4.6, seems clear and straightforward, nonetheless the development of public project prioritisation criteria for the five-year plan remains a prerequisite for the project planning strategy to be reliable. Additionally, the improvement of construction
procurement requires a better understanding of key areas which, when efficiently handled, lead to better performance. The government’s tendering law and regulations are the only available guide to public procurement. However, the limited published research about construction procurement in Oman provides a general idea about some of the most important strategic and planning factors influencing construction time and cost. The non-availability of public construction procurement guidelines and lack of client team development are two constraints causing delays and cost overruns in construction projects in Oman. Moreover, Alkalbani et al. (2013) and Islam and Khadem (2013) argued that lack of past project records, budget limitations, and changes have been frequently ranked as important factors influencing construction time and cost. Construction procurement is similar to other business operations; organisations are required to frequently assess their operations and take actions to overcome any problems through collaboration with other partners. Top management support, as seen in Section 3.5.7, plays a vital role by translating difficulties into actions and encouraging new ideas.

Figure 4.6 Five-year plan process
4.11.2 Public Construction Procurement Systems

The construction industry in Oman has been growing fast, especially during the past five years. Bearing in mind Oman’s relatively small population of only 4.2 million people, the scale of the construction and infrastructure development projects that have already been completed or are under construction is impressive.

Oman’s last five-year plan (2011 to 2015) envisages a total capital expenditure of 79 billion USD. The bulk of this value is set to be invested in large construction projects across the country (Courtney-Hatcher et al., 2013). The construction of these projects is outsourced to the private sector using one of the following procurement systems:

- **Design-build – Unit rate contract**
  The client organisation is responsible for the development of the required scope of work and provisional quantities so that all proposals are evaluated on the same commercial basis. After award, the contractor is paid based on the actual re-measured quantities.

- **Design-build – Lump-sum contract**
  In this case, the public organisation develops the design and construction documents and the bidders are asked to propose a fixed cost for the design and construction. However, the tendering regulations still require the client to include provisional quantities in the tender documents for the contractor to price. The contractor is then paid a percentage of each item in the bill of quantities based on the work’s progress. The rates entered by the contractor against each item can also be used to evaluate the cost of any variation to the contracted scope of work.

- **Design-bid-build - Unit rate contract**
  The public construction client initially appoints a specialised consultant to design the required facilities and develop the construction documents. After that, bidders are asked to submit proposals according to a detailed scope of work, specifications, bill of quantities, and drawings. The actual quantities are re-measured during construction and the contractor is paid based on actual completed work.
- **PPP procurement in Oman**

At present, PPP procurement in Oman is limited to power generation and water desalination. The procurement process is governed by the Tender Law and the Electricity and Water Privatisation Law. The concessioner is responsible for designing, financing, constructing and operating the facilities. The first BOOT project was awarded in 1994 for power generation project and its 20-year concession will end in 2022 (Oman Power and Water Procurement Company, 2012). Since this project, all other PPP projects have been awarded on a BOO basis. The Oman Power and Water Procurement Company is responsible for purchasing the produced water and electricity and pays the concessioner the agreed fees. These fees are generally one of two types:

- **Fixed Fee**: This is paid for the availability of the product (water/electricity).
- **Variable Fee**: This is paid for the utilised quantity of the product.

**4.11.3 Public Sector Procurement Principles**

The public sector is by far the largest procurer of construction in Oman (Courtney-Hatcher et al., 2013). Public procurement is governed by the Tender Law, which was first issued in 1984 and then updated in 2008. Based on the Tender Law, public procurement must comply with the following main principles:

- **Transparency.**
  
  Public tenders are published in local newspapers and on the Tender Board website. Furthermore, tenderers are required to submit their proposals by hand and attend each envelope’s opening at the time of submission. Tenderers’ prices are announced in front of tenderers and any tender not complying with the set instructions is disqualified immediately.

- **Provide equal opportunities for all companies/freedom of competition.**
  
  All companies meeting the published criteria are eligible to collect the tender documents and submit a proposal. At the same time, the tender specification is general and should not be directed toward a specific product or supplier.
- **Equality.**
  The tender award is based on the criteria provided in the tender documents. Tenderers that do not meet the set criteria are informed in writing by the Tender Board.

- **Change control during construction**
  The Tender Law (Ministry of Legal Affairs, 2008) defines a scope change as any alteration to the contract after the project award. This includes but is not limited to specifications, quantities, durations, and prices. However, the law authorises the concerned department to issue variations without referring to the Tender Board to the extent of a total value not exceeding 10% of the original contract approved by the Tender Board. Furthermore, the concerned department can issue an extension to the contract without referring to the Tender Board as long it is justifiable.

Changes initiated by the client have frequently been reported as one of the most significant causes of cost and time overruns (Doloi, 2013; Iyer and Jha, 2005; Trost and Oberlender, 2003). Doloi argued that changes by the client can be made for several reasons, mainly poor site management and supervision, unforeseen ground conditions, and decision making issues. Although contractors and consultants are important elements in activities such as site management and cost control, it is more important for the client project manager to achieve overall project success (Iyer and Jha, 2005). Therefore, public clients’ ability to be involved during construction allows better control over construction time and cost. Decisions on changes highly depend on the project manager's judgement and understanding of the decision-making process. Proactive decision approval by the project manager significantly enhances the contractor’s management ability and the overall project management (Doloi, 2013).

**4.11.4 Procurement Process**
The Tender Board was established in 1974 to overlook all tenders above 250,000 OMR, which was increased to three million in 2013 (Ministry of Legal...
Affairs, 2013). Figure 4.8 illustrates the procurement process and the relationships between the Tender Board, the client organisation, and bidders. A project is initiated when the client organisation identifies the need for a facility, the objectives and the initial cost estimate and starts communication with the Supreme Planning council about the five-year plan. All public client organisations’ requests are reviewed together with direct coordination between the council and the Ministry of Finance. As per the new legislation issued in 2011, the five-year plan and yearly budget are required to pass through the Majlis Al Shura. In 2015, the Majlis Al Shura reviewed and approved a five-year plan for the first time. To date, it is not clear how the Majlis Al-Shura is exercising its rights as guaranteed under the new legislation.

Following the budget approval, the procurement process follows the standard process. The process mainly involves three parties: the client, the Tender Board and tenderers if the project’s value is above three million OMR, or only the client and tenderers if the project estimate is less than three million. The Tender Board is a central procurement organisation that was established to ensure an impartial tendering process and compliance with the Tender Law.

The client organisation is the central part of the project delivery; however, the majority of procurement activities are outsourced to third parties. Consultants in most cases act as clients’ representatives from the initiation stage to construction completion. For example, at the initiation stage the consultants carry out the project’s feasibility studies, identify users’ requirements, plan the project, and obtain permits from the concerned authorities. In general, the consultant is the client’s representative and client employees visit the project site rarely during the construction lifecycle.

4.11.5 Contractor and Consultant Selection
At present, consultants and contractors are mostly selected based on quality/price criteria which are configured to suit the complexity and objectives of each project. Evaluation of the tenderers’ proposals is conducted by a consultant under the client’s supervision. After the review of the evaluation report by the client, award recommendations are presented to a committee within the client organisation; the committee award the project if the cost is less
than three million, otherwise a recommendation is sent to the Tender Board for review and award.

Even though a scoring method is used for tender evaluation, bidders could be disqualified if the client finds that the information provided is incorrect, if they use fraudulent means to influence the award decision, or if they have failed to satisfactorily perform their obligations under a previous contract with any organisation that is subject to the provision of the Tender Law (Tender Law, 2008).

The tender law also allows direct negotiation in specific situations, in which case the client is required to provide strong justification to the Tender Board for accepting the case.

Figure 4.7 Procurement process in Oman

4.11.6 Construction Procurement Challenges
Even though the public sector is calling for better performance in the development of construction projects, study of public construction shows that
the client organisation is the main source of project delays and cost overruns. According to Mohsin (1985), public clients in Oman lack the knowledge and skills needed for managing and controlling construction projects. More specifically, Alkalbani et al. (2013) and Islam and Khadem (2013), as shown in Table 4.3, identified various barriers to performance improvement in the construction sector in Oman.

Table 4.3 Challenges to performance improvement in construction procurement

<table>
<thead>
<tr>
<th>Barriers identified by (Alkalbani et al., 2013)</th>
<th>Barriers identified by (Islam and Khadem, 2013)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Resistance to change in the construction sector.</td>
<td>- Lack of professionalism in construction management.</td>
</tr>
<tr>
<td>- Lack of training and change management ability.</td>
<td>- Incompetent project supervisors.</td>
</tr>
<tr>
<td>- Shortage of skilled professionals.</td>
<td>- Incomplete drawings.</td>
</tr>
<tr>
<td>- Cultural issues: people do not accept liability for change and prefer practicing what they are used to doing.</td>
<td>- Lack of top management support.</td>
</tr>
<tr>
<td>- Lack of personal incentives (human behaviour).</td>
<td>- Lack of collaboration between team members.</td>
</tr>
<tr>
<td></td>
<td>- Financial issues.</td>
</tr>
</tbody>
</table>

The studies of Alkalbani et al. (2013) and Islam and Khadem (2013) uncovered some of the key challenges in working toward procurement improvement in Oman. These challenges are in line with the factors discussed in Chapters 2 and 3. Therefore, the development of the client organisation’s capabilities is a priority for better procurement performance. This development should not be limited to training in technical aspects, but should also focus on social and organisational management. Furthermore, in order to be successful in implementing change, team members should share the perception that change benefits the entire sector (Alkalbani et al., 2013).
A study conducted by Alnuaimi et al. in 2010 identified 21 major causes of variation orders in public construction projects in Oman. The client was determined as the top problem category in construction projects in Oman (Alnuaimi et al., 2010; Mohamad et al., 2012; Islam and Khadem, 2013). Based on Alnuaimi et al. (2010), the five major key effects of these causes include:

- Delays to the completion dates of projects
- Claims and disputes
- Cost overruns
- Adverse effects on the performance and morale of labourers
- Adverse effects on the quality of work

A study by Yafai et al. (2014) classified factors causing construction project delays and cost overruns in public construction into “very high risk” and “moderate risk”. According to these studies, client-related factors can be classified into five groups (Table 4.4): strategies and planning, collaboration, social factors, consultancy efficiency and construction efficiency.

These factors are not just limited to Omani construction procurement; in fact, the literature review in Chapters 2 and 3 indicates that these factors have persisted for a long time in construction procurement. For example, Ling et al. (2013) identified eight critical success factors in Australian construction procurement, namely: accurate project planning and monitoring, design efficiency, effective site management, effective communication, contractors’ efficiency, project characteristics, market competition, and finally due diligence.

Stakeholders’ involvement, performance assessment, knowledge management, encouragement of new ideas, learning from experience, and learning sharing are other factors that appear to be critical according to the literature review in Chapters 2 and 3, but their effects on delays and cost overruns have not yet been tested within public procurement in Oman. These elements not only influence procurement in single projects, but also establish a basis for sustainable procurement improvement through continuous performance assessment, more interaction, collaboration and the support of corrective actions. The growing integration needs between procurement partners requires embedding these factors within the overall procurement systems.
Table 4.4 Causes of delays and cost overruns in Omani construction projects

<table>
<thead>
<tr>
<th>Causes of delays and cost overruns</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Procurement strategies and planning</strong></td>
<td></td>
</tr>
<tr>
<td>Non-availability of public procurement guidelines</td>
<td>Alnuaimi et al. (2010)</td>
</tr>
<tr>
<td>Lack of past project records to inform future decisions and support better performance</td>
<td>Alnuaimi et al. (2010)</td>
</tr>
<tr>
<td>Client team lacks knowledge and skills</td>
<td>Alnuaimi et al. (2010) (Yafai et al., 2014)</td>
</tr>
<tr>
<td>Lack of clarity in decision-making</td>
<td>Alnuaimi et al. (2010)</td>
</tr>
<tr>
<td>Insufficient budget for the required scope</td>
<td>Alnuaimi et al. (2010) (Yafai et al., 2014)</td>
</tr>
<tr>
<td>Lack of understanding about best value</td>
<td>(Yafai et al., 2014)</td>
</tr>
<tr>
<td><strong>Collaboration</strong></td>
<td></td>
</tr>
<tr>
<td>Poor communication between relevant government departments</td>
<td>Alnuaimi et al. (2010)</td>
</tr>
<tr>
<td>Lack of contractor supports for achieving the project’s objectives</td>
<td>(Yafai et al., 2014)</td>
</tr>
<tr>
<td>Efficiency of contractors’ and consultants’ communication</td>
<td>(Yafai et al., 2014)</td>
</tr>
<tr>
<td>Trust between contractor and clients</td>
<td>(Yafai et al., 2014)</td>
</tr>
<tr>
<td>Contractor and owner cooperation</td>
<td>(Yafai et al., 2014)</td>
</tr>
<tr>
<td>Contractor and consultant cooperation</td>
<td>(Yafai et al., 2014)</td>
</tr>
<tr>
<td>Use of new technology</td>
<td>(Yafai et al., 2014)</td>
</tr>
<tr>
<td><strong>Social and environmental</strong></td>
<td></td>
</tr>
<tr>
<td>Workforce resource availability</td>
<td>(Yafai et al., 2014)</td>
</tr>
<tr>
<td>Legislation and regulations</td>
<td>Alnuaimi et al. (2010) (Yafai et al., 2014)</td>
</tr>
<tr>
<td>Working culture in the construction industry</td>
<td>(Yafai et al., 2014)</td>
</tr>
<tr>
<td>Fraud and abuse</td>
<td>(Yafai et al., 2014)</td>
</tr>
<tr>
<td><strong>Consultancy efficiency</strong></td>
<td></td>
</tr>
<tr>
<td>Consultants’ ability and experience</td>
<td>Alnuaimi et al. (2010) (Yafai et al., 2014)</td>
</tr>
<tr>
<td>Failure to achieve the desired quality level</td>
<td>(Alnuaimi et al., 2010) (Yafai et al., 2014)</td>
</tr>
<tr>
<td>Terms and conditions of design services do not suit the present construction situation</td>
<td>Alnuaimi et al. (2010)</td>
</tr>
<tr>
<td>Unrealistic design time</td>
<td>Alnuaimi et al. (2010) (Yafai et al., 2014)</td>
</tr>
<tr>
<td>Project’s special features</td>
<td>(Yafai et al., 2014)</td>
</tr>
<tr>
<td>Lack of clarity about clients’ requirements</td>
<td>Alnuaimi et al. (2010) (Yafai et al., 2014)</td>
</tr>
<tr>
<td>Inadequate information in the tender documents</td>
<td>Alnuaimi et al. (2010) (Yafai et al., 2014)</td>
</tr>
<tr>
<td>Errors in the design deliverables</td>
<td>Alnuaimi et al. (2010)</td>
</tr>
<tr>
<td>Consultants fail to deliver their scope of work effectively</td>
<td>Alnuaimi et al. (2010) (Yafai et al., 2014)</td>
</tr>
<tr>
<td><strong>Construction efficiency</strong></td>
<td></td>
</tr>
<tr>
<td>The client makes requirement changes</td>
<td>Alnuaimi et al. (2010) (Yafai et al., 2014)</td>
</tr>
<tr>
<td>Terms and conditions of construction services do not suit the present construction situation</td>
<td>Alnuaimi et al. (2010)</td>
</tr>
<tr>
<td>Weak contractor abilities</td>
<td>Alnuaimi et al. (2010) (Yafai et al., 2014)</td>
</tr>
<tr>
<td>Delays in contractor payments</td>
<td>(Yafai et al., 2014)</td>
</tr>
<tr>
<td>Sub-contractors’ ability</td>
<td>(Yafai et al., 2014)</td>
</tr>
<tr>
<td>Site restriction</td>
<td>(Yafai et al., 2014)</td>
</tr>
<tr>
<td>Difficulties in material procurement</td>
<td>(Yafai et al., 2014)</td>
</tr>
</tbody>
</table>
4.12 Summary

Oman is relatively a small country with a population of about four million. However, this population is spread over 309 thousand kilometres squared, which requires huge funding for the development of services like roads, water, electricity, health, and education. Lack of professionals makes it more difficult to best utilise public funding. Public construction projects suffer from both delays and cost overruns. Public sector procurement lacks clarity about activities that could help in minimising delays and cost overruns. A systematic approach is needed for the best utilisation of the limited professionals. In addition, the construction procurement process involves many fragmented parties without a collaborative framework focusing on team integration, teamwork, knowledge sharing. The Omani community has a very strong social structure where people like to be involved; however, such an environment is not well employed in public sector practices. Therefore, public sector team development should not only be limited to technical aspects within the construction lifecycle process; equal attention should be given to social elements and wider community interests.

There are limited studies investigating construction procurement in Oman. Previous studies indicate difficulties in implementing changes in construction procurement in Oman. A better understanding of the procurement working environment is a prerequisite for the implementation of any change, not only in Oman but also in other contexts. This research depends on gathering data from the public construction in Oman and the direct involvement of people working in Oman. The participation of these people will reflect the working culture in Oman and provide direction for the development of systems that are acceptable to them and can be integrated into daily working practices.
5 CHAPTER FIVE: RESEARCH METHODOLOGY

5.1 Introduction
This chapter discusses the research methodology upon which this research is based. It outlines the approach followed in this research to achieve the set aim and objectives. The first four sections of the chapter highlight the philosophical consideration in the research. Then the chapter discusses the research strategy, design, and methods. Subsequently, the chapter also presents the data collection, and finally concludes with how these data were analysed. Each of these sections describes the approach adopted in this research and how the research process was undertaken.

5.2 Research Methodology
Research methodology was defined by Kothari (2004) as the logic used in the context of the research study, which explains the methods or techniques used so that research results can be evaluated either by the researcher or by others. In addition to the set of methods, the methodology includes the set of conceptual and philosophical assumptions that justify the use of a practical or abstract investigation. Therefore, the research methodology comprises philosophy, strategies, approaches, method choices, data collection, and analysis techniques and interpretation (Saunders et al., 2012).

5.1 Research philosophy
Understanding the research philosophy is essential for the researcher to make a critical selection of an appropriate research strategy (Robson, 2002). Three reasons have been noted by Easterby-Smith et al. (2012) for understanding the philosophical issues in research:

- It can help to define the research design.
- It can help to identify which design matches the research objectives.
- It can help the researcher to consider the research constraints of different knowledge structures.

The researcher should acknowledge the assumption of one of two main philosophical perspective traditions: ontological and epistemological (Bryman, 2008). According to Bryman (2008), the epistemological and ontological
considerations are the main positions of philosophy in social research and in research that is concerned with construction management.

5.2 The Concept of Client Success Components

Delays and cost overruns in construction projects continue to be major concern in public procurement. According to Sterman (2000), the actions taken by policymakers to solve such important problems often fail, or even make things worse or create new problems. In fact, policymakers pay an enormous, hidden price when trying to solve problems by breaking them into parts and giving less attention to the whole picture (Senge, 1990). This is because changes in one part of the system can affect other parts and subsequently the outcome of the project. Thinking about the whole picture captured in the world can order people’s thought and practices (Checkland, 1981). Recent attempts to enable improvement using the concept of critical success factors (CSF) are unfortunately either limited to few separate elements or factors developed without allocating the controlling party (see Section 3.2.3).

Back in 1961, Daniel (1961) first discussed the concept of success factors in management. The focus was on industry-related CSF, mostly relevant for any company in a particular industry. In 1972, Anthony et al. (1972) were more specific, emphasising the need to link CSF to both a company’s particular strategic objectives and its particular managers. Combining the perspectives of Daniel (1961) and Anthony et al. (1972), Rockart (1979) confirmed that organisations in the same industry may exhibit different CSFs because of differences in geographic location and objectives. According to Rockart (1979), CSF analysis is beneficial in identifying key areas which, if efficiently handled, will ensure successful competitive performance for an organisation in the specific geographical area. Therefore, the identification of CSF can provide a clear definition of the activities that a client must focus its effort on to meet a construction project’s objectives, rather than being distracted with less important activities. Client management will then also get direction as to the success components of their involvement in the development of construction projects. Accordingly, a check and balance of these success components allows weak areas to be identified and subsequently appropriate actions to enhance overall client performance can be thought about.
Aiming to facilitate efficient client participation in public procurement, this research considers a holistic approach to the analysis of public client success components, focusing on client success components’ constituent interrelated parts. It considers the whole operation cycle, starting from its original inception and ending with construction completion. Therefore, the study’s approach implies the study of client success components as a whole, rather than as simply an assembly of separate parts (Bertalanffy, 1968; Laszlo, 1996). This approach helps to study how to change and improve clients’ involvement more effectively and to act more in harmony with the natural processes of real daily practices. Also, it could help clients to recognise which action to take and when.

The literature review in Chapters 2, 3 and 4 identified 75 (Appendix 2) separate client activities that might affect project performance. Therefore, the adoption of appropriate analysis tools can initiate and guide actions that take into account the interaction between the different parts of public client intervention activities. Developing models on the basis of experience allows intervention, and in reality, the project becomes more successful. Furthermore, Pidd (2004) argued that changes and improvements are usually achieved by building and using systems models. Pidd further clarifies that modelling is an activity used to develop a representation that provides useful insights into what is being modelled. To be more effective, modelling must focus on the clients’ needs, because the client is the party whose behaviour must be changed to solve the problem (Sterman, 2000). Moreover, Little (1970) suggests that the essential properties of a model are to be simple, easy to understand and help people to think and take decisions. Models can be used in four main ways, based on the level of human interaction (Pidd, 2009):

- Decision automation. In this type, models are used to replace human decisions. Decisions can be automated and therefore interaction is limited. Such models must accurately represent all real-world circumstances and must be subjected to severe tests of validity before actual implementation.
- Routine decision support. In this type, models are used to support human decisions, but not to replace them. The model must be based on accurate data, but not necessary cover all circumstances.
- System investigation and improvement. This type of model is developed to understand why a system is behaving as it seems to be, or to consider options for improvement. These models are less precise than those of routine decision support. The system is modelled using approximate data rather than very detailed.

- Models that provide insight. This type is highly reliant on users and has little value without intelligent users. The model provides the users with direction to navigate and make a decision.

Construction projects are very dynamic and complex, and decisions can vary based on people’s judgement in each situation. Therefore, models for construction procurement can be developed to provide insight and support systems investigation and improvement. More than one researcher (see Pidd, 2003; Powell and Baker, 2003; Rivett, 1994) has noted that mathematic and statistical approaches lie at the core of modelling. Moreover, both principal component analysis and regression analysis have been widely used in investigating various issues in construction management. The vast majority of the studies cited in Section 3.2.3 (Table 3.2) used both types of analysis.

5.3 Conceptual Model
The conceptual model presented in Figure 5.1 illustrates that a number of separate client activities were identified in the literature that appeared to be important when developing a construction scheme in the public sector. The figure highlights the link between important client activities and construction procurement performance. On the right-hand side of the model is a continuum, which ranges from low performance at the bottom to high performance at the top. Even with the lowest performance, the client will still get a facility that can be used to provide services. However, at the top of the continuum, the public client has the potential to create additional public value as well as creating a physical facility. It was expected that the procurement performance would vary along the continuum depending on seven sets of client activities (client success components): project strategies, project planning, design efficiency, effective site management, collaboration, construction efficiency and social environment. Further, investigation of this relationship by collecting actual data from the real world can provide insight about the relationships amongst the 75 client activities
and identify the important client success components that, when achieved efficiently, can significantly minimise the risks of construction delays and cost overruns.

Figure 5.1 Conceptual model - client success components’ effects on procurement performance

5.3 Ontological and Epistemological Considerations

5.3.1 Ontological Position
Ontology involves the investigation of the theory of social entities and the key issues that exists within it (Walliman, 2006). The central ontological question is: “Do we know things about the real world, or is our knowledge a reflection of our manipulation of the world?” (Reich, 1994). Grix (2002), Walliman (2006) and Bryman (2008) all indicate that there are two main theoretical positions of ontology: objectivism and constructivism.
Objectivism is the belief that reality exists independent of social actors, as they are facts that have an independent existence. A characteristic of an objectivistic worldview is the existence of objective and unconditional truths (Lakoff and Johnson, 1980). Furthermore, the investigation is assumed to be value-free, thus the researcher remains neutral and objective (Darke et al., 1998).

Constructivism is the belief that reality is in a constant state of change because it is dependent on social interactions as they take place (Walliman, 2006). Constructivist researchers mostly focus on specific contexts in order to understand the historical and cultural backgrounds of the participants (Blaxter et al., 2007a; Creswell, 2003).

### 5.3.2 Epistemological Position


Positivism deals with the application of natural science procedures to the study of social reality. Additionally, the positivist position reflects a deterministic philosophy that the world conforms to the laws of cause and effect, and complex situations can be undertaken using a simplified approach (Creswell, 2014). Research initially makes claims and then refines or abandons some of them for other claims more strongly warranted (Phillips and Burbules, 2000). In practice, data are collected on instruments based on measures completed by participations (Phillips and Burbules, 2000). It is possible to capture these data using research instruments such as experiments and questionnaires (Blaxter et al., 2007).
In interpretivism, subjective meanings play a crucial role in social actions (Walliman, 2006). The understanding and interpretation of social reality are carried out by humans according to their beliefs (Darke et al., 1998). Thus, the researcher’s beliefs and values become the driving force in the interpretation of the findings (Bryman, 2004; Fitzgerald and Howcroft, 1998).

5.3.3 Philosophical Position of this Research
This research adopted a positivist position, as the researcher believes that real knowledge is based on observed facts. Additionally, the outcome of a project’s interim of delays and cost overruns is a result of actions by the client at various stages of the project lifecycle. Consequently, it is possible to construct measures that yield numerical data, which can then be further explored and interpreted by statistical analysis.

5.4 Research Strategies
A research strategy refers to the method that connects the researcher to a specific approach for collecting and analysing data (Denzin and Lincoln, 2000). According to Creswell (2014), research strategies can be classified into qualitative, quantitative and mixed. The adoption of any particular strategy depends on the aim of the study (Naoum, 2007). The two main strategies is discussed in the following sections.

5.4.1 Quantitative
Quantitative strategies seek to collect data in the form of numbers and study the relationships between the collected data (Blaxter et al., 2007; Punch, 2014). They tend to follow a positivist position to gather factual data in order to study the relationships between facts. Statistical techniques are employed to identify facts and relationships. Thus, data are analysed by interpreting numbers derived from these statistical techniques. Analysis is used to verify theories and search for a causal relationship between various variables (Gill et al., 2010). Thus, quantitative research follows the deductive approach in relation to theory and focuses on design measurement.
Robson (2002) noted that deductive research goes through five sequential stages:

- Deducting hypotheses from theory.
- Presenting these hypotheses in operational terms.
- Testing the hypotheses.
- Examining the outcomes of the research.
- Updating the theory in line with findings.

Hypotheses may be deducted by the researcher by synthesising concepts and ideas that already exist in the literature (Remenyi et al., 1998) and subsequently, a conceptual or theoretical structure is developed prior to empirical observation and testing. In most cases, a hypothesis is tested by analysing quantitative data collected from a large population sample. Analysing the outcomes of these quantitative data provides a broad set of findings to generalise (Patton, 2002). Thus, the outcome of sample analysis can be generalised to the population. Generally, experiments and surveys are the most common data collection methods used to gather quantitative data.

5.4.2 Qualitative Strategy

Qualitative research seeks to explore and understand people’s perceptions of a social or human problem (Creswell, 2014). It is characterised as explanatory and subjective in nature (Rubin and Babbie, 2007). The research process involves collecting data in the form of words rather than numbers, and the researcher interprets the meaning of the data without depending on numerical measurement (Fellows and Liu, 2008). In contrast with the quantitative strategy, the qualitative strategy follows an inductive approach. The inductive approach moves from data to theory. Blaikie (2000) noted four key stages in the inductive approach: observing and recording facts, interpretation of the collected facts, comparing and classifying and developing theory.

Therefore, the inductive approach starts with the collection of data about specific events and may then contribute to a new theory. The specific nature of qualitative research allows the researcher to select a small sample of respondents to establish different views of the specific events (Easterby-Smith
et al., 2012). Thus, the developed theory is fitted to a specific event and not expected to be generalised (Saunders et al., 2012).

Three types of data collection method are commonly used in qualitative research: direct observation, in-depth and open-ended interviews, and written documents. The data collection mainly focuses on determining what things exist, rather than quantifying. Therefore, the researcher's skills and competency play major roles in interpreting data in qualitative research (Patton, 2002).

5.4.3 Strategy Adopted for the Research
A quantitative strategy has been adopted in this research for the following reasons:

- The research involves testing the relationship between public client activities and construction projects' delays and cost overruns.
- The research aim is to assess the effect of public client activities through a study of the existing practices.
- The findings of the research are to be generalised to the study population and guide future public procurement practices.
- The researcher is an independent number in the study, leading to an unbiased result.

Bryman (2008) outlined the most important steps in quantitative research, as shown in Figure 5.2. The figure illustrates ideal quantitative research progress and the interconnection between the steps. Bryman (2008) further clarified that research is rarely linear as shown in the figure. However, the figure provides a useful description of the different stages in conducting quantitative research.
5.5 Research Design

The research design sets in place the master plan that guides the execution of the techniques of data collection and then data analysis. Saunders et al. (2012) mentioned that the selection of a research method should be guided by the research questions and objectives. On the other hand, Grix (2002) stated that research design should be viewed independently from ontological and epistemological assumptions, and research design should be guided by the research questions. Bryman (2004) noted that the choice of a particular research design should be guided by the research questions and objectives and
the extent of the existing knowledge. Furthermore, the same author clarifies that the selection should reflect the importance of the following:

- Identifying the causal relationships between variables.
- The generalisation of findings to larger groups than those that participated in the study.
- Understanding behaviours in their specific social context and the meaning of those behaviours.
- The temporal dimensions of social phenomena and their interconnection.

Fellows and Liu (2008) identified four research designs that are viable for addressing research questions in construction management. These designs are experiments, surveys, actions and case studies. Because the quantitative approach was adopted as the research strategy underpinning this study, the focus was mainly on two designs: experiment and survey, of which experiment was later not adopted for reasons explained in Section 5.5.3.

5.5.1 Experimental Research
Experimental research is best suited for formulating and testing hypotheses or issues in which the variables involved are known (Blaxter et al., 2007b). However, this type of research is not feasible for many types of management research for various reasons, such as the willingness of people to participate in the experiment, difficulties in arriving at a representative sample, ethical issues and cost (Saunders et al., 2012).

Generally, experimental research is undertaken in laboratories to test the relationships between the defined variables (Fellows and Liu, 2008). Experiments might also be done in real life environments, but according to McNeill (1990), it is very difficult to control the possible variables in the field.

5.5.2 Survey Research
Survey research is best suited for answering the questions who, what, where, how much and how many in research. Furthermore, surveys provide the basis for producing models of the relationships between variables and generating findings that represent the population. In designing a survey, various data collection methods may be employed, such as questionnaires and interviews.
Compared with the experimental design, survey design involves far larger samples (Bryman, 2004; Fellows and Liu, 2008). The data are collected from sample respondents by asking a number of predefined questions in a structured questionnaire (Blaxter et al., 2007b). Collecting primary data using a survey approach is very popular and common in management and business research (Saunders et al., 2012). The statistical analysis of the collected data provides the basis for reasoning about the relationship between variables and producing models of these relationships (Saunders et al., 2012). However, the dependence on respondents to get the required data can delays the progress of the research (Saunders et al., 2012). Other problems might arise with the truthfulness and accuracy of the collected data due to respondents’ difficulties understanding the questions (Blaxter et al., 2007b). However, the researcher can minimise these weaknesses with a well-designed survey.

5.5.3 Adopted Research Design
As mentioned in Section 5.5.2, a survey design provides the basis for establishing the relationships between variables and building models using statistical tools. The main question of this research is:

- What is the relationship between the client activities and construction procurement performance?

So, the survey design is the most appropriate for identifying the relationship between the activities of the client and delays and cost overruns based on a selected sample. Furthermore, it is a highly valuable method of assessing trends using statistical tools.

An experimental research design was not adopted because it would require the researcher to be involved in projects for many years, beyond the duration of this research. Furthermore, an experimental research design is cyclic in nature, with the researcher manipulating the variables until the desired results are achieved. Based on the process of these designs, which requires extensive time and resources, the researcher rejected this approach due to time limitation and resource constraints.
5.6 Data Collection Methods
Research generally follows one of two types of data collection approaches: empirical and non-empirical, which are also called primary and secondary data collections. Non-empirical is often desk research and involves reviewing literature relevant to the research subject. The empirical approach involves interaction with the field to gather facts about working practices (Easterby-Smith et al., 2012). Thus, this research adopted a survey design to gather empirical data.

5.6.1 Literature Review
A deep review of related literature is very important in research, first to justify the research, then to identify what has been done before and subsequently outline the right path for problem investigation. Thus, the literature review allowed the researcher to gain more of an understanding and insight necessary for identifying the relationship between public client procurement activities and construction delays and cost overruns.

Sources of literature include journal articles, books, conference papers and thesis (Creswell, 2014; Kumar, 2010). However, refereed journals provide information vetted by leading experts in the subject (Walliman, 2006). The relevance of such sources is achieved by searching for keywords or defined terms in electronic databases and web search engines. Examples of databases used in this research include Science Direct, Scopus, and Catalogue Plus.

The literature review in this research was conducted to investigate and identify construction procurement practices and those of other industries (automotive and aerospace industries), with the focus on client activities influencing construction time and cost. This part of the review helped to achieve the first three objectives and establish the basis for the research methodology and empirical research. The reason for investigating other industries was to identify best procurement practices. Both selected industries have engineering design and production phases, similar to the construction industry. Additionally, all three industries have high capital investment. However, it is very important to note that there are significant differences between the other two industries and the construction industry in terms of procurement activity approaches and applications. The automotive industry is leading in terms of supply chain
management applications and improvement, and to some extent, the aerospace industry has managed to learn from it to enhance its supply chain management (AlMaian et al., 2015; Gann, 1996; Hong-Minh et al., 1999). Therefore, the automotive and aerospace industries have been identified as sources for learning the best practices for client-related activities in construction procurement.

The relevant literature review is discussed in Chapter 1 (introduction), Chapter 2 (client activities throughout the procurement lifecycle), Chapter 3 (client organisational success activities) and Chapter 4 (construction procurement in Oman).

5.6.2 Questionnaire Survey

The questionnaire survey is a widely used data collection approach and can be used to collect primary data on any topic from large or small samples of people. Furthermore, the collected data are analysed more “scientifically” and objectively than other data collection methods. According to Fellows and Liu (2008), collecting data from a sufficient sample produces valuable information about an entire population. The results of the questionnaire can be quickly and easily quantified by the use of a software package such as SPSS. When data has been quantified, the results can be used to measure change effects. Additionally, positivists believe that using quantitative data collection methods allows researchers to test existing hypotheses and/or confirm new theories (Bryman, 2008; Creswell, 2014).

The researcher starts by translating the research objective into questions and then asking respondents to answer the same set of questions (Bernard, 2013). Interviews with a few people can be used to confirm the content validity of the questions (Wisker, 2001). Saunders et al. (2012) bring researchers’ attention to a number of elements that need to be considered when creating a questionnaire, which are as follows:

- The respondents’ characteristics.
- The importance of selecting specific respondents.
- The importance of not contaminating or distorting the respondents’ answers.
- Sample size.
- The type of questions that need to be asked to collect the data.
- The number of questions required for collecting the data.
- The time limit for data collection
- The cost of collecting the data.
- Use of ICT in collecting the data.

It is therefore important to consider these elements when conducting a questionnaire survey. A more detailed discussion addressing these elements is presented in Sections 5.7 to 5.12.

Here, it is important to note that questionnaires can be classified by method of administration: in-person, web-based, over the phone (Bernard, 2013), or mailed (email or post) (Fellows and Liu, 2008). Even though a questionnaire survey is less expensive than other methods, it has some limitations such as low response rate, self-selection bias, and lack of opportunities to clarify issues (Kumar, 2010; Rothwell, 1995).

5.6.3 Interview Survey

An interview survey is a purposeful conversation between two or more individuals with the aim of gaining information related to the specific research objectives (Sekaran, 2003). It is classified as either structured, semi-structured or unstructured based on the degree of flexibility of the survey. Structured interviews provide uniform information because the same questions are used for every respondent (Kumar, 2010). In contrast, a researcher carrying out unstructured interviews talks with the respondent without using predetermined questions (Fellows and Liu, 2008). The researcher may come out with in-depth data in this situation, but it may be difficult to use for analysis compared with structured interview data (Kumar, 2010). Similar features are shared with semi-structured interviews, but with a degree of structure to the questions, around which the interview is built (Naoum, 2007). The researcher can formulate new questions during the interview and use a structured set of questions to build structure into the collected data (Fellows and Liu, 2008).
Face-to-face meetings with respondents allow researchers to obtain in-depth data (Greenfield, 1996). However, interviews, in general, are time-consuming and expensive and more subjective than questionnaires (Kumar, 2010; Moore, 2000; Moore, 1983). King (1994); King and Horrocks, 2010) argued that the interview approach is best when:

- The research focus is the meaning of specific phenomena to the participants.
- There is a need for a series of interviews to study individual perceptions of a process within a social organisation.
- Individual historical views are required to study how a specific phenomenon has developed.
- An explanatory view is required for carrying out a quantitative study.
- There is a need to validate a determined measure or clarify the meaning of a quantitative study finding.

5.6.4 Adopted Data Collection Method

The questionnaire survey method was used in this research because it provides a wide representation of public client procurement practices and can be more efficiently administered and analysed than an interview survey. The wide representation allowed the researcher to learn about general trends in public client activities affecting construction delays and cost overruns. Even though similar conclusions could be achieved by carrying out an interview survey, that approach would require a long time and incur high costs, beyond the capacity of this research. Furthermore, responses in interviews are not in standardised format, thus, the analysis of a large number of interviews takes a long time. In contrast, the questionnaire survey method provides standardised responses, flexibility, a wider view and greater accuracy and reduces bias. The use of a standardised response rating makes it easy and quick for participants to complete and then to compile answers. Additionally, it also allows time for the participants to check facts, such as projects’ contractors, percentages of delays and cost overruns, and then think about their answers. This approach, according to Walliman (2006), tends to produce results with more accurate data. Furthermore, unlike interview surveys, questionnaire surveys increase the chances of getting truthful answers to sensitive questions such as those about
delays, cost overruns and assessment of client performance in past projects. Finally, questionnaires reduce bias, as they include uniform question and answer presentation and no middle-man bias. In other words, the researcher’s own opinions do not influence the respondents’ answers.

Larger samples are better than smaller samples (all other things being equal), because larger samples tend to minimise the probability of errors, maximise the accuracy of population estimates, and increase the generalisability of the results (Tabachnick and Fidell, 2006).

5.7 Questionnaire Design and Development
The questions were designed with the aim of capturing project managers’ opinions about certain client-related activities. Likert scale rating questions were used to elicit project managers’ opinions through indications of how closely each statement corresponds to the actual situation in the project. They were asked to rate their opinions against each question according to a five-point scale (1 = Very Low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very High) with reference to the most recent projects they had been involved in. The questionnaire (Appendix 2) included eight sections containing questions about: project strategies, project planning, design efficiency, effective site management, collaboration, construction efficiency, social environment and socio-demographic. The items included in each section have frequently been mentioned in previous studies as client-related activities influencing construction time and cost.

Rothwell (1995), Rossi et al. (2013) and Cavana et al., (2001) noted seven main elements of a well-designed questionnaire:

- The wording of the questions.
- The wording should address the purpose of the questions in order to get the appropriate data. Furthermore, appropriate language and words should be used.
- The questionnaire measurements.
- The data collected should be appropriate for testing the hypothesis and appropriate techniques should be used to measure concepts.
- The appearance of the questionnaire.
- It is very important to attract the attention of the respondents. A good introduction, a logical sequence of questions and clear instructions on how to answer the questions make the questionnaire more attractive. Furthermore, it encourages respondents to participate and provide the required data.
- Closed questions were seen as more appropriate for this research, as according to Bryman and Bell (2003), it is easier for respondents to answer, and also the study targeted a large sample.

5.8 Questionnaire Validity

A valid questionnaire provides the researcher with accurate data, and a reliable one ensures that the collected data is consistent. Thus, different measures were taken into consideration to ensure the validity and reliability of the data, starting from the literature review stage through to the data analysis stage.

Validity refers to the extent to which measurements are accurate in measuring what the researcher intends to measure. According to Cronbach and Meehl (1955), Fink (2006, 2013), Saunders et al. (2012), Westen and Rosenthal (2003), and Kothari (2004), it is necessary for a researcher to consider content validity, criterion validity and construct validity in order to ensure the validity of the entire survey.

5.8.1 Content Validity

Content validity refers to the extent to which the sample selected for the test is adequate to represent the whole domain of interest. Cavana et al. (2001) noted three ways to ensure content validity: literature, discussion with experts and qualitative research. For the context of this research, an extensive literature review was carried out to identify the specific client activities that describe the research concept. The literature review covered in Chapters 2, 3 and 4 identified 75 variables (Appendix 2) frequently addressed as client-related activities that affect construction time and cost. Accordingly, the first set of questionnaires (Appendix 2) was developed and subjected to expert discussion to further validate the content, followed by a pilot questionnaire survey. Additionally, the large number of projects targeted for assessment increased the sampling validity (See Section 6.2.1).
5.8.2 Criterion Validity
Criterion validity is also known as predictive validity, and it indicates the ability of a questionnaire to identify the relationship between a measure and the outcome, or provides the ability of the measure to correlate with other standard measures (Kothari, 2004; Westen and Rosenthal, 2003). There are two types of criterion validity: concurrent validity and predictive validity (Cronbach and Meehl, 1955). Both types involve administering two measures and the simple distinction between them is concerned with the time interval between obtaining the first and second sets of measures.

The concurrent method involves administering the first and second measures to the same group of samples at as close to the same point in time as possible. Then the scores of the two measures are correlated and the correlation of the scores demonstrates evidence of validity. Researchers often use concurrent validity as an alternative to predictive validity because of the difficulties of using a predictive design that was discussed earlier. However, when it is important to show a relationship between a measure and future performance, predictive validity was used to establish evidence of validity.

5.8.3 Construct Validity
Construct validity demonstrates the extent to which a measure is actually measuring the presence of a construct. Construct validity is classified into two main types: convergent validity and discernment validity. Convergent validity is established to show the degree to which two measures of constructs are correlated and measuring the same concept, while discriminant validity tests that measurements are not correlat (Campbell and Fiske, 1959).

Cronbach and Meehl (1955) noted that through observation of constructs’ correlation to each other, the researcher can generate a new construct. They stated that illustrating the relationship between observed measures is essential to test the construct validity. For this research’s construct, validity was determined initially from literature and ensured empirically through principal component analysis.
5.9 Questionnaire Sampling Method
A carefully chosen sample can be used to represent public construction procurement in Oman. Bartlett et al. (2001) mentioned two common sampling methods in surveys: probability and non-probability. According to Walliman (2006), the probability sampling method gives the most reliable representation of the population. Each member of the population in probability sampling has a known non-zero probability of being selected. On the other hand, in the non-probability method, samples are selected from the population in a non-random manner. This includes judgment sampling, convenience sampling, quota sampling, and snowball sampling. The advantage of the probability sampling method is it produces statistical measurements of the target population that are unbiased and has a measurable sampling error, which is expressed as a confidence interval (Kish, 1995). In contrast, the degree to which the sample differs from the population in non-probability sampling remains unknown.

Probability sampling includes simple random sampling, cluster sampling, systematic sampling, and stratified sampling. Stratified sampling was used in this research to select the sample from Oman’s top 10 public construction clients. Proportional stratified random sampling uses a homogeneous population that gives samples with low sampling errors compared to the heterogeneous population (De Vaus, 1996). This can be achieved by dividing the population into homogeneous subgroups or strata, then randomly selecting subjects proportionally from each sub-group (Kothari, 2004). This technique also increases the representativeness of the population (Love, 2002).

5.10 Reliability
Reliability refers to measurement constancy and stability. It indicates the extent to which a measurement is consistent across time and other measures (Cavanaugh et al., 2001). The different types of reliability assessment mentioned by Saunders et al. (2012) are: test re-test, internal consistency, and alternative form. Test re-test requires administering the questionnaire twice to respondents, which is difficult, and therefore it was not adopted. Data reliability is associated with respondents, thus, only respondents who have detailed knowledge and professional experience in the sample projects, from the planning stage to construction completion, were asked to answer the questionnaire.
Internal reliability is very important for testing whether each scale is measuring a single idea and the items making up the scale are internally consistent. In order for each construct to be measured, the score of each item should correlate with the total score of the remaining items. Internal reliability can be measured by calculating Cronbach Alpha (α) (Saunders et al., 2012; Bryman, 2008). Cronbach Alpha is the widest measure used for internal reliability. Cronbach Alpha over 0.7 indicates that the scale is reliable, and the higher the value the more internally reliable the scale (Nunnally, 1978). For this research, Cronbach Alpha is considered for ensuring the internal reliability. Using reliability analysis, (SPSS) can:

- Establish the extent to which the items in the questionnaires are related to each other.
- Provide an overall index of the whole scale’s repeatability or internal consistency.
- Enable the identification of problematic items that must be excluded from the scale.

5.11 Questionnaire Discussion with Experts
Survey researchers often ask experts to review questionnaires as tools for identifying possible issues in the question answering process, and other potential sources of difficulty such as unclear wording (Olson, 2010). In other words, the expert’s review serves two primary goals (Willis et al., 1999):

- Identify problems with a questionnaire (Appendix 2) so that they can be remedied prior to going into the field.
- Help the researcher to classify questions into clusters that are less or more likely to exhibit measurement errors.

The number of expert reviewers tends to be in the range of two or three experts (Holbrook et al., 2007; Jansen, 2005; Presser and Blair, 1994). Therefore, four experts familiar with the subject and targeted respondents were contacted and three of them agreed to have the discussion. These experts were selected because each of them had more than 15 years of experience in construction projects in Oman and had played different roles in the public sector. The discussions were conducted over the phone from the UK and lasted for one to
one-and-a-half hours. The duration of the discussion had not been pre-
determined and the timing of the discussion was dependent on each expert’s
availability. The discussions of the questionnaire (Appendix 2) were conducted
to ensure the following:

- Correct and appropriate language and wording were used in the
  questionnaire.
- The questionnaire measurement was clear and the technique used was
  appropriate to answering the questioners.
- Feedback was received on the appearance of the questionnaire.
- The questionnaire covered all client activities that frequently affect
  projects’ time and cost changes.
- The researcher had the opportunity to hear any other comments that
  could enhance the content of the questionnaire and the outcome of the
  research.

5.12 Questionnaire Pilot Survey
A pilot survey can identify potential difficulties and improve the response rate
(Fellows and Liu, 2008; Fink, 2013). Additionally, a pilot survey helps
researchers to obtain some assessment of their questions’ validity and the
reliability of the data (Saunders et al., 2012). Thus, a pilot survey was used in
the refinement of the questions to eliminate potential sources of difficulty and
increase the response rate. The pilot survey was carried out with project
managers from the top 10 public clients. These project managers had been
working within client organisations from project initiation until completion.

The number of participants in a pilot survey depends on many factors, such as
data collection methods, the nature of the research, and the time of the
research (Fink, 2013). Bell (2005) noted that the use of a higher number of
participants to get feedback can improve a questionnaire in terms of clarity,
duration to complete and attractiveness. However, 10 respondents tends to be
an appropriate number for a pilot test (Fink, 2013). Therefore, 10
questionnaires (Appendix 2) were distributed to project managers during the
pilot survey, out of which eight were responded to with feedback. The
questionnaire (see Appendix 2 for full detail) included eight sections containing
questions about client activities related to: project strategies, project planning, design efficiency, effective site management, collaboration, construction efficiency, social environment and socio-demographic. The items included in each section have frequently been mentioned in previous studies as client-related activities influencing construction time and cost. Furthermore, the questionnaire included information about each project’s contractors, consultants, construction commencement date, planned completion date and cost, and actual completion date and cost. The targeted data should facilitate analysis of the relationship between changes in the performance level of client activities and construction performance.

Subsequently, a pilot survey was conducted to ensure the following:

- Potential difficulties are identified resolved.
- The questionnaire is comprehensive and proposed client activities are critical part of the construction procurement.
- The estimated time for completing the questionnaire is adequate.
- The questionnaire measurement is clear and the technique used appropriate to answering the questioners.
- The questionnaire covers all client activities that frequently affect projects’ time and cost changes.
- Other comments that could enhance the content of the questionnaire and the outcome of the research are considered.

All respondents agreed that the questionnaire was comprehensive and the proposed activities were critical parts of the client organisation’s role. Meanwhile, five respondents provided valuable comments on project information details, such as names of projects, tender numbers, contractors’ names and construction commencement and completion dates. For example, they recommended removing any details that identified contractors and project dates for confidentiality reasons. Therefore, project names, tender numbers, and contractors were modified to optional answers for the respondents to provide, and percentages of time and cost changes were included instead of project dates. Moreover, all the respondents stated that they spent around 20 minutes completing the questionnaire. This helped to determine the appropriate time required to complete the questionnaire during the main survey.
5.13 Approach Adopted to Increase the Response Rate

An appropriate response rate is essential for a survey to achieve an acceptable conclusion (Fellows and Liu, 2008). Frazer and Lawley (2000) and Fink (2013) noted that the response rate is calculated by dividing the number of responses by the total number of eligible respondents approached.

The literature is inconclusive about the influence of different survey administration methods on increasing response rates (Bowling, 2005). However, Rossi et al. (2013) stated that sensitive data are best asked about through the more impersonal self-administration method. Moreover, impersonal and self-administration methods most frequently lead to more accurate data and a higher number of responses (Bowling, 2005). A higher number of responses enables meaningful data analysis (Fowler, 2014). Thus, great attention was given to maximising the response rate. Special attention was given to survey design, questionnaire validity, sample selection, and questionnaire administration.

The questionnaire was designed with a variety of questions, covering client-related activities from the project initiation stage up to construction completion. Special attention was given to rephrasing the wording of the questions to reflect the actual daily working words used in Oman. As mentioned in Sections 5.11 and 5.12, expert discussions and a pilot survey were carried out in order to increase the clarity of the research and make the questionnaire more understandable.

Respondents were identified jointly by the researcher and senior managers within each organisation. Then they were asked to randomly select completed projects about which to answer the questionnaire survey. This was one of the most critical and challenging tasks in data collection because of difficulties in getting information on construction delays and cost overruns. In order to eliminate this constraint from the data collection, the researcher utilised the data available on the Tender Board website to collect all the projects awarded for all the organisations between 2008 and 2013. Subsequently, the collected data were grouped for each organisation and senior managers were requested to mark the completed projects. After that, the list of completed projects was
printed on A3 sheets and then soft and hard copies of the list were sent to the accounts and contracts departments to provide the actual completion dates and the actual costs of the projects. To ensure confidentiality and increase the response rate, the completed list was forwarded to the senior project managers directly without the direct involvement of the researcher. Upon receiving the completed project list with all the data the senior managers called for a meeting; all the project managers attended and were handed copies of the questionnaire in the presence of the researcher. They were asked to run through the questions and the researcher clarified all the questions. Valuable clarifications were requested, such as the possibility of including projects other than the ones in the list, where the answer was to include as many projects as possible. Here, it is important to note that the project list and delays and cost overruns information collection was carried out during the period between January and March 2015, while the main survey was administered over six weeks during April and May 2015.

5.14 Data Analysis
After questionnaire collection, data analysis is the next step to answer the research questions. Zikmund et al. (2010) mentioned four stages of data analysis: editing, coding, data filing and then data analysis. Editing data is the process of checking data for any mistakes made by the participants and checking the completeness of the responses. The second step is to code the data by sample or numerical code to avoid any repetition errors. The next step is to file the data in a spreadsheet, ready for the upcoming analysis. Data analysis is carried out using four types of analysis: descriptive, univariate, bivariate, and multivariate analysis (Zikmund et al., 2010). In this research, two types are used: descriptive analysis and two multivariate analysis tools which are principal component analysis and regression analysis.

5.15 Data Analysis Software
A number of software applications can be used to aid in data analysis. Software applications have the ability to handle large volumes of data and allow the researcher to manipulate and display the data in a number of ways (Robson, 2002). Also, the use of software applications makes the data analysis process
more transparent and comprehensive, thus increasing the validity and reliability of the survey analysis.

The SPSS (Statistical Package for Social Science) is one of the most widely used statistical analysis software applications. Thus, SPSS software was used for the data analysis in this research, not only because it is widely used, but also because it supports the statistical analysis of the collected data.

5.16 Descriptive Data Analysis
Descriptive statistics is used to describe the main features of a collection of data. According to Fink (2013), various type of descriptive statistics are used for survey research, including measures of central tendency (mean, mode and median), measures of variations (range and standard deviation), counts (number or frequency) and proportions (percentages). The objective of descriptive analysis is to identify the extent (1 = Very Low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very High) of occurrences of each activity in public construction projects. Both counts and frequency analysis are descriptive statistical methods that show the number and percentage of occurrences of each situation. Therefore, this research used counts and frequency for the descriptive analysis.

5.17 Principal Component Analysis
Principal component analysis is used to establish a relatively small number of components that can be used to represent the relationship between sets of many interrelated variables (Norusis, 1992; Li et al., 2005; Field, 2013). Thus, principal component analysis confirms the validity of the scale and reduces the variables for meaningful regression analysis to be subsequently performed. According to Tabachnick and Fidell (2006), component scores are often more reliable than the scores of the individual variables. Additionally, principal component analysis can be used to solve the problem of multicollinearity by combining variables that are collinear with each other (Field, 2013).

Principal component analysis includes five steps: selecting and measuring a set of variables, preparing the correlation matrix, determining the number of components, rotating the components and the naming of the components (Tabachnick and Fidell, 2006). However, two main issues must be considered
when conducting principal component analysis: sample size and component loading (Pallant, 2010).

### 5.17.1 Sample Size and Component Loading

Various recommendations exist about the minimum sample size necessary to obtain components that are adequately stable and that closely correspond to population. Recommendations are typically stated in terms of either the minimum sample size or the minimum ratio of the sample size to the number of variables. The minimum sample suggested by Hutcheson and Sofroniou (1999) and Pallant (2010) is 150, while the minimum ratio of sample size to number of variables recommended by Gorsuch (1983) is 5:1. However, research has demonstrated that the general recommendations about minimum sample size are not valid or useful (Costello and Osborne, 2005; MacCallum et al., 1999). Some authors have suggested that communalities of components should be greater than 0.6; additionally, Velicer et al. (1998) argued that the more the variable loading, the more it is a pure measure of the components, and noted that a loading of .80 is high, a loading of .60 is moderate, and a loading of .40 is a very poor measure of the component. However, Hair et al. (1995) suggested that a variable is considered to load on a given component if the loading value after rotation is 0.5 or more for that variable.

The details of the completed construction projects were not readily available at the time of the data collection stage because the project files were scattered in different places and not well organised. Therefore, the sample size of the survey was determined by analysing the total number of public construction projects awarded by the government Tender Board between 2008 and 2013. The construction projects awarded during this period can be searched for on the Tender Board website. The survey was then distributed among the top 10 organisations within the public sector based on the values of the awarded projects. Other organisations were excluded from the list because they are not frequent construction clients and therefore their experience is limited to just one or two projects during the past five years. In total, 331 questionnaires were distributed.
In this research, the actual number of samples is greater than 150, and the communalities of the components are greater than 0.6, therefore the sample size is appropriate for principal component analysis and only variables with a loading of above 0.5 were included to ensure good measures of components. Additionally, the Kaiser-Mayer Olkin measure of sample adequacy (KMO) was used to ensure sampling adequacy. The value of the KMO is 0.720, which is greater than the minimum acceptable value (KMO= 0.5) recommended by Kaiser (Kaiser, 1960).

5.17.2 Correlation Matrix
When conducting principal component analysis, it is expected that variables should correlate with each other because they are measuring the same thing. Therefore, it is essential to check that the correlation coefficient is not close to zero; in other words, the correlation matrix is not an identity matrix. In this research, Bartlett’s test (test of sphericity) value was considered to test how different the correlation matrix was from the identity matrix. A significance level of less than 0.05 suggests that the correlation matrix is not an identity matrix (Field, 2013).

5.17.3 Extraction of Components
Extraction is the process used in principal component analysis for deciding how many components to retain (Field, 2013). There are two ways of deciding the number of components: the associated eigenvalues, which indicate the importance of components, or a scree plot. While Kaiser (1960) suggested retaining all components with eigenvalues greater than 1, Cattell (1966) recommended plotting each eigenvalue against the component with which it is associated and retaining only factors on the left of the point of inflexion. Cattell (1978) has shown that the use of eigenvalues in large matrices overestimates the number of rotated components. Therefore, in this research, a scree plot was used to decide the number of components to be rotated and retained, because by plotting the eigenvalues, the relative importance of the components becomes apparent.

5.17.4 Component Rotation
Rotation is mainly used to maximise the high correlation between components and variables and minimise the low correlation for each component, thus
rotation results are simplified, more meaningful and easy to interpret (Kline, 1994). The term “rotation” is used because the axes are rotated so that the clusters of variables fall as closely as possible to them. Rotation methods are classified into two broad types: orthogonal and oblique (Kline, 1994). The difference between the two methods is that orthogonal rotations produce components that are uncorrelated, while oblique rotation allows the components to correlate with each other (Field, 2013; Kline, 1994). Osborne (2015) noted that the goal of both methods of rotation is simplicity and clarity of component loading. Orthogonal rotation is used in this research because it solves the problem of collinearity and also helps in identifying the unique effect of each component on delays and cost overruns. More specifically, orthogonal Varimax rotation is used because it was developed as an incremental improvement upon the prior methods quartimax and equamax.

5.17.5 Component Score and Naming
Components describe variables measured and their relative importance for each component. Having discovered the variables loading on the components, it becomes possible to estimate the score of each component (Field, 2013). The scores most frequently used to produce components include summing scores by component, summing scores above a cut-off value, summing scores using standardised values and weighted sum scores. In this research, the sum of scores by component was used instead of other methods because it preserves the variations in the original data. According to Hair et al. (2006), the sum score method is the most desirable when the scale used to collect the original data is exploratory. Similarly, Tabachnick and Fidell (2006) noted that summing the score by component is generally acceptable for exploratory research situations such as this research. Thus, the score of each component involves summing the raw scores corresponding to all extracted items on a component. If negative loading is associated with an item, the raw score of that item is subtracted because it is negatively related to the component.

\[
\text{Component (x)score} = \frac{\sum \text{raw score of items included in component (x)}}{\text{Number of included items}} \quad \cdots \cdots \cdots \text{Equation 5.1}
\]
Finally, there is no right or wrong way of naming the extracted components. However, it is highly important to give them the names that best represent the variables within each one (Ford et al., 1986). The ultimate goal is the identification of underlying components that summarise a set of variables, so variables with higher loadings on a component play an important role in naming the component.

5.18 Multiple Regression Analysis
Multiple regression analysis is a statistical technique used to assess the effects of several components on the variation of the dependent variable concurrently (Cohen et al., 2003; Schroeder et al., 1986). More specifically, regression analysis measures how the value of the dependent variable (delays and cost overruns) is affected when any one of the independent variables (extracted components) is varied, while the other independent variables are held fixed. According to Hair et al. (2006), multiple regression is a form of general linear modelling and it is widely used for explanation and prediction purposes. The general multiple regression model given by Mendenhall and Sincich (2003) and Tabachnick and Fidell (2006) is used in this study and it is as follows:

\[ Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k \]  

Where
- \( Y \) is the independent variable; in this research, delays and cost overruns.
- \( X_1, X_2, \ldots, X_k \) are the independent variables; in this research, the components extracted from principal component analysis.
- \( \beta_0, \beta_1, \beta_2, \ldots, \beta_k \) are the regression coefficients that determine the size of the effect of the independent variables on delays and cost overruns.

In this research, multiple regression is used to identify the components affecting construction delays and cost overruns and determine the most importance client activity components.

5.18.1 Major Methods of Multiple Regression
There are three major methods of multiple regression: standard multiple regression, sequential (hierarchical) regression, and stepwise regression (Tabachnick and Fidell, 2006). The main difference between the three methods is the way in which components are entered into the model. However, when the
components are completely uncorrelated, the order of entry has a limited effect on the regression results (Field, 2013).

In the case of standard multiple regression, all components are entered into the regression equation simultaneously. Standard multiple regression is appropriate to assess the unique contribution of each component. However, some components may appear unimportant if they are highly correlated with each other, even though both of them highly correlate with the delays and cost overruns. Therefore, this method is appropriate when the components are uncorrelated.

In sequential multiple regression methods, the researcher decides which component to enter first and each component is assessed in terms of what it adds to the equation. The first component entered gets priority for being entered into the equation and thereby assigned its unique and overlapping contribution. In other words, any of the components entered in the next steps may become unimportant if they are correlated with the first component.

Finally, stepwise regression is similar to sequential regression, except the sequence of component entry is decided based on a mathematical criterion. The component that most affects delays or cost overruns is retained and prioritised for entry into the equation and, similar to sequential regression, assignation of its unique and overlapping contribution. Additionally, if the next component does not make a significant contribution, it is excluded from the model.

This research used stepwise multiple regression, because it identifies the most important components that significantly affect construction delays and cost overruns. Therefore, it provides the greatest effect of each component on both time and cost changes.

5.18.2 Assumptions of Multiple Regression
The inferences associated with regression modelling are validated by examining the extent to which the analysis assumptions are met. The linear regression model needs to meet these assumptions to avoid regression coefficient estimate bias. According to Cohen et al. (2003), bias means that the coefficient
concluded based on the sample is not, on average, equal to the true value of the coefficient in the population. Field (2013) further clarified that bias mostly comes in the form of assumption violation. Therefore, the examination of assumptions is essential to ensure the inferences associated with the model are valid. Graphical display tests are used in this research because often, the use of graphical displays tests detects a wider variety of bias than statistical tests (Cohen et al., 2003). Both Field (2013) and Tabachnick and Fidell (2006) noted four assumptions of linear regression: absence of multicollinearity, absence of outliers, independence of residuals, and normality, linearity and homoscedasticity of residuals.

The absence of outliers is one of the most important assumptions in regression analysis. The regression coefficient can be affected by outlier cases. Outliers exist when a case substantially differs from the main trend of the data (Field, 2013). Careful examination of the standardised residuals can identify potential outliers (Cohen et al., 2003).

The second and most important assumption in regression analysis is that the relationship between residuals and dependent variable scores is linear (Tabachnick and Fidell, 2006). In other words, the residuals should be randomly distributed and the overall shape of the scatter plot is not curved. The third assumption of multicollinearity exists when there is a perfect correlation between two variables. When multicollinearity exists, it is impossible to obtain the unique effect of these variables because they are interchangeable (Field, 2013). Thus, it becomes difficult to assess the importance of each variable. In this research, principal component analysis was used to ensure the absence of multicollinearity, because the scores of the principal component analysis are uncorrelated.

The independence of residuals assumption is another assumption in regression analysis, and means any two residuals must be independent of one another (Cohen et al., 2003). The independence of residuals can be tested with the Durbin-Watson test, and a very conservative rule, according to Field (2013), is that test values less than 1 or greater than 3 are the cause for concern.
Finally the normality and homoscedasticity of residuals assumptions can be tested by examining the residuals’ scatterplots (Cohen et al., 2003; Tabachnick and Fidell, 2006). In all three assumptions, it is assumed that the residuals are randomly distributed in the centre of the scatterplot (Tabachnick and Fidell, 2006).

Normality assumes that the residuals of the dependent scores are normally distributed (Tabachnick and Fidell, 2006). The validity of regression model parameters are not affected by a lack of normality, and only in small samples will the significant and confidence interval tests be weakened (Field, 2013).

The homoscedasticity assumption is that the variance of the residuals around the dependent variable scores is the same for all predicted scores (Tabachnick and Fidell, 2006). Similar to normality, the validity of regression model parameters is not affected by homoscedasticity and only the significant and confidence interval tests will be weakened (Field, 2013).

5.18.3 Reducing Bias
Having looked at potential sources of bias during the assumption evaluation, it is necessary to reduce the impact of this bias. Field (2013) identified four methods for correcting problems with data: trimming the extreme data, winsorizing, analysis with robust methods, and lastly, data transformation.

Trimming the extreme scores for a certain amount of data is the simplest method (Field, 2013). This simply means removing the data from the sample contributing the outlier, where two rules can be used to decide the number of data to be trimmed. The first one uses standard deviation, where data beyond a certain number of standard deviations are deleted. The second way uses a percentage-based rule, where a percentage of the highest and lowest scores are removed.

The second method of reducing bias is winsorizing, which mean substituting outliers with the highest score that is not an outlier. Meanwhile, the third method and a much more promising technique is to use robust methods such as M-estimator and bootstrapping. M-estimator is a trimming method used to reduce the impact of outliers (Field, 2013). It differs from the trimming method
in that the amount of trimming is determined empirically. The fourth and final method that can deal with normality and linearity is data transformation. In regression analysis, problematic variables are transformed to correct potential bias in the data (Cohen et al., 2003; Tabachnick and Fidell, 2006). Log transformation, square root transformation, reciprocal transformation, and reverse score transformation are the most common transformation approaches that can be used to correct violation of assumption issues (Tabachnick and Fidell, 2006). The first two approaches can correct positive skew, unequal variance (heteroscedasticity) and lack of linearity (Tabachnick and Fidell, 2006). Reciprocal transformation can correct positive skew and unequal variance (heteroscedasticity), while reverse score transformation can mainly correct negative skew (Tabachnick and Fidell, 2006).

In this research, a percentage-based rule was used to trim the extreme scores because the standard-based rule is biased when there are outliers in the data.

5.19 Summary
The chapter discusses the research methodology used to achieve the set aim and objectives. The chapter has explained the research philosophy, research strategy, research design, data collection methods, and data analysis.

Philosophically, the research adopted the positivist epistemological position and the objectivist ontological position. The choices to adopt a quantitative strategy and a survey design for this research were explained and justified. Thus, a self-administered questionnaire survey was identified as the most appropriate data collection method. Subsequently, principal component analysis was adopted to first examine the relationships between public client activities and then to group the most important activities for the next step of the data analysis. Regression analysis was the second step of the analysis, which was used to identify the relationship between the public activities groups (components) and construction delays and cost overruns.

Having identified the research strategy, design, data collection and data analysis, Chapter 6 will present data preparation and descriptive analysis, and then Chapter 7, primary data analysis.
6 CHAPTER SIX: DATA PREPARATION AND DESCRIPTIVE ANALYSIS

6.1 Introduction
This chapter presents the main features of the collected data and prepares the data for more extensive statistical analysis. The first part of the chapter presents the results of the questionnaire survey, the respondents' characteristics, and the response rate. The second part provides an overview of the existing client practices, construction delays, and cost overruns.

6.2 Questionnaire Administration and Response Rate

6.2.1 Questionnaire Administration
A total of 331 questionnaires were distributed to project managers in 10 public departments covering highways, roads, water transmission and distribution, school buildings, health services buildings and electricity transmission and distribution. These departments were selected from the top public departments by the value of total annual awards. As shown in Table 6.1, 187 questionnaires were received back from seven departments; no responses were received from two building departments: the schools and health sectors. This may be an indication that other sectors have greater interest in public construction time and cost changes issues compared to the school and health sectors.

<table>
<thead>
<tr>
<th>Departments</th>
<th>Distributed</th>
<th>Responds</th>
<th>Response rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department 1</td>
<td>75</td>
<td>66</td>
<td>88.0</td>
</tr>
<tr>
<td>Department 2</td>
<td>53</td>
<td>48</td>
<td>71.0</td>
</tr>
<tr>
<td>Department 3</td>
<td>40</td>
<td>32</td>
<td>80.0</td>
</tr>
<tr>
<td>Department 4</td>
<td>29</td>
<td>13</td>
<td>44.8</td>
</tr>
<tr>
<td>Department 5</td>
<td>21</td>
<td>11</td>
<td>52.4</td>
</tr>
<tr>
<td>Department 6</td>
<td>25</td>
<td>17</td>
<td>68</td>
</tr>
<tr>
<td>Department 7</td>
<td>20</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>Department 8</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Department 9</td>
<td>40</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Department 10</td>
<td>20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>331</strong></td>
<td><strong>187</strong></td>
<td><strong>56.50</strong></td>
</tr>
</tbody>
</table>

Nearly 76% of the respondents who completed the questionnaires had more than 11 years of experience. This shows the respondents possessed a great
deal of in-depth experience of construction projects. The 187 projects were assessed by project managers from the top seven public departments involved in repeat projects after excluding building projects. The highest response rate was recorded from department 1 (88%), whilst the lowest response rate was from department 4 (44.8%).

As shown in Figure 6.1, responses were received for two procurement systems: design-bid-build (traditional) and design-build. A higher response rate was recorded for the traditional procurement system (52.9%), whilst the response rate for design-build is slightly less (47.1%).

![Figure 6.1 Response by procurement system](image)

### 6.2.2 Missing Values and Analysis

Missing value analysis was checked for each statement, as it helps to address concerns related to data analysis. The result of this missing data analysis indicates that the values of five statements are missing in one response. Therefore, the statistical analysis results can be presented based on the non-missing values and the active sample size was closely monitored and treated appropriately in order to nullify possible influence caused by these statements.

### 6.3 Reliability

The long years of experience of the respondents indicates that they have adequately experienced professionals within their client departments.
Furthermore, Cronbach’s Alpha (α) was computed to test the reliability and internal consistency of the survey data. The computed Alpha (α) value (0.94) is above 0.8, which is considered meritorious (Nunnally, 1978; Carmines and Zeller, 1979; Litwin, 1995).

6.4 Construction Schedule Delays
Respondents were asked to provide time changes as percentages of the initial construction duration. Table 6.2 shows that the average delays in traditional procurement (46.44%) is much higher than the average delays in design-build procurement (34.62%). However, the highest delays recorded (252%) was in the design-build procurement systems, compared with 200%, which was the highest within traditional procurement. In contrast, only two projects were completed ahead of time; these two projects are exceptional cases of design-build projects. Overall, the range of delays in both traditional procurement and design-build procurement systems was higher than 200% and delays is apparent in the vast majority of projects in both procurement systems.

<table>
<thead>
<tr>
<th>Number of responses</th>
<th>Traditional</th>
<th>Design Build</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum (%)</td>
<td>0.00</td>
<td>-16.00</td>
</tr>
<tr>
<td>Maximum (%)</td>
<td>200.00</td>
<td>252.00</td>
</tr>
<tr>
<td>Mean (%)</td>
<td>46.44</td>
<td>34.62</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>42.72</td>
<td>44.04</td>
</tr>
</tbody>
</table>

6.5 Construction Cost Overruns
Respondents were asked to provide cost changes as percentages of initial contract costs. Table 6.3 presents cost overruns in traditional and design-build procurement systems. The results show that cost overruns is more common in traditional procurement than design-build procurement. However, the average cost overruns in both procurement systems is almost twice the 5% contingency limit generally included in project contracts. Moreover, cost overruns can exceed 300% and 85% of the original contract amount in the traditional and design-build procurement systems respectively. These values highlight serious issues in construction procurement in Oman, which stresses the importance of
the public sector designing and adopting well-defined procurement strategies in
order to minimise the risks of construction delays and cost overruns.

Approximately 55% of projects in both procurement systems were completed
beyond the project contingency limit (5%) stated in the standard conditions for
civil and electromechanical works. In contrast, five projects in the traditional
procurement system and four projects in the design-build system were
completed at less than the initial contract cost. The largest cost reductions in
design-bid-build, -57% and -24%, differ dramatically from the reductions in the
other three projects: -10%, -7% and -5%. Similarly, the highest cost reductions
in design-build, -30% and -24%, differ substantially from the other two projects
at -10% and -4.77%.

<table>
<thead>
<tr>
<th>Table 6.3 Construction cost overruns</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of responses</strong></td>
</tr>
<tr>
<td>Minimum (%)</td>
</tr>
<tr>
<td>Maximum (%)</td>
</tr>
<tr>
<td>Mean (%)</td>
</tr>
<tr>
<td>Std. Deviation</td>
</tr>
</tbody>
</table>

6.6 Design Efficiency
This client component cover design activities related to the client and expected
to have an impact on construction delays and cost overruns. The component
included nine activities, and the respondents were asked to rate the actual
situations of their projects on a scale from 1 (very low) to 5 (very high). This
component is considered one of the most important parts of construction
procurement because it establishes the basis for other, downstream stages,
especially the construction stage. The client team is expected to score very
highly in each of the activities included in this component in order to mitigate
construction delays and cost overruns. However, the results presented in
Table 6.4 show that, in reality, scores in the majority of the nine activities were
moderate or lower, with the exception of four activities that were rated higher in
just slightly above 50% of the projects. Moreover, in about a quarter of the
projects, the scores were low or very low in five out of the nine activities. In general, there is great potential for improvement in all the nine activities. More attention should be given to the activities that scored less than moderate in the majority of projects, which include:

- Selection of consultants with very high key management personnel and technical personnel abilities.
- Development of accurate consultancy scope of services.
- Use of suitable terms and conditions.
- Ensuring the accuracy of the construction tender documents.
## Table 6.4 Design efficiency activities

<table>
<thead>
<tr>
<th>Client activity</th>
<th>Very low</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
<th>Very high</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability of consultants’ key management personnel to deliver the required services</td>
<td>10.2</td>
<td>22.5</td>
<td>27.3</td>
<td>31.0</td>
<td>8.6</td>
<td>0.5</td>
</tr>
<tr>
<td>Ability of consultants’ technical personnel to deliver the required design services</td>
<td>8.6</td>
<td>17.6</td>
<td>28.9</td>
<td>33.2</td>
<td>11.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Accuracy of project requirements when consultancy service bids are invited</td>
<td>11.8</td>
<td>11.2</td>
<td>26.2</td>
<td>42.8</td>
<td>7.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Extent to which technical specifications meet the required quality level</td>
<td>9.1</td>
<td>16.6</td>
<td>20.3</td>
<td>41.7</td>
<td>11.8</td>
<td>0.5</td>
</tr>
<tr>
<td>Accuracy of consultancy scope of services when consultancy services bids are invited</td>
<td>10.7</td>
<td>7.0</td>
<td>37.4</td>
<td>27.4</td>
<td>15.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Client’s ability to assess consultant’s performance during the pre-construction phase</td>
<td>16.0</td>
<td>7.0</td>
<td>21.9</td>
<td>41.2</td>
<td>13.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Suitability of the consultancy service’s terms and conditions for the defined services</td>
<td>14.4</td>
<td>10.7</td>
<td>34.4</td>
<td>32.6</td>
<td>7.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Accuracy of construction tender documents</td>
<td>6.4</td>
<td>18.7</td>
<td>32.1</td>
<td>28.9</td>
<td>13.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Consideration of consultants’ past performance records when awarding the contract</td>
<td>2.1</td>
<td>12.3</td>
<td>32.1</td>
<td>35.3</td>
<td>17.6</td>
<td>0.5</td>
</tr>
</tbody>
</table>
6.7 Collaboration
The collaborative working approach is used for knowledge development, problem-solving and innovation in construction procurement. As argued by Murray (2011), collaboration in construction procurement takes different forms, such as access to resources, reducing risk, efficiency, coordination and learning. Therefore, in addition to the positive effect of collaboration on construction project success, as pointed out by Phua and Rowlinson (2004) and Walker et al., (2017), collaboration is a valuable source for problem solving, knowledge development and innovation.

This section covers collaboration activities related to the client which are expected (Chapter 2 and Chapter 3) to have an impact on construction delays and cost overruns. As shown in Table 6.5, seven public client activities were grouped under one component. The respondents were asked to rate the actual situation on the project on a scale from 1 (very low) to 5 (very high). All the activities (Appendix 2) should be rated very high in order to mitigate construction delays and cost overruns. The results in Table 6.5, however, reveal that in more than half of the projects, the ratings for all activities range between moderate and very low. Moreover, in 72.2% of the projects, the rating for efficiency of communications between stakeholders was between moderate and very low. Similarly, the level of trust between public sector stakeholders is the only factor for which the percentage of projects rated moderate to low is less than 66%. These findings suggest great potential for improvement in all seven activities, especially those rated high and very high in the lowest percentage of projects (less than 35.3% of the projects), which include:

- The efficiency of communication between stakeholders.
- The extent of sharing lessons learned between stakeholders.
- The level of collaboration between stakeholders in solving difficulties.
- Use of pre-identified goals and targets for various project phases to measure project performance.
Table 6.5 Collaboration activities

<table>
<thead>
<tr>
<th>Client activity</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very low</td>
</tr>
<tr>
<td>Extent of sharing lessons learned between stakeholders</td>
<td>3.2</td>
</tr>
<tr>
<td>Use of Information Communication Technology (ICT)</td>
<td>3.2</td>
</tr>
<tr>
<td>Efficiency of communication between stakeholders</td>
<td>10.7</td>
</tr>
<tr>
<td>Level of collaboration between stakeholders in solving difficulties</td>
<td>8.6</td>
</tr>
<tr>
<td>Control of scope changes during construction phase</td>
<td>10.2</td>
</tr>
<tr>
<td>Level of trust between public sector stakeholders</td>
<td>1.1</td>
</tr>
<tr>
<td>Use of pre-identified goals and targets for various project phases to measure project performance</td>
<td>1.6</td>
</tr>
</tbody>
</table>
6.8 Construction Efficiency
This section covers construction efficiency activities related to the client and expected to have an impact on construction delays and cost overruns. As shown in Table 6.6, a very minimal percentage of projects rated high or very high in two out of the six activities grouped under construction efficiency. These two activities are related to the commitment of:

- Public stakeholders (intra-organisational) to achieving the project goals.
- Stakeholders (inter-organisational) to implementing corrective actions in order to enhance project performance.

For both, the percentage of projects rated high or very high is less than 34%. This indicates a lack of commitment by stakeholders in the majority of the projects, despite the high or very high involvement of client teams in more than 75% of the projects.

Another interesting observation is that only in 39.9% of the projects was the subcontractor's ability to deliver the scope allocated to them rated as high or very high. The situation is slightly better in the case of levels of contractor understanding of the technical challenges associated with the special features of the project, but still, in only about 50% of the projects was the level rated high or very high.
### Table 6.6 Construction efficiency activities

<table>
<thead>
<tr>
<th>Client activity</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very low</td>
</tr>
<tr>
<td>Suitability of standard contract terms and conditions for the project</td>
<td>4.3</td>
</tr>
<tr>
<td>Involvement of the client team in construction progress reviews</td>
<td>4.6</td>
</tr>
<tr>
<td>Sub-contractors’ ability to deliver the scope allocated to them</td>
<td>5.8</td>
</tr>
<tr>
<td>Public stakeholders’ commitment to achieving the project goals</td>
<td>4.8</td>
</tr>
<tr>
<td>Levels of contractor understanding of the technical challenges associated with the special features of the project</td>
<td>10.7</td>
</tr>
<tr>
<td>Stakeholders’ commitment to implementing corrective actions in order to enhance project performance</td>
<td>7.0</td>
</tr>
</tbody>
</table>
6.9 Site Management
This section covers site management activities related to the client that are expected to have an impact on delays and cost overruns. The site management component included eight negative statements (Table 6.7), and the respondents were asked to rate the actual situations on their projects on a scale from 1 (very low) to 5 (very high). It was expected that items rated very high would negatively affect construction time and cost. Interestingly, in the majority of the projects, site management difficulties were between moderate and very low. However, it is important to note that in about a quarter of the projects, difficulties rated as “high” or “very high” arose in one or more of the following situations:

- Gaining access to the project site.
- Sourcing construction materials.
- The significance of variation orders requested by the contractor.

Thus, clients’ attention to mitigating issues related to these three elements seems very critical, especially regarding project site access and control of variation orders. This includes the adoption of tools such as early involvement of contractors and collaboration with other stakeholders when solving difficulties early in the project lifecycle. Further analysis will provide more information about the impact of these issues on construction delays and cost overruns.
### Table 6.7 Site management activities

<table>
<thead>
<tr>
<th>Client activity</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficulties due to protests by the public against the project</td>
<td>33.2 13.9 20.9 19.8 12.3 0.0</td>
</tr>
<tr>
<td>Difficulties faced by the contractor in gaining access to the project site</td>
<td>32.6 19.3 15.0 29.4 3.7 0.0</td>
</tr>
<tr>
<td>Difficulties in sourcing construction materials</td>
<td>24.1 21.4 20.3 29.4 4.8 0.0</td>
</tr>
<tr>
<td>Significance of variation orders requested by the contractor</td>
<td>8.0 17.6 39.0 28.3 7.0 0.0</td>
</tr>
<tr>
<td>Difficulties due to changes in laws and regulations</td>
<td>12.8 36.4 28.3 19.3 3.2 0.0</td>
</tr>
<tr>
<td>Difficulties in handing over the project site to the contractor</td>
<td>33.2 28.3 23.0 12.8 2.7 0.0</td>
</tr>
</tbody>
</table>
6.10 Multiphase Involvement of Stakeholders
Table 6.8 illustrates six elements related to the multiphase involvement of stakeholders in the development of construction projects. Attention paid to technical and financial training support (by the concerned authorities) for small and medium enterprises, to help them cope with construction market conditions, varies across projects. The attention to SMEs’ development is at its lowest levels (very low or low) in more than 69% of the projects, while it is only at its highest levels (high or very high) in 8.6% of the projects.

Use of workshops, initially with stakeholders, and then during the tendering stage with bidders, are two approaches public clients could utilise to identify possible issues and solutions before the construction stage. The results in Table 6.8 show that in the majority of the projects, the use of workshops ranges between very low and low. A slightly better situation could be observed in the cases of risk assessment and information availability. In both cases, it can be seen that in the majority of the projects, attention to risk assessment and information availability ranges between high and very high, but it is still not a common practice, as this level was identified in less than 50% of the projects. Finally, the situation in the case of use of brainstorming sessions in the planning phase to identify possible issues and solutions does not differ much from the use of workshops. It is clear from the results in Table 6.8 that only in 18.7% of projects was the use of brainstorming rated between high and very high, compared with 39.5% of projects, in which it was rated low or very low. Thus, in general, there is great potential for improvement through the multiphase involvement of stakeholders in construction procurement in the majority of the elements, if not all of them.
Table 6.8 Multiphase involvement of stakeholders activities

<table>
<thead>
<tr>
<th>Client activity</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical and financial training support (by the concerned authorities) for small and medium enterprises to help them cope with construction market conditions</td>
<td>42.2 27.3 21.9 4.3 4.3 0.0</td>
</tr>
<tr>
<td>Use of workshops with main stakeholders to identify possible issues and solutions before inviting construction bids</td>
<td>23.0 38.0 22.5 14.4 2.1 0.0</td>
</tr>
<tr>
<td>Use of workshops with bidders during the tender evaluation stage to resolved possible issues</td>
<td>26.7 23.0 32.1 17.6 0.5 0.0</td>
</tr>
<tr>
<td>Attention given to identifying possible risks during the planning phase</td>
<td>9.1 19.3 31.6 28.3 11.8 0.0</td>
</tr>
<tr>
<td>Information availability for accurately defining the project’s scope</td>
<td>8.6 6.4 41.7 31.0 12.3 0.0</td>
</tr>
<tr>
<td>Use of brainstorming sessions in the planning phase to identify possible issues and solutions</td>
<td>17.6 21.9 41.7 17.1 1.6 0.0</td>
</tr>
</tbody>
</table>
6.11 Review of Learning from Past Projects
Reviews of past projects’ issues includes four elements related to budget constraints, sharing of learning within the public sector, geological conditions, and repetition of past project difficulties. The results in Table 6.9 show that only in 8.6% of the projects were the budget estimates between low and very low compared to construction tender scope cost. This indicates that in the majority of the projects, the allocated budget was adequate. In contrast, in the majority of the projects, the level of sharing of learning between public stakeholders is rated less than high. Additionally, high changes due geological conditions and high repetition of past project difficulties appear in more than a third of the project. Therefore, expected budget constraints do not seem to be major issues; more serious issues are associated with sharing of learning between public stakeholders, projects’ geological conditions and repetition of past project difficulties.

6.12 Accuracy of Project Objectives and Requirements
Three elements are included under the accuracy of objectives and requirements changes. Changes in project objectives during construction were rated as less than “high” in the majority of the projects. Furthermore, high and very high changes in project requirements appear to be more common than objective changes. It can be seen from Table 6.10 that high or very high requirement changes occurred in more than 35% of the projects, while high or very high changes in project objectives occurred in about 27% of the projects. More importantly, in the majority of the projects (62%), the significance of the requirement modifications initiated by the client rated as high or very high. Thus, these results indicate that the client is the major cause of requirement modifications.
### Table 6.9 Reviews of past projects' issues

<table>
<thead>
<tr>
<th>Client activity</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very low</td>
</tr>
<tr>
<td>Budget estimates compared to construction tender scope cost</td>
<td>1.1</td>
</tr>
<tr>
<td>Extent of sharing learning from this project with other team members within the public sector</td>
<td>5.3</td>
</tr>
<tr>
<td>Significance of changes due to geological conditions at the project site</td>
<td>9.1</td>
</tr>
<tr>
<td>Repetition of past projects' difficulties in this project</td>
<td>6.4</td>
</tr>
</tbody>
</table>

### Table 6.10 Accuracy of project objectives and requirements

<table>
<thead>
<tr>
<th>Client activity</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very low</td>
</tr>
<tr>
<td>Changes in the project objectives during construction</td>
<td>20.9</td>
</tr>
<tr>
<td>Changes in the project requirements during construction</td>
<td>20.9</td>
</tr>
<tr>
<td>Significance of requirement modifications initiated by the client</td>
<td>2.7</td>
</tr>
</tbody>
</table>
6.13 Resource Optimisation
Table 6.11 presents six elements related to resources optimisation in construction projects. The first element is related to building the client team’s capabilities by providing the knowledge and skills training needed to efficiently deliver the project. The results show that in more than a third of the projects, significant training was needed but not provided to the client. Other non-technical elements related to resource optimisation include financial and workforce issues. The attention given to the contractor’s financial capabilities was rated less than high in the majority of the projects. The result further shows that the contractor faces high or very high cash flow difficulties in more than 25% of the projects. Similarly, conflicts between the main contractor and sub-contractors during the construction can be noticed in about 25% of the projects. Additionally, contractors seem to face difficulties in recruiting labour and professionals in more than a third of projects. Therefore, in addition to other initiatives to optimise resources, standardised processes, documents and templates can be adapted to reduce unnecessary use of resources on repeated tasks. However, the results in Table 6.11 reveal that just in about a quarter of the projects, the level of standardisation used was between high and very high, which indicates a high potential for standardisation in construction procurement.
### Table 6.11 Resources optimisation activities

<table>
<thead>
<tr>
<th>Client activity</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very low</td>
</tr>
<tr>
<td>Significance of the knowledge and skills training needs not provided to the client team</td>
<td>4.3</td>
</tr>
<tr>
<td>Consideration of contractors’ financial capabilities and track records when awarding the contract</td>
<td>2.7</td>
</tr>
<tr>
<td>Contractor cash flow difficulties during construction</td>
<td>19.3</td>
</tr>
<tr>
<td>Difficulties faced by the contractor in recruiting labour and professionals for the project</td>
<td>9.6</td>
</tr>
<tr>
<td>Conflicts between the main contractor and subcontractors during the project</td>
<td>24.1</td>
</tr>
<tr>
<td>Extent of use of standardised processes, documents and templates to reduce unnecessary use of resources on repeated tasks</td>
<td>3.7</td>
</tr>
</tbody>
</table>
6.14 Planning and Permit Approvals
Planning and permit approvals are two elements that are mainly related to the public sector. Table 6.12 presents two activities public clients can be involved in when developing a construction project. The first one is resolving difficulties in obtaining planning and permit approval and the second one is resolving difficulties due to changes in statutory and permit requirements during the construction phase. The results in Table 6.12 show that the majority of construction projects face high or very high difficulties in obtaining planning and permit approvals.

6.15 Decision-making and Information Coordination
Decisions on construction projects can be made directly by the project team or others may need to be involved. Client teams’ understanding of which decisions they can make alone and which decisions require the involvement of others is very important, so that appropriate time is allocated to mitigate associated risks. The results in Table 6.13 show that in about 50% of the projects, the client teams’ understanding of the decisions they could make was rated as high or very high. These results indicate great potential for decision-making improvement within public clients.

The efficiency of the information coordination process between stakeholders is one of the most important elements in construction procurement. The results in Table 6.13 reveal that, in the majority of the projects, the efficiency was rated lower than high. In fact, in the vast majority of the projects, the efficiency of the information coordination process was rated as low.
DATA PREPARATION AND DESCRIPTIVE ANALYSIS

Table 6.12 Planning and permit approval activities

<table>
<thead>
<tr>
<th>Client activity</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficulties in obtaining planning and permit approval</td>
<td>Very low</td>
</tr>
<tr>
<td></td>
<td>8.0</td>
</tr>
<tr>
<td>Difficulties due to changes in statutory and permit requirements during the construction phase</td>
<td>4.3</td>
</tr>
</tbody>
</table>

Table 6.13 Decision making and information coordination activities

<table>
<thead>
<tr>
<th>Client activity</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client team's understanding of which decisions they can make alone and which decisions require the involvement of others</td>
<td>Very low</td>
</tr>
<tr>
<td></td>
<td>1.6</td>
</tr>
<tr>
<td>The efficiency of the information coordination process between stakeholders</td>
<td>Very low</td>
</tr>
<tr>
<td></td>
<td>1.6</td>
</tr>
</tbody>
</table>
6.16 Summary
The descriptive analysis in this chapter has provided an overview of the existing procurement practices in Oman. The results show the schedule delays and cost overruns in design bid build and design build projects. The analysis also provides an indication of the existing practices and difficulties in public construction in Oman. Analysis of delays and cost overruns reveals outliers that needed to be carefully examined before the regression analysis. Furthermore, the frequency of difficulties and the extent of adoption of certain practices within public construction give indications of the potential for improvement in each area and subsequently the enhancement of overall project performance. More focus is needed on those areas that significantly help public clients in minimising delays and cost overruns. Further analysis in the next chapter aims to identify those areas, which when efficiently handled by public clients, will result in substantial performance improvement.

The next chapter is designed to present the primary data analysis, which will include first the principal component analysis and then the regression analysis.
7 CHAPTER SEVEN: PRIMARY DATA ANALYSIS

7.1 Introduction
This chapter presents the primary analysis of the questionnaire survey carried out with the client’s project managers to identify the public client’s success components, which represents the interrelationship between activities and practices. Firstly, the principal component analysis was used to explore the grouping and identify uncorrelated components. Secondly, regression analysis was used to establish the relationship between public client components and each of construction delays and cost overruns. Therefore, this chapter consists of two main sections; the first presents the relationship between public client success activities and thus defining the important client activity components. Then the following sections present the modelling of public client procurements and provide client activities effect on construction delays and cost overruns.

7.2 Data Re-Coding
Some questions in a survey were worded positively such that high score of the item is reflected by the high positive impact on the project while other questions are worded negatively (Difficulties or constraints) such that high positive impact on the project is reflected by low scores on the item. Therefore, before running PCA and regression analysis negatively worded items scale was reversed so that a high score indicates the same type of response on every item in the survey. So, the scoring of the negative questions (highlighted in appendix 3) was revised in the following way:

<table>
<thead>
<tr>
<th>Response Score</th>
<th>Reversed score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>
7.3 Principal Component Analysis

7.3.1 Appropriateness of the Analysis
Principal component analysis was conducted to reduce the number of variables to relatively smaller number of components that represent the relationship between the public client activities in construction procurement. Initially, the suitability of principal component analysis was examined. As mentioned in the methodology section 5.17.1, the suitability of data for principal component analysis is identified by satisfying two main prerequisites: appropriate sample size and confirmation that correlation matrix is not an identity matrix.

Firstly, in this research the actual number of samples is greater than 150, therefore, the sample size was deemed to be sufficient for principal component analysis. Only variables with loading above 0.5 were included to ensure a good measure of components. Additionally, the Kaiser-Mayer Olkin (KMO) measure was used to ensure sampling adequacy. The results in Table 7.1 show that the value of the KMO is 0.72, which is greater than the minimum acceptable value (KMO = 0.5) recommended by Kaiser (Kaiser, 1960). Furthermore, Table 7.1 shows that the result of Bartlett’s test of sphericity is large ($\chi^2 (187) = 14837.239, p < .001$), suggesting that the correlation matrix is not an identity matrix. Finally, the commonality values are all above 0.6 (see Appendix 2), further confirming that each variable shared some common variance with other variables. Given these overall indicators, principal component analysis was conducted with all 75 variables listed in Appendix 2.

<table>
<thead>
<tr>
<th>Table 7.1 KMO and Bartlett's Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</td>
</tr>
<tr>
<td>Bartlett's Test of Sphericity</td>
</tr>
<tr>
<td>Df</td>
</tr>
<tr>
<td>Sig.</td>
</tr>
</tbody>
</table>

7.3.2 Principal Component Analysis Results
Principal component analysis was undertaken on the 75 variables related to public client procurement items using the SPSS program. The analysis results (shown in Table 7.3) produced 17 components with eigenvalues greater than one, which explain 78.469% of the public client procurement variance. However, in this research, the scree plot (Figure 7.1) was used to determine the
number of components because, according to Cattell (1978), the use of eigenvalues in large matrices overestimates the number of rotated components. Therefore, the eigenvalues were plotted against the components numbers. 14 components were produced, because the plot shows a distinct break between the steep slope of the first 14 components and the sharp horizontal line of the rest. Therefore, 14 components were produced using Varimax rotation. As shown in Table 7.2, these 14 components explain 74.118% of the public client construction procurement variance. A total of 51 variables were extracted; each of the variables belonged to only one component and the loading of each variable exceeded 0.50. In contrast, 24 variables were excluded because they failed to meet the criterion of having a loading of 0.5 or above. The following sections present each of the produced components with all the extracted variables’ loading.

![Scree Plot](image)
### Table 7.2 Variance Explained by Extracted Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Initial Eigenvalues</th>
<th>Extraction Sums of Squared Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>% of Variance</td>
</tr>
<tr>
<td>1</td>
<td>20.747</td>
<td>27.663</td>
</tr>
<tr>
<td>3</td>
<td>4.938</td>
<td>6.584</td>
</tr>
<tr>
<td>4</td>
<td>3.800</td>
<td>5.067</td>
</tr>
<tr>
<td>5</td>
<td>3.021</td>
<td>4.028</td>
</tr>
<tr>
<td>6</td>
<td>2.793</td>
<td>3.724</td>
</tr>
<tr>
<td>7</td>
<td>2.536</td>
<td>3.382</td>
</tr>
<tr>
<td>8</td>
<td>2.194</td>
<td>2.925</td>
</tr>
<tr>
<td>9</td>
<td>1.697</td>
<td>2.263</td>
</tr>
<tr>
<td>10</td>
<td>1.647</td>
<td>2.196</td>
</tr>
<tr>
<td>11</td>
<td>1.591</td>
<td>2.121</td>
</tr>
<tr>
<td>12</td>
<td>1.544</td>
<td>2.058</td>
</tr>
<tr>
<td>13</td>
<td>1.494</td>
<td>1.992</td>
</tr>
<tr>
<td>14</td>
<td>1.250</td>
<td>1.667</td>
</tr>
<tr>
<td>15</td>
<td>1.153</td>
<td>1.538</td>
</tr>
<tr>
<td>16</td>
<td>1.074</td>
<td>1.432</td>
</tr>
<tr>
<td>17</td>
<td>1.035</td>
<td>1.381</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.

#### 7.3.3 Design Efficiency (Component 1)

This component accounts for 27.663% of the total variance in public client activities and includes nine items that focus primarily on design efficiency. The results in Table 7.3 reveal that the client success in the achievement of an efficient design requires the selection of consultants with capable management and technical personnel, accurate project requirements, accurate consultancy scope, a client capable of assessing consultants’ performance, suitable consultancy service terms and conditions, accurate construction tender documents, and the consideration of consultants’ past performance records when awarding the contract. Therefore, the client success in enhancing the design efficiency level is determined by the level of client performance in each of the nine elements.
Table 7.3 Public client activities in component 1

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Design Efficiency (component 1)</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>Ability of consultants’ key management personnel to deliver the required services</td>
<td>0.809</td>
</tr>
<tr>
<td>30</td>
<td>Ability of consultants’ technical personnel to deliver the required design services</td>
<td>0.802</td>
</tr>
<tr>
<td>26</td>
<td>Accuracy of project requirements when consultancy service bids are invited</td>
<td>0.778</td>
</tr>
<tr>
<td>28</td>
<td>Extent to which technical specifications meet the required quality level</td>
<td>0.720</td>
</tr>
<tr>
<td>27</td>
<td>Accuracy of consultancy scope of services when consultancy services bids are invited</td>
<td>0.675</td>
</tr>
<tr>
<td>35</td>
<td>Client ability to assess consultant performance during the pre-construction phase</td>
<td>0.666</td>
</tr>
<tr>
<td>36</td>
<td>Suitability of the consultancy service’s terms and conditions for the defined services</td>
<td>0.654</td>
</tr>
<tr>
<td>33</td>
<td>Accuracy of the construction tender documents</td>
<td>0.653</td>
</tr>
<tr>
<td>34</td>
<td>Consideration of consultants’ past performance records when awarding the contract</td>
<td>0.568</td>
</tr>
</tbody>
</table>

Table 7.3 shows that the selection of consultants with capable management has a high loading of 0.809, while the selection of consultants with capable technical personnel also has a high loading at 0.802. The other two high-loading variables are accurate project requirements (0.778) and the extent to which technical specifications meets the required quality level (0.720). Additionally, to achieve an efficient design, the client must initially develop an accurate consultancy scope (loading 0.675), and then be able to assess consultants’ performance (loading 0.666). The sixth and seventh items in this component cover suitable consultancy service terms and conditions and the accuracy of construction tender documents, which have approximately equal effects on this component, with loadings of 0.654 and 0.653 respectively. Finally, consideration of consultants’ past performance records when awarding the
contract have a significant loading (loading 0.568) on design efficiency. Thus, the score of component 1 (Equation 7.1) involves summing raw scores corresponding to items extracted in the component.

\[
Component \ (1) \ score
= \frac{\sum \text{raw score of items (26, 27, 28, 29, 30, 33, 34, 35 and 36)}}{9} \quad \ldots \ldots \ldots \text{Equation 7.1}
\]

7.3.4 Collaboration (Component 2)
The collaboration component accounts for 8.448% of the total variance of public client procurement and includes seven items (Table 7.4): the sharing of lessons learned between stakeholders, use of Information Communication Technology (ICT), the efficiency of communications between stakeholders, collaboration between stakeholders in solving difficulties, collaboration in controlling scope changes, trust between public sector stakeholders, and use of pre-identified goals and targets.

High loadings are associated with the first four items: sharing lessons learned (loading 0.783), use of ICT (loading 0.747), efficient communication (loading 0.738) and collaboration in solving difficulties (loading 0.728). Furthermore, the results in Table 7.4 show very close loadings from the other three items: control of scope changes during construction (loading 0.548), trust between public stakeholders (0.541), and use of pre-identified goals and targets (loading 0.533). Thus, the score of component 2 (Equation 7.2) involves summing raw scores corresponding to items extracted in the component.

\[
Component \ (2) \ score
= \frac{\sum \text{raw score of items (2, 21, 52, 53, 54, 55, and 56)}}{7} \quad \ldots \ldots \ldots \text{Equation 7.2}
\]
Table 7.4 Public client activities in component 2

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Collaboration (Component 2)</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>54</td>
<td>Extent of sharing lessons learned between stakeholders</td>
<td>0.783</td>
</tr>
<tr>
<td>56</td>
<td>Use of Information Communication Technology (ICT)</td>
<td>0.747</td>
</tr>
<tr>
<td>55</td>
<td>Efficiency of communications between stakeholders</td>
<td>0.738</td>
</tr>
<tr>
<td>53</td>
<td>Level of collaboration between stakeholders in solving difficulties</td>
<td>0.728</td>
</tr>
<tr>
<td>2</td>
<td>Control of scope changes during construction phase</td>
<td>0.548</td>
</tr>
<tr>
<td>52</td>
<td>Level of trust between public sector stakeholders</td>
<td>0.541</td>
</tr>
<tr>
<td>21</td>
<td>Use of pre-identified goals and targets for various project phases to measure project performance</td>
<td>0.533</td>
</tr>
</tbody>
</table>

7.3.5 Construction Efficiency (Component 3)
This component consists of six items pertaining to efficiency during the construction phase and it explains 6.584% of the total variance of client activities. As shown in Table 7.5, the six interrelated items are included in the construction efficiency component. The first three items suitability of standard contract terms and conditions, the involvement of the client team in construction progress reviews and subcontractors’ ability to deliver the scope allocated to them have high loadings of 0.752, 0.674 and 0.666 respectively.

Furthermore, the fourth and fifth items, public stakeholders’ commitment to achieving the project goals and contractors’ understanding of the technical challenges associated with the special features of the project load equally (loading 0.531) on this component. While the sixth item Stakeholders’ commitment to implementing corrective actions in order to enhance project performance loads slightly less at 0.514. Overall, the results reveal that all six items significantly load on this component. Thus, the score of component 3 (Equation 7.3) involves summing raw scores corresponding to items extracted in the component.
Component (3) score
\[ \sum_{\text{raw score of items (44, 46, 57, 59, 60 and 68)}} \]  
\[ \frac{6}{...} \quad \ldots
Component (4) score

\[ \text{Component (4) score} = \frac{\sum \text{raw score of items (42, 49, 50, 67, 70, and 74)}}{6} \quad \ldots \ldots \ldots \text{Equation 7.4} \]

Table 7.6 Public client activities in component 4

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Site management (Component 4)</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>Difficulties due to protests by the public against the project</td>
<td>0.752</td>
</tr>
<tr>
<td>50</td>
<td>Difficulties faced by the contractor in gaining access to the project site</td>
<td>0.720</td>
</tr>
<tr>
<td>42</td>
<td>Difficulties in sourcing construction materials</td>
<td>0.665</td>
</tr>
<tr>
<td>67</td>
<td>Significance of variation orders requested by the contractor</td>
<td>0.661</td>
</tr>
<tr>
<td>74</td>
<td>Difficulties due to changes in laws and regulations</td>
<td>0.642</td>
</tr>
<tr>
<td>49</td>
<td>Difficulties in handing over the project site to the contractor</td>
<td>0.606</td>
</tr>
</tbody>
</table>

7.3.7 Multiphase Involvement of Stakeholders (Component 5)

This component accounts for 4.028% of public client procurement, and Table 8.7 shows that six items are included in this component, with loadings of between 0.811 and 0.534. Training support for small and medium enterprises appears to be the most significant item in this component with a loading of 0.811. Additionally, the use of workshops with the main stakeholders (loading 0.758) and bidders (loading 0.748) highly loads on this component. The attention given to identifying possible risks at the planning phase appears to load fairly high (loading 0.599) on this component. Finally, slightly lower loadings are associated with information availability for accurately defining the project’s scope (loading 0.535) and the use of brainstorming sessions in the planning phase to identify possible issues and solutions (loading 0.534). Thus, the score of component 5 (Equation 7.5) involves summing raw scores corresponding to items extracted in the component.

Component (5) score

\[ \text{Component (5) score} = \frac{\sum \text{raw score of items (14, 23, 75, 76, 77 and 78)}}{6} \quad \ldots \ldots \ldots \text{Equation 7.5} \]
Table 7.7 Public client activities in component 5

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Multiphase involvement of stakeholders (Component 5)</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>78</td>
<td>Technical and financial training support (by the concerned authorities) for small and medium enterprises to help them cope with construction market conditions</td>
<td>0.811</td>
</tr>
<tr>
<td>76</td>
<td>Use of workshops with main stakeholders to identify possible issues and solutions before inviting construction bids</td>
<td>0.758</td>
</tr>
<tr>
<td>77</td>
<td>Use of workshops with bidders during the tender evaluation stage to resolved possible issues</td>
<td>0.748</td>
</tr>
<tr>
<td>23</td>
<td>Attention is given to identify possible risks during the planning phase</td>
<td>0.599</td>
</tr>
<tr>
<td>14</td>
<td>Information availability for accurately defining the project’s scope</td>
<td>0.535</td>
</tr>
<tr>
<td>75</td>
<td>Use of brainstorming sessions in the planning phase to identify possible issues and solutions</td>
<td>0.534</td>
</tr>
</tbody>
</table>

7.3.8 Review of Learning from Past Projects (Component 6)
This component includes four important items which explain 3.724% of public client procurement. The first two items positively load on the component, while the other two items load negatively. The difference in these loading signs indicates the way each item is related to the component and must be considered when computing the component’s aggregated score. Positive loading items include budget estimates compared to construction tender scope cost (loading 0.754) and the extent of sharing learning from this project with other team members within the public sector (loading 0.664). In contrast, the significance of changes due to geological conditions (loading 0.649) and repetition of past projects’ difficulties (loading 0.512) have negative loadings. The two positive items are associated with the highest loadings, while the two negative items load slightly less on the component score. Thus, the score of component 6 (Equation 7.6) involves summing raw scores corresponding to items extracted in the component.
Component (6) score
\[
= \frac{\sum \text{raw score of items (4, 10, 11 and 38)}}{4}
\] … … … … Equation 7.6

Table 7.8 Public client activities in component 6

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Review of learning from projects (Component 6)</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Budget estimates compared to construction tender scope cost</td>
<td>0.754</td>
</tr>
<tr>
<td>10</td>
<td>Extent of sharing learning from this project with other team members within the public sector</td>
<td>0.664</td>
</tr>
<tr>
<td>38</td>
<td>Significance of changes due to geological conditions at the project site</td>
<td>-0.649</td>
</tr>
<tr>
<td>11</td>
<td>Repetition of past projects’ difficulties in this project</td>
<td>-0.512</td>
</tr>
</tbody>
</table>

7.3.9 Accuracy of Projects Objectives and Requirements (Component 7)
This component consists of two items and it explains 3.382% of client public procurement. Both items load highly on the component: changes in the project objectives load by 0.828 and changes in the project requirements load by 0.710. Thus, the score of component 7 (Equation 7.7) involves summing raw scores corresponding to items extracted in the component.

\[
\text{Component (7) score} = \frac{\sum \text{raw score of items (18 and 19)}}{2}
\] … … … … Equation 7.7

7.3.10 Client Team Development (Component 8)
Table 7.9 shows that the two items included in this component load in opposite ways. The first item measures the significance of the training needed by the client team but not provided, and it negatively loads (loading -0.715) on this component. In contrast, the second item positively loads (loading 0.597) on the component and it explains the relative importance of the client’s ability to assess contractors’ financial capabilities and track records when deciding on who to award a contract to. Table 7.9 shows that the two items in this component explain 2.925% of public client procurement activities. Thus, the
score of component 8 (Equation 7.8) involves summing raw scores corresponding to items extracted in the component.

\[
Component (8)\text{score} = \frac{\sum \text{raw score of items (–6 and 63) \text{ squared}}}{2} \quad \ldots \ldots \ldots \text{Equation 7.8}
\]

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Accuracy of projects Objectives and requirements (Component 7)</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Changes in the project objectives during construction</td>
<td>0.828</td>
</tr>
<tr>
<td>19</td>
<td>Changes in the project requirements during construction</td>
<td>0.710</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Client team development (Component 8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
</tr>
<tr>
<td>63</td>
</tr>
</tbody>
</table>

### Table 7.9 Public client activities in components 7 and 8

#### 7.3.11 Project Planning and Permits Approvals (Component 9)
Difficulties in obtaining planning and permits approvals and those caused by changes in statutory and permit requirements explain 2.263% of public client procurement. Higher loading (loading 0.807) is associated with difficulties in obtaining planning and permit approval, compared with the lower loading of 0.515 from difficulties due to changes in statutory and permit requirements. Thus, the score of component 9 (Equation 7.9) involves summing raw scores corresponding to items extracted in the component.

\[
Component (9)\text{score} = \frac{\sum \text{raw score of items (5 and 17) \text{ squared}}}{2} \quad \ldots \ldots \ldots \text{Equation 7.9}
\]

#### 7.3.12 Availability of Construction Workforce (Component 10)
The availability of construction workforce component consists of two items and it accounts for 2.196% of public client procurement. As shown in Table 7.10, the
difficulties faced by the contractor in recruiting labour and professionals (loading -0.700) loads higher than the loading of the use of standardised processes, documents, and templates to reduce unnecessary use of resources on repeated tasks (loading 0.513). Thus, the score of component 10 (Equation 7.10) involves summing raw scores corresponding to items extracted in the component.

\[
\text{Component (10) score} = \sum_{\text{items (9 and 71)}} \frac{\text{raw score of items} \cdot (9 - 71)}{2} \ldots \ldots \ldots \text{Equation 7.10}
\]

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Project planning and permits (Component 9)</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Difficulties in obtaining planning and permit approval</td>
<td>0.807</td>
</tr>
<tr>
<td>17</td>
<td>Difficulties due to changes in statutory and permit requirements during the construction phase</td>
<td>0.515</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Availability of construction workforce (Component 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>71</td>
</tr>
<tr>
<td>9</td>
</tr>
</tbody>
</table>

7.3.13 Decision Making (Component 11)
This component explains 2.121% of public client procurement and includes only one item, related to the client team’s understanding of which decisions they can make alone and which decisions require the involvement of others. As can be seen in Table 7.11, the item highly loads (loading 0.720) on this component. Thus, the score of component 11 (Equation 7.11) involves summing raw scores corresponding to item extracted in the component.

\[
\text{Component (11) score} = \sum_{\text{item (17)}} \frac{\text{raw score of items (17)}}{1} \ldots \ldots \ldots \text{Equation 7.11}
\]
7.3.14 Contractor Difficulties (Component 12)
This component consists of two items which account for 2.058% of public client procurement. Table 7.11 reports that higher loading (loading 0.729) is associated with contractor cash flow difficulties, while conflicts between the main contractor and subcontractors load 0.536 on this component. Thus, the score of component 12 (Equation 7.12) involves summing raw scores corresponding to items extracted in the component.

\[
\text{Component (12) score} = \frac{\sum \text{raw score of item (43 and 62)}}{2} \ldots \ldots \ldots \text{Equation 7.12}
\]

Table 7.11 Public client activities in components 11 and 12

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Decision making (Component 11)</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Client team’s understanding of which decisions they can make alone and which decisions require the involvement of others</td>
<td>0.720</td>
</tr>
<tr>
<td>62</td>
<td>Contractor cash flow difficulties during construction</td>
<td>0.729</td>
</tr>
<tr>
<td>43</td>
<td>Conflicts between the main contractor and subcontractors during the project</td>
<td>0.536</td>
</tr>
</tbody>
</table>

7.3.15 Information Coordination Process (Component 13)
The efficiency of the information coordination process between stakeholders loads highly (loading 0.631) on this component and it accounts for 1.992% of public client procurement activities. These two indicators explain the relative importance of this component for public procurement. Thus, the score of component 13 (Equation 7.13) involves summing raw scores corresponding to items extracted in the component.

\[
\text{Component (13) score} = \sum \frac{\text{raw score of item (12)}}{1} \ldots \ldots \ldots \text{Equation 7.13}
\]
7.3.16 Requirement Modifications Initiated by the Client (Component 14)
The significance of requirement modifications initiated by the client is the last
extracted item and the only item in this component. The component accounts
for 1.667% of the total variance in public client activities. As can be seen in
Table 7.12, the extracted item negatively loads (loading -0.573) on this
component. Thus, the score of component 14 (Equation 7.14) involves
summing raw scores corresponding to items extracted in the component.

\[
Component\ (14)\ score = \frac{-raw\ score\ of\ item\ 47}{1}
\]

... ... ... Equation 7.14

Table 7.12 Public client activities in components 13 and 14

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information coordination process (Component 13)</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>The efficiency of the information coordination process between stakeholders</td>
<td>0.631</td>
</tr>
<tr>
<td>47</td>
<td>Requirement modifications initiated by the client (Component 14)</td>
<td>-0.573</td>
</tr>
</tbody>
</table>

7.4 Regression analysis
Following the principal component analysis in Section 7.3, this section
addresses the modelling of public procurement in design bid build and design
build projects. As already explained in Chapter 5, models were developed for
the assessment of the effects of client success components on construction
delays and cost overruns throughout the procurement lifecycle.

Drawing on the client activity components extracted from the principal
components analysis, stepwise multiple regression analysis was conducted to
establish the relationship between the 14 client components as the independent
variables and delays and cost overruns as the dependent variables. In total,
four models were developed, two for each procurement system. The first model
in each system was developed to explore the influence of the 14 client activity
components of public client procurement on the level of delays, and the second
model explores the influence of the components on the level of cost overruns. The following sections present the results of the regression modelling for each procurement system.

7.4.1 Data Screening
Prior to regression analysis, the data were examined for potential outliers and missing values. In 14 cases, the dependent variables were very different from the other cases (Section 6.3). Therefore, the extreme delays and cost overruns of the cases that contributed to the outliers were deleted using a percentage-based rule. A 5% trim was adopted to exclude these extreme cases and reduce the impact of the few highest and lowest values. Based on the 5% trimming rule, the two lowest cases of delays (-16% and -13%) were excluded and the four lowest cases of cost overruns (-57%, -30%, -24% and -23%) were excluded. Similarly, the four highest cases of delays (252%, 200%, 199%, and 180%) were excluded and the four highest cases of cost overruns (316%, 199%, 100% and 86%) were also excluded. Therefore, when conducting regression analysis in SPSS, the "selected cases" command was used to exclude the trimmed data from the analysis. Accordingly, the sample sizes adopted for the final results were 91 for the design bid build procurement system and 82 for the design-build procurement system. It is important to note that the design-build included one missing case, thus the actual sample size adopted for the final results was 81.

7.5 Design Bid Build (DBB) Delays Model

7.5.1 DBB Delays Model Summary
The analysis results in Table 7.13 indicate that four models were developed. However, the table shows that model number 4 is the most optimum model, as it includes the smallest possible set of components. The model summary in Table 7.13 provides the $R^2$ and adjusted $R^2$ values of the four models, where $R^2$ of model number 4 indicates that 31% of delays is explained by public client success components. The adjusted $R^2$ indicates that if the model was derived from the population rather from the sample, it would explain approximately 27.8% of the variance in delays. In general, the higher the $R^2$ figure, the better the model fits the data. But what “large” or “high” means is not really defined what makes a “good” R-squared depends on the subject area. For example behavioural sciences $R^2$ figure of 29% can be considered very high (Cohen et
Therefore, important conclusion can be drawn even with low $R^2$ figure and statistically significant predictors. Regardless of the $R^2$ value, the significant coefficient still can represent how changes in the predictor values are associated with the changes in the response values. Obviously, this type of information can be extremely valuable. In fact, it is entirely common that the $R^2$ values in similar researches are around 30%. Therefore, $R^2$ value of 27% is reasonably within an acceptable range when compared with other similar studies using principal component and regression analysis, such as 25% and 28% in Molenaar and Songer (1998) investigation for delays and cost overruns respectively in public projects, 27% and 35% of delays and cost overruns respectively in Scott-young and Samson (2008) study of project success factors.

The ANOVA results in Table 7.14 show that model 4 overall explain construction delays in DBB significantly well. In other words, ANOVA test ($F=9.672$, $p < 0.0005$) indicates that, overall, the regression model significantly explains the influence of public client activity components on delays in the design bid build procurement system.

### Table 7.13 DBB delays model summary

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Durbin-Watson</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.370&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.137</td>
<td>.127</td>
<td>34.53515</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>.486&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.236</td>
<td>.219</td>
<td>32.67002</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>.524&lt;sup&gt;c&lt;/sup&gt;</td>
<td>.274</td>
<td>.249</td>
<td>32.03492</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>.557&lt;sup&gt;d&lt;/sup&gt;</td>
<td>.310</td>
<td>.278</td>
<td>31.41029</td>
<td>1.676</td>
</tr>
</tbody>
</table>

<sup>a</sup>. Dependent Variable: Delays

### Table 7.14 DBB delays ANOVA results

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Regression</td>
<td>38168.224</td>
<td>4</td>
<td>9542.056</td>
<td>9.672</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>84848.154</td>
<td>86</td>
<td>986.606</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>123016.378</td>
<td>90</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>. Dependent Variable: Delays

7.5.2 DBB Delays Model Parameters

The coefficients in Table 7.15 indicate that the public client activities contribute significantly ($p < 0.0005$) to the model (see the "Sig." column). More importantly,
the standardised coefficients (β values) in the table show the relative
importance of each client component against the others in influencing delays in
the design bid build procurement system. Thus, the parameters of the model
are those client activity components that significantly influence delays.

The results in Table 7.13 indicate that 27.8% of the variance in DBB
construction delays can be explained by four public client activity components,
namely: collaboration, modification initiated by the client during construction,
contractor difficulties and accuracy of objectives and requirements. The results
in the coefficient table (Table 7.15) reveal that collaboration (β = -0.366, p <
0.001) and requirement modifications initiated by the client (β = 0.341, p <
0.0005) contribute significantly to the model. The standardised coefficient value
of collaboration is slightly higher than that of requirement modification initiated
by the client, indicating the greater influence of collaboration on delays in the
design bid build procurement system. The coefficient values of the other two
components, contractor difficulties (β = 0.226, p < 0.015) and accuracy of
objectives and requirements changes (β = -0.219, p < 0.037), are slightly lower
compared to the first two components.

Subsequently, the relationship between client activity components and delays
(Δ𝑇_{DBB}) in DBB projects can be presented as:

\[
Δ𝑇_{DBB} = 119.83 - 18.115 (Comp2) + 12.109 (Comp14) + 8.298 (Comp12) \\
- 6.948 (Comp7) \ldots \ldots \ldots \ldots \ldots \ldots (7.1)
\]

The implication of Equation 7.1 is that greater use of collaborative approaches
and higher accuracy of objectives and requirements could provide public clients
with a firm foundation for minimising delays in design bid build procurement. In
contrast, greater abilities on the part of contractors in dealing with difficulties
during contraction stage could increase delays. This suggests that contractors
who have higher capabilities to manage construction difficulties would have
higher probability to cause additional construction time after the awarding of a
contract.
7.5.3 **DBB Delays Model Validation**

The regression model was validated by examining the extent to which the assumptions were met. These assumptions, as stated in Section 5.18.2 of the methodology, include:

- **The absence of multicollinearity**: Table 7.15 shows that the VIF is within the acceptable limit (VIF < 10), which confirms the independence of variables, so this assumption is met.

- **The absence of outliers**: From a visual check of the scatterplot in Figure 7.3, it appears that no single score is very different from the rest of the data, thus the assumption of the absence of outliers is not violated.

- **Independence of residuals**: As can be seen from Table 7.13, the Durbin-Watson test value is 1.676, indicating that the residuals are uncorrelated.

- **Normality of residuals**: A visual check of the scatterplot in Figure 7.2 shows that the residuals appear to be close to a straight line, thus they follow a normal distribution. In other words, the assumption of normal distribution is not violated.

- **The linearity of residuals**: By examining the graphical display in Figure 7.3 and looking for evidence of nonlinearity, it is apparent that the residuals are randomly distributed and the overall shape of the scatter plot is not curved. These indicators support the specified linear relationship between the public client success components and delays.

- **Homoscedasticity of residuals**: It can be seen from Figure 7.3 that the points are randomly and approximately evenly dispersed, indicating that the assumption of homoscedasticity is not violated.
Table 7.15 DBB delays coefficients

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardised Coefficients</th>
<th>Standardised Coefficients</th>
<th>t</th>
<th>Sig.</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
<td>VIF</td>
</tr>
<tr>
<td>4</td>
<td>(Constant)</td>
<td>119.830</td>
<td>19.601</td>
<td>6.113</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Collaboration (Component 2)</td>
<td>-18.115</td>
<td>5.200</td>
<td>-3.484</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>Requirement modifications initiated by the client (Component 14)</td>
<td>12.109</td>
<td>3.298</td>
<td>3.671</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Contractor difficulties (Component 12)</td>
<td>8.298</td>
<td>3.360</td>
<td>2.470</td>
<td>.015</td>
</tr>
<tr>
<td></td>
<td>Accuracy of Objectives and requirements (Component 7)</td>
<td>-6.948</td>
<td>3.277</td>
<td>-2.120</td>
<td>.037</td>
</tr>
</tbody>
</table>

Dependent Variable: delays
7.6 DBB Cost Overruns Model

7.6.1 DBB Cost Overruns Model Summary
The results in Table 7.16 indicate that 44.6% of cost overruns is explained by public client components. The adjusted $R^2$ indicates that if the model was derived from the population rather from the sample, it would explain approximately 40.6% of the variance in cost overruns in design bid build procurement.

The ANOVA results in Table 7.17 show that model 6 overall explain construction cost overruns in DBB significantly well. In other words, ANOVA test ($F=11.250$, $p < 0.0005$) which indicates that, overall, the regression model
significantly explains the influence of public client components on cost overruns in the design bid build procurement system.

Table 7.16 DBB cost overruns model summary

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Durbin-Watson</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.403</td>
<td>.162</td>
<td>.153</td>
<td>13.98598</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>.482</td>
<td>.232</td>
<td>.215</td>
<td>13.46739</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>.569</td>
<td>.324</td>
<td>.301</td>
<td>12.70871</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>.624</td>
<td>.389</td>
<td>.360</td>
<td>12.15381</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>.646</td>
<td>.417</td>
<td>.383</td>
<td>11.93565</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>.667</td>
<td>.446</td>
<td>.406</td>
<td>11.71290</td>
<td>1.771</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Cost overruns

Table 7.17 DBB cost overruns ANOVA results

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>9260.529</td>
<td>6</td>
<td>1543.422</td>
<td>11.250</td>
<td>.000</td>
</tr>
<tr>
<td>Residual</td>
<td>11524.134</td>
<td>84</td>
<td>137.192</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>20784.664</td>
<td>90</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Dependent Variable: Cost overruns

7.6.2 DBB Cost Overruns Model Parameters

The results in Table 7.16 indicate that the 40.6% of the variance in DBB construction cost overruns can be explained by six public client components, namely: multiphase involvement of stakeholders, design efficiency, availability of construction workforce, contractor difficulties, client team development, and collaboration. The results in the coefficient table (Table 7.18) reveal that contractor difficulties (β = 0.287, p < 0.001) and availability of construction workforce (β = 0.282, p < 0.009) are the most significant components, strongly affecting cost overruns in design bid build procurement. The standardised coefficient values of client team development (β = 0.275, p < 0.007) and collaboration (β = -0.276, p < 0.042) are approximately equal, indicating similar effects from each of these two components on cost overruns in design bid build procurement. Finally, minor difference is presented between the fifth component, design efficiency (β = -0.253, p < 0.046), and the sixth component, multiphase involvement of stakeholders (β = -0.246, p < 0.022).
Subsequently, the relationship between client activity components and cost overruns ($\Delta C_{\text{DBB}}$) in DBB projects can be presented as:

$$
\Delta C_{\text{DBB}} = 37.485 - 4.620 (\text{Comp5}) - 4.778 (\text{Comp 1}) + 5.114 (\text{Comp10})
+ 4.332 (\text{Comp12}) + 5.420 (\text{Comp 8})
- 5.609 (\text{comp 2}) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (7.2)
$$

The implication of Equation 7.2 is that the multiphase involvement of stakeholders, higher design efficiency, higher availability of workforce, developing client team knowledge and skills and collaboration should help the client to minimise cost overruns. In contrast, contractors' high abilities to deal with difficulties during the contraction stage could increase cost overruns. This suggests that contractors who have higher financial and management capabilities have the potential to add extra construction costs after the awarding of the contract. Therefore, the client team should develop their knowledge and skills to improve project performance in terms of minimising cost overruns.

### 7.6.3 DBB Cost Overruns Model Validation

The regression model was validated by examining the extent to which the assumptions were met. The results Table 7.16 show that the assumptions about the absence of multicollinearity and the independence of residuals are not violated. Furthermore, by examining the graphs in Figure 7.4 and Figure 7.5 it can be seen that the residuals assumptions about normality, absence of outliers, linearity and homoscedasticity are not violated.
Table 7.18 DBB cost overruns parameters

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>(Constant)</td>
<td>37.485</td>
<td>8.202</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Multiphase involvement of stakeholders (Component 5)</td>
<td>-4.620</td>
<td>1.980</td>
<td>-.246</td>
<td>-2.334</td>
</tr>
<tr>
<td></td>
<td>Design Efficiency (Component 1)</td>
<td>-4.778</td>
<td>2.462</td>
<td>-.253</td>
<td>-1.941</td>
</tr>
<tr>
<td></td>
<td>Availability of construction workforce (Component 10)</td>
<td>5.114</td>
<td>1.922</td>
<td>.282</td>
<td>2.661</td>
</tr>
<tr>
<td></td>
<td>Contractor difficulties (Component 12)</td>
<td>4.332</td>
<td>1.245</td>
<td>.287</td>
<td>3.479</td>
</tr>
<tr>
<td></td>
<td>Client team development (Component 8)</td>
<td>5.420</td>
<td>1.954</td>
<td>.275</td>
<td>2.774</td>
</tr>
<tr>
<td></td>
<td>Collaboration (Component 2)</td>
<td>-5.609</td>
<td>2.716</td>
<td>-.276</td>
<td>-2.065</td>
</tr>
</tbody>
</table>
7.7 Design Build (DB) Delays Model

7.7.1 DB Delays Model Summary
The results in Table 7.19 indicate that 28.4% of delays is explained by public client components. The adjusted $R^2$ indicates that if the model was derived from the population rather from the sample, it would explain approximately 25.5% of the variance in delays in design-build procurement.

The ANOVA results in Table 7.20 show that model 3 overall explain construction delays in DB significantly well. In other words, ANOVA test ($F=10.034, p < 0.0005$) which indicates that, overall, the regression model
significantly explains the influence of public client components on delays in the design-build procurement system.

Table 7.19 DB delays model summary

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Durbin-Watson</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.400&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.160</td>
<td>.149</td>
<td>30.65900</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>.480&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.230</td>
<td>.210</td>
<td>29.54007</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>.533&lt;sup&gt;c&lt;/sup&gt;</td>
<td>.284</td>
<td>.255</td>
<td>28.68586</td>
<td>1.784</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Delays

Table 7.20 DB delays ANOVA results

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>24769.893</td>
<td>3</td>
<td>8256.631</td>
<td>10.034</td>
<td>.000&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Residual</td>
<td>62538.777</td>
<td>76</td>
<td>822.879</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>87308.670</td>
<td>79</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Dependent Variable: Delays

7.7.2 DB Delays Model Parameters

The results in Table 7.21 indicate that 25.5% of the variance in DB construction time overruns can be explained by three public client components, namely: accuracy of objectives and requirements, construction efficiency and difficulties in project planning and permit approvals. A minor difference can be noticed between the effects of accuracy of objectives requirements (β = -0.306, p < 0.003) and construction efficiency (β = -0.302, p < 0.004) on delays in design-build procurement. The results further indicate that difficulties in planning and gaining permit approval have less effect on delays (β = -0.234, p < 0.020).

Subsequently, the relationship between client components and delays (∆Τ<sub>DB</sub>) in DB projects can be presented as:

\[
\Delta T_{DB} = 138.462 - 8.591(Comp7) - 15.658(Comp3) - 8.296(Comp9) \ldots \ldots \ldots \ldots \ldots \ldots \ldots (7.3)
\]

The implication of Equation 7.3 is that the dependent variables included in the model have positive relationships with project performance in terms of minimising construction delays. This finding suggests that minimisation of construction delays could be achieved by increasing the accuracy of objectives
and requirements, increasing construction efficiency and resolving planning and permit approval difficulties.

7.7.3 DB Delays Model Validation
The regression model was validated by examining the extent to which the assumptions were met. The results in Tables 7.19 and 7.21 shows the assumptions about the absence of multicollinearity and the independence of residuals are not violated. Furthermore, by examining the graphs in Figure 7.6 and Figure 7.7, it can be seen that the residuals assumptions about normality, absence of outliers, and linearity are not violated. Also, it can be seen from Figure 7.7 that the variance differs along the horizontal line, which can lead to increased Type I error rates. However, the violation of the homoscedasticity assumption must be quite severe in order to present a major problem given the robust nature of ordinary least square regression (Field, 2013).
Table 7.21 DB delays parameters

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardised Coefficients</th>
<th>Standardised Coefficients</th>
<th>t</th>
<th>Sig.</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 (Constant)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
<td>VIF</td>
</tr>
<tr>
<td>Accuracy of objectives and requirements</td>
<td>138.462</td>
<td>21.582</td>
<td>-.306</td>
<td>6.416</td>
<td>.000</td>
</tr>
<tr>
<td>(Component 7)</td>
<td>-8.591</td>
<td>2.827</td>
<td>-.306</td>
<td>-3.038</td>
<td>.003</td>
</tr>
<tr>
<td>Construction efficiency (Component 3)</td>
<td>-15.658</td>
<td>5.221</td>
<td>-.302</td>
<td>-2.999</td>
<td>.004</td>
</tr>
<tr>
<td>Difficulties in project planning and permits (Component 9)</td>
<td>-8.296</td>
<td>3.489</td>
<td>-.234</td>
<td>-2.378</td>
<td>.020</td>
</tr>
</tbody>
</table>

Dependent Variable: Delays
7.8 DB Cost Overruns Model

7.8.1 DB Cost Overruns Model Summary
The results in Table 7.22 indicate that 49% of cost overruns is explained by public client components. The adjusted $R^2$ indicates that if the model was derived from the population rather from the sample, it would explain approximately 45.6% of the variance in cost overruns in design-build procurement.

The ANOVA results in Table 7.23 show that model 5 overall explain construction cost overruns in DB significantly well. In other words, ANOVA test ($F=14.245, p < 0.0005$) which indicates that, overall, the regression model...
significantly explains public client components influence on cost overruns in the design-build procurement system.

Table 7.22 DB cost overruns model summary

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Durbin-Watson</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.554</td>
<td>.307</td>
<td>.298</td>
<td>13.01077</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>.607</td>
<td>.368</td>
<td>.351</td>
<td>12.50797</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>.646</td>
<td>.417</td>
<td>.394</td>
<td>12.08630</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>.669</td>
<td>.447</td>
<td>.418</td>
<td>11.85266</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>.700</td>
<td>.490</td>
<td>.456</td>
<td>11.45584</td>
<td>1.712</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Cost overruns

Table 7.23 DB cost overruns ANOVA results

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>9346.991</td>
<td>5</td>
<td>1869.398</td>
<td>14.245</td>
<td>.000</td>
</tr>
<tr>
<td>Residual</td>
<td>9711.476</td>
<td>74</td>
<td>131.236</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>19058.467</td>
<td>79</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Dependent Variable: Cost overruns

7.8.2 DB Cost Overruns Model Parameters
The results in Table 7.24 indicate that 45.6% of the variance in DB construction cost overruns can be explained by five public client components, namely: design efficiency, requirement modification by the client, client team development, accuracy of objectives and requirements, and collaboration. The results indicate differences in the beta values of the five components. The coefficient of design efficiency (-0.372, p = 0.011) is higher than that of the other four components. Similarly, large coefficient value differences can be noticed between collaboration (-0.287, p = 0.014) and the other three components, while small coefficient value differences exist between accuracy of objectives and requirements (-0.263, p = 0.010), client team development (0.252, p = 0.004) and requirement modification initiated by the client (0.244, p = 0.014).

Subsequently, the relationship between client components and cost overruns ($\Delta C_{DB}$) in DB projects can be presented as:
The implication of Equation 7.4 is that design efficiency, collaboration and objective and requirement changes have positive relationships with project performance in terms of minimising construction cost overruns. This finding suggests that the minimisation of construction cost overruns could be achieved by enhancing design efficiency and collaboration and accuracy of objectives and requirements. In contrast, the model indicates that requirement modifications by the client and limitation in the development of the client team knowledge and skills have negative relationships with project performance in terms of minimising cost overruns. Therefore, in order to help improve project performance, clients should minimise requirement modifications during the construction stage. Furthermore, more attention should be given to maximising training related to knowledge and skills development and minimising training on financial aspects.

7.8.3 DB Cost Overruns Model Validation
The regression model was validated by examining the extent to which the assumptions were met. The results in Table 7.22 and Table 7.24 show that the assumptions about the absence of multicollinearity and the independence of residuals are not violated. Furthermore, from examining the graphs in Figure 7.8 and Figure 7.9, it appears that the residuals assumptions about normality, absence of outliers, and linearity are not violated.
<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardised Coefficients</th>
<th>Standardised Coefficients</th>
<th>t</th>
<th>Sig.</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
<td>VIF</td>
</tr>
<tr>
<td>5 (Constant)</td>
<td>69.515</td>
<td>8.784</td>
<td>7.913</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>Design Efficiency (Component 1)</td>
<td>-6.117</td>
<td>2.333</td>
<td>-372</td>
<td>-2.623</td>
<td>.011</td>
</tr>
<tr>
<td>Requirement modifications initiated by the client (Component 14)</td>
<td>4.100</td>
<td>1.633</td>
<td>.244</td>
<td>2.510</td>
<td>.014</td>
</tr>
<tr>
<td>Client team development (Component 8)</td>
<td>5.472</td>
<td>1.828</td>
<td>.252</td>
<td>2.993</td>
<td>.004</td>
</tr>
<tr>
<td>Accuracy of objectives and requirements changes (Component 7)</td>
<td>-3.450</td>
<td>1.309</td>
<td>-.263</td>
<td>-2.636</td>
<td>.010</td>
</tr>
<tr>
<td>Collaboration (Component 2)</td>
<td>-5.815</td>
<td>2.319</td>
<td>-.287</td>
<td>-2.507</td>
<td>.014</td>
</tr>
</tbody>
</table>
7.9 Summary

Principal component analysis reduced the 75 independent variables to 14 components representing client success components in construction procurement. These 14 public client success components were then used to generate models capable of producing more stable estimates of regression coefficients, delaysoverruns. The fourteen components represent the basic public procurement success components, which when efficiently attained empower construction clients to act proactively throughout the procurement lifecycle to deliver the project intended objectives. The regression modelling further reduced the success components to ten which when efficiently attained by the client can minimize the risk of construction delays and cost overruns. Interpretation of these results will be discussed in chapter eight.
Chapter Eight: Validation

8.1 Introduction
The results in chapter seven revealed that the effect of client activities on schedule delays and cost overruns is substantial for a number of specific activities. Activities in six key components appeared to greatly affect construction schedule delays, while activities in eight components appeared to have substantial effects on construction cost overruns. This chapter checks the extent to which these findings reflect client organisation practice and circumstance. Therefore, the chapter focuses on validating whether the relationships defined through regression modelling correspond with reality. It covers the aim and objectives of validation, the validation process, and validation results.

8.2 Aim and Objectives
The aim of validation is to assess the extent to which the study findings reflect client organisations’ practices and circumstances. To achieve this aim, the following specific validation objectives were identified:

- To assess the level of agreement amongst professionals from the industry on the extent to which each client activity affects construction delays and cost overruns.
- To explore the appropriateness and practicality of the client activity components for construction procurement in dealing with construction time and cost overruns.
- To assess whether the client activity components can help improve knowledge of aspects that must be efficiently practiced in construction projects to reduce delays and cost overruns.
- Other comments.

8.3 Public Client Activity Components
Certain components of public client activities are proposed in this thesis to address the aim described in Section 1.3. Consequently, these components outline the fact that highly influential client activities, when efficiently practiced by the public sector, can minimise the risk of construction delays and cost.
overruns. The client activity components shown in Table 8.1 are based on the analysis results in chapter seven, which concluded that four and six client activity components appear to greatly affect construction delays and cost overruns in DBB respectively, while three and five client activity components affect delays and cost overruns in DB respectively.

**Table 8.1 Public client activity components effects on construction performance**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Design bid build procurement system</th>
<th>Design-build procurement system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>delays</td>
<td>Cost overruns</td>
</tr>
<tr>
<td>Design Efficiency (Component 1)</td>
<td>excluded</td>
<td>-0.253</td>
</tr>
<tr>
<td>Collaboration (Component 2)</td>
<td>-0.366</td>
<td>-0.276</td>
</tr>
<tr>
<td>Construction efficiency (Component 3)</td>
<td>excluded</td>
<td>excluded</td>
</tr>
<tr>
<td>Site management (Component 4)</td>
<td>excluded</td>
<td>excluded</td>
</tr>
<tr>
<td>Early involvement of stakeholders (Component 5)</td>
<td>excluded</td>
<td>-0.246</td>
</tr>
<tr>
<td>Learning from past experience (Component 6)</td>
<td>excluded</td>
<td>excluded</td>
</tr>
<tr>
<td>Objective and requirement changes (Component 7)</td>
<td>-0.219</td>
<td>excluded</td>
</tr>
<tr>
<td>Client team development (Component 8)</td>
<td>excluded</td>
<td>0.275</td>
</tr>
<tr>
<td>Difficulties in project planning and permits (Component 9)</td>
<td>excluded</td>
<td>excluded</td>
</tr>
<tr>
<td>Availability of construction workforce (Component 10)</td>
<td>excluded</td>
<td>0.282</td>
</tr>
<tr>
<td>Decision making (Component 11)</td>
<td>excluded</td>
<td>excluded</td>
</tr>
<tr>
<td>Contractor difficulties (Component 12)</td>
<td>0.226</td>
<td>0.287</td>
</tr>
<tr>
<td>Information coordination process (Component 13)</td>
<td>excluded</td>
<td>excluded</td>
</tr>
<tr>
<td>Requirement modifications initiated by the client (Component 14)</td>
<td>0.341</td>
<td>excluded</td>
</tr>
</tbody>
</table>
8.4 Client Activity Component Validation Method
Validation improves credibility and understanding by strengthening confidence in findings (Patton, 2002). The findings of this research comprised public client activities that highly influence construction delays and cost overruns. The research provides public clients with activities that can be applied by the client team to minimise the risks of construction delays and cost overruns.

The validation process involves getting feedback from respondents on the final research findings, which allows the researcher to learn a great deal about the accuracy of the findings. It can be seen that experts’ judgements have a key role in establishing the validity of findings (Patton, 2002). In fact, respondents’ and experts’ judgements have been widely used to validate research findings (Bryman and Bell, 2011; Lincoln and Guba, 1985). This research adopted the expert judgement approach to validate its main findings. Semi-structured interviews with six experts were used to validate the research findings.

8.5 Validation Sampling Method
Six sets of interview templates and consent forms were disseminated to senior project managers/directors and advisors within the public client departments initially covered in the questionnaire survey. Validation was limited to these departments for the following reasons:

- These departments cover almost all major infrastructure projects (highways, roads, electricity, and water) in Oman.
- The validation objective was to assess the practicality of implementing the key findings within these departments.
- Good response rates to the questionnaire survey from these departments were an indication of their willingness to implement performance improvement initiatives.

To gain a different view of the research, the interviewees involved in the validation were not those who had completed the questionnaire survey. Furthermore, interviews were organised with participants who had expertise in project management, tendering, and construction procurement. The details of the six interviewees are presented in Table 8.2.
Table 8.2 Details of validation interviewees

<table>
<thead>
<tr>
<th>Code</th>
<th>Role/Position</th>
<th>Years of experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Projects Advisor</td>
<td>18</td>
</tr>
<tr>
<td>P2</td>
<td>Director General</td>
<td>20</td>
</tr>
<tr>
<td>P3</td>
<td>Senior Projects Manager</td>
<td>15</td>
</tr>
<tr>
<td>P4</td>
<td>QS and Contracts Manager</td>
<td>16</td>
</tr>
<tr>
<td>P5</td>
<td>Projects advisor</td>
<td>25</td>
</tr>
<tr>
<td>P6</td>
<td>Projects advisor</td>
<td>20</td>
</tr>
</tbody>
</table>

8.6 Validation Process

The validation process was carried out in two phases, as described below:

**Phase 1**

Findings (Table 8.1 and Table 8.3) on client activities that affect construction delays and cost overruns were presented to interviewees from the various public client departments. They were asked to assess current client performance in each activity within their own organisations and the possibility of enhancing the existing situation, and then to indicate their levels of agreement on the extent to which higher performance by clients in each activity can affect construction delays and cost overruns. The respondents were asked to rate the extent to which each activity affected construction delays and/or cost overruns on a five-point scale to ensure all items measured the same thing. The rating for each statement used in the validation process was constructed as described below:

**Strongly disagree** was represented by a rating of 1, meaning that the respondent was completely confident that performance improvement by the client in the activity under consideration absolutely would not affect construction delays or cost overruns based on his/her experience.

**Disagree** was represented by a rating of 2, meaning the respondent did not agree that improved performance by the client in the activity under consideration would affect construction delays or cost overruns based on his/her experience.
Uncertain was represented by a rating of 3, meaning the respondent was not sure that a higher performance level by the client in the activity under consideration would affect construction delays or cost overruns based on his/her experience.

Agree was represented by a rating of 4, meaning that the respondent was generally in agreement that a higher performance level by the client in the activity under consideration would affect construction delays or cost overruns based on his/her experience.

Strongly Agree was represented by a rating of 5, indicating that the respondent had no doubt that a higher performance level by the client in the activity under consideration would definitely affect construction delays or cost overruns based on his/her experience.

Phase 2

Respondents were then asked to comment on the client activities defined in the research to assess:

- The appropriateness and practicality of the client activities in dealing with construction delays and cost overruns as part of construction procurement.
- Whether the client activities can help improve knowledge of aspects that must be efficiently practiced during construction projects to reduce construction delays and cost overruns.
- Other comments

During the interviews, participants were encouraged to provide feedback on the client success components. They were asked to provide feedback on each component of the client activities.

8.7 Validation Results

8.7.1 Design Efficiency

The results in Table 8.3. report that the interviewees were in general agreement that design efficiency activities can greatly reduce construction cost overruns. The levels of agreement on the effect of this component’s activities ranged
between agree and strongly agree, with an average of between 4.5 and 4.83. The results indicate in all activities, the average level of agreement is higher than 4.5. Five interviewees (P2, P3, P4, P5, and P6) stated that the design activities identify critical areas that require particular attention in order for improvement to take place. Similarly, two interviewees (P2 and P3) said that the grouping of the design efficiency activities enabled client teams to see the links between activities. The interviewees also found that this component included important activities. The higher ratings of the selection of consultants with higher management and technical abilities and greater accuracy of project requirements indicate great potential for performance enhancement in these areas. In summary, better client performance in the design efficiency activities can reduce construction cost overruns.

8.7.2 Collaboration
The majority of the interviewees strongly agreed on the importance of collaborative activities for reducing construction delays and cost overruns. The agreement ratings for collaborative activities were higher than those of the design efficiency activities. Levels of agreement on the effect of collaborative activities in reducing construction delays and cost overruns ranged between 4.5 and 5. The level of agreement about greater use of information communication technology being able to reduce construction delays was rated the highest, while the effect of reducing cost through both higher levels of collaboration between stakeholders in solving difficulties and higher effectiveness in using pre-defined goals and targets were rated higher than other activities. The interviewees were of the view that clients, especially in the public sector, might face difficulties in enhancing effectiveness in these three activities. One interviewee (P2) highlighted the fact that stakeholders might not share the goals of clients, but they will still expect clients’ support to achieve their goals, therefore acknowledgement of other parties’ interests is essential for better collaboration. Another interviewee (P1) indicated that collaboration with other parties should not be the responsibility of the client. In general the interviewees agreed that collaborative activities can be implemented in construction projects in Oman; however, the concept of collaborative working requires all stakeholders to understand that they have mutual interests which can be
achieved through higher levels of collaboration. It can be inferred from the interviews that the development of a collaborative working environment is a challenging task which requires a great deal of effort, not only on the part of the client, but also on the part of other stakeholders. In summary, greater collaboration offers high potential for the improvement of construction performance in Oman; however, the enhancement of existing working practices will require a lot of effort, especially by public clients.

8.7.3 Construction Efficiency
In this section, the interviewees agreed that greater construction efficiency is important for reducing construction delays. The average rating of this component’s activities ranged between 4.33 and 5; greater attention to ensuring the contractor’s understanding of the technical challenges associated with the project was rated the highest among all the activities. This feedback from interviewees indicates that ensuring contractors’ understanding of projects’ complexity plays a significant role in reducing construction delays. One interviewee (P4) mentioned that contractors’ understanding can be assessed by reviewing their project delivery strategies and plans (including resources and schedules) for managing expected project challenges. Another interviewee (P3) suggested reviewing the contractor selection criteria to allocate a higher score for construction methodology, rather than focusing on number of resources.

In general, the feedback on this component’s activities supports the suggestion that improved client performance in these activities can reduce construction delays. Higher levels of agreement on the importance of ensuring the contractor’s understanding before the award does not imply any underestimation of the importance of other activities; in fact, the selection of the right contractor can support the client’s efforts to achieve higher performance in all the other activities.

8.7.4 Multiphase Involvement of Stakeholders
The interviewees were of the view that stakeholders’ involvement in a project is essential. However, the majority of interviewees pointed out that the identification of all influential stakeholders is not always possible, especially those amongst the general public. An important point stressed by one interviewee (P5) regarding workshops with bidders was that “the existing
contractor selection evaluation process does not allow scoring reviews based on the outcomes of workshops with bidders”. This interviewee further highlighted that these workshops allow better assessment of contractors’ capability to deal with a project’s challenges, and it is essential to allow a review of the bidders’ scores. In general, the interviewees suggested that the public sector needs to review the selection process to include elements other than the information submitted by the bidders in their proposals.

Overall, the average ratings of activities included in this component ranged between 4.33 and 4.83. In summary, greater attention and more effective involvement of stakeholders both have great potential for reducing construction cost overruns.

8.7.5 Accuracy of Project Objectives and Requirements
There was consensus among the interviewees that clients’ inability to express their requirements accurately can lead to time extension claims and incur additional cost. This was further elaborated upon by one interviewee (P3): “What the clients have in mind may well not be accurately written, or it might be misunderstood. Therefore, the clients end up with unexpected outcomes, or not what they actually want.” Three interviewees (P2, P3 and P6) suggested that clients may over-rely on project consultants to complete construction tender documents, rather than assisting the consultants’ effort in enhancing the accuracy of the document. Additionally, all the interviewees reported that different public parties could result in conflicting requirements and also prolong planning approval, which might result in changes to the conditions at the project site.

Overall, the average rating of all this component’s activities was higher than 4.67, which indicates that more attention from the client on defining accurate project objectives and requirements can reduce both construction delays and cost overruns. However, particular attention needs to be given to the effect of other stakeholders on project objectives and requirements.

8.7.6 Client Team Development
All the interviewees made it clear that the dynamic nature of the construction industry makes continuous development an essential element for the success of
not only the client organisation, but also other organisations. The interviewees took the view that it is difficult to adopt design-build procurement in Oman due to a lack of knowledge about new ways of developing construction projects. This was illustrated by more than one interviewee who articulated that, to date, the public sector uses the same terms and conditions for both the design bid build and the design-build procurement system. Additionally, five interviewees (P1, P2, P3, P5, and P6) went further; highlighting that enhancing the knowledge of wider public sector organisations could clear the path for better collaboration and subsequently better construction performance. Four of the interviewees (P1, P3, P4, and P6) clarified that, unlike construction delays, higher financial capabilities on the part of the contractor do not necessary help in reducing construction cost. However, they further elaborated that clients need to carefully review low bids, especially in major projects, as some contractors rely on changes during construction to recover the actual project cost and gain additional profit. Overall, all client teams need to be equipped with the appropriate capabilities in order to deliver projects within time and cost.

In summary, the average rating of this component’s activities range between 3.0 and 4.67. Furthermore, areas of client development can vary from project to project; however, according to five of the interviewees (P1, P3, P4, P5, and P6) normally, training is provided based on individual requests and on an annual basis. This indicates that at present, public client organisations do not conduct structured competency analysis to identify areas for further development.

8.7.7 Project Planning and Permit Approval
There was consensus among the interviewees that planning and permit approval is a major issue in construction projects in Oman. They elaborated that in Oman, the concerned authorities provide clients with “No Objection” letters and approval is only issued after the appointment of the construction contractor. In contrast, tendering regulation requires all approvals to be obtained before the award of the construction contract. The interviewees further clarified that planning authorities have the right to change their requirements at any time before the approval of the final design of the project. Overall, all interviewees were of the view that planning and permit approval is one of the most complex issues within the public sector. They further clarified
that very little effort has been dedicated to regulating and organising the planning and permit approval process. In summary, the interviewees’ average rating of activities included in this component is between 4.17 and 4.67. The overall feedback from the interviewees indicates the need for top management to get involved in the establishment of planning and permit approval regulations and processes.

8.7.8 Availability of Construction Workforce
The interviewees indicated that many contractors face difficulties in recruiting labour and professional workforce for construction projects. Two interviewees (P2 and P3) reported that their teams include dedicated personnel who help construction companies with issues related to planning permits approval and obtaining clearance for the employment of expatriates for projects. All the interviewees clarified that they were not involved in either the development of plans or strategies for the employment of nationals in construction or the development of SMEs. They went further to comment that, due to projects’ time constraints; it is a common practice for project teams to give greater attention to technical issues than other organisations responsibilities. However, there was a common agreement among all interviewees that they would be willing to collaborate with other organisations in the process of developing a local workforce and SMEs’ capabilities to cope with construction working environments. In summary, the effect of greater client involvement in resolving difficulties in recruiting labour and professionals was rated 4.67, indicating great potential for performance improvement.

8.7.9 Contractor Difficulties
The interviewees stated that, with some contractors, insufficient cash flow leads to construction delays. As such, they stressed the importance of scrutinising contractors’ cash flow and subcontractors’ abilities before the award of construction contracts. All interviewees stated that it is more appropriate to address these issues before the award. The average rating of these component activities was higher in the case of construction delays than cost overruns. This indicates that this specific activity has higher potential to reduce construction delays than cost overruns. Overall, the average rating of activities
ranged between 4.33 and 4.67 in term of delays and between 2.33 and 2.5 in term of cost.

The interviewees also clarified that it is obviously more difficult to reach an agreement on changes to cost and time with major contractors than with lower-level contractors (grade 1, for example). In fact, lower-level contractors completely rely on client payments, and because of lengthy variations approval processes, there is great potential for construction delays as well. Four of the interviewees elaborated that they were unaware of major disputes by contractors other than excellent or international contractors. All interviewees said that it can become extremely difficult to control both a project’s cost and time when there are changes either because of a lack of accuracy in the construction tender document or new findings during construction. Therefore, the view of all the interviewees was that more attention should be to improving the construction tender document in order to mitigate the difficulties caused by changes during the construction stage.
### Table 8.3 Respondents' levels of agreement with client activities' effects on construction performance

<table>
<thead>
<tr>
<th>Client activities</th>
<th>Delays Average Score</th>
<th>cost overruns Average score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design efficiency</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Selecting consultants with higher <strong>key management</strong> and personnel abilities to deliver the required services</td>
<td>4.83</td>
<td></td>
</tr>
<tr>
<td>2. Selecting consultants with higher <strong>technical personnel abilities</strong> to deliver the required design services</td>
<td>4.83</td>
<td></td>
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<tr>
<td>3. Higher accuracy of <strong>project requirements</strong> before consultancy services bids are invited</td>
<td>4.83</td>
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</tr>
<tr>
<td>4. Higher accuracy in the technical specifications</td>
<td>4.67</td>
<td></td>
</tr>
<tr>
<td>5. Higher accuracy of <strong>consultancy scope</strong> of services before consultancy services bids are invited</td>
<td>4.67</td>
<td></td>
</tr>
<tr>
<td>6. Higher client ability to assess consultant performance during the pre-construction phase</td>
<td>4.67</td>
<td></td>
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<tr>
<td>7. Enhancement of the consultancy service’s terms and conditions for the defined services</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>8. Higher accuracy in the construction tender documents</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>9. Higher consideration of consultants' past performance records while deciding on award</td>
<td>4.67</td>
<td></td>
</tr>
<tr>
<td><strong>Collaboration</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. More sharing of lessons learned between stakeholders</td>
<td>4.67</td>
<td>4.67</td>
</tr>
<tr>
<td>11. Higher use of Information Communication Technology (ICT)</td>
<td>5</td>
<td>4.67</td>
</tr>
<tr>
<td>12. Higher efficiency of communication between stakeholders</td>
<td>4.5</td>
<td>4.67</td>
</tr>
<tr>
<td>13. Higher level of collaboration between stakeholders in solving difficulties</td>
<td>4.67</td>
<td>5</td>
</tr>
<tr>
<td>14. More control over scope changes during construction phase</td>
<td>4.67</td>
<td>5</td>
</tr>
<tr>
<td>15. Higher level of trust between public sector stakeholders</td>
<td>4.83</td>
<td>4.67</td>
</tr>
<tr>
<td>16. Higher effectiveness in using pre-identified goals and targets at various project phases to measure project performance</td>
<td>4.67</td>
<td>5</td>
</tr>
<tr>
<td><strong>Construction efficiency</strong></td>
<td><strong>Client activities</strong></td>
<td><strong>Delays Average Score</strong></td>
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<tr>
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</tr>
<tr>
<td>17</td>
<td>Enhancement of standard contract terms and conditions for each specific project</td>
<td>4.33</td>
</tr>
<tr>
<td>18</td>
<td>Higher involvement of the client team in construction progress review</td>
<td>4.5</td>
</tr>
<tr>
<td>19</td>
<td>Higher attention to ensuring subcontractors’ ability to deliver the scope allocated to them before the award</td>
<td>4.83</td>
</tr>
<tr>
<td>20</td>
<td>Higher level of public stakeholders’ commitment to achieving project goals</td>
<td>4.67</td>
</tr>
<tr>
<td>21</td>
<td>Higher attention to ensuring the contractor understands the technical challenges associated with the project before the award</td>
<td>5</td>
</tr>
<tr>
<td>22</td>
<td>Higher commitment from stakeholders to implementing corrective actions in order to enhance project performance</td>
<td>4.67</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Multiphase involvement of stakeholders</strong></th>
<th><strong>Client activities</strong></th>
<th><strong>Delays Average Score</strong></th>
<th><strong>cost overruns Average score</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>Higher involvement of SME authorities on issues related to technical and financial training; support for Small and Medium Enterprises to help them cope with construction market conditions</td>
<td>4.67</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Higher use of workshops with main stakeholders before inviting construction bids in order to identify possible issues and solutions</td>
<td>4.5</td>
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<tr>
<td>25</td>
<td>Higher use of workshops with bidders during the tender evaluation stage to resolve possible issues</td>
<td>4.83</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Giving more attention to the identification of possible risks during the planning phase</td>
<td>4.67</td>
<td></td>
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<tr>
<td>27</td>
<td>The availability of more information to accurately define the project scope</td>
<td>4.33</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Higher use of brainstorming sessions in the planning phase to identify possible issues and solutions</td>
<td>4.33</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Accuracy of objectives and requirements</strong></th>
<th><strong>Client activities</strong></th>
<th><strong>Delays Average Score</strong></th>
<th><strong>cost overruns Average score</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>Higher client control over changes in the project objectives during construction</td>
<td>4.67</td>
<td>4.67</td>
</tr>
<tr>
<td>30</td>
<td>Higher client control over changes in project requirements during construction</td>
<td>4.67</td>
<td>4.67</td>
</tr>
<tr>
<td>31</td>
<td>Higher accuracy of client objectives and requirements during in the planning stage</td>
<td>4.83</td>
<td>4.83</td>
</tr>
<tr>
<td>Client activities</td>
<td>Delays Average Score</td>
<td>cost overruns Average score</td>
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<tr>
<td><strong>Client team development</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>32 Development of client team’s capabilities to fill knowledge and skills gaps identified in previous projects and meet new projects’ needs</td>
<td></td>
<td>4.67</td>
<td></td>
</tr>
<tr>
<td>33 More consideration of contractors’ financial capabilities and track records when deciding on contract award</td>
<td></td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>34 Development of clients’ capability to deal with major contractors</td>
<td></td>
<td>4.67</td>
<td></td>
</tr>
<tr>
<td><strong>Project planning and permits approvals</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35 Higher involvement of client team in resolving difficulties in obtaining planning and permit approval</td>
<td>4.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36 Higher involvement of client team in resolving difficulties due to changes in statutory and permit requirements during the construction phase</td>
<td>4.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Availability of construction workforce</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37 Higher involvement of client team in resolving difficulties faced by the contractor in recruiting labour and professionals for the project</td>
<td></td>
<td>4.67</td>
<td></td>
</tr>
<tr>
<td>38 The use of standardised processes, documents and templates to reduce unnecessary use of resources on repeated tasks</td>
<td></td>
<td>2.83</td>
<td></td>
</tr>
<tr>
<td><strong>Contractor difficulties</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39 Higher involvement of client team in resolving contractor cash flow difficulties during construction  (Higher consideration of contractor cash flow capabilities when deciding on contract award)</td>
<td>4.67</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>40 Higher involvement of client team in resolving conflicts between the main contractor and subcontractors on the project (Greater consideration of sub-contractors ability when deciding on the contract award)</td>
<td>4.33</td>
<td>2.33</td>
<td></td>
</tr>
</tbody>
</table>
8.7.10 Appropriateness and Practicality of Client Activities
Most of the interviewees stated that the proposal of the key client activities might be the first attempt to make explicit the elements that, when achieved by the client, can improve construction performance, and specifically, minimise the risks of construction delays and cost overruns. Hence, the activities unearth the key elements that have to be proactively tackled within client organisations in order to deliver high-level construction performance. This is why interviewees believed that the setting out of specific client activities that are highly influential is very useful, as these activities bring together elements that will result in more focus on client teams’ competency development and better project management.

The interviewees concluded that public construction is currently lacking initiatives to improve performance. All interviewees acknowledged that the client activities suggested would enhance clients’ knowledge about the key activities that support the efficient delivery of construction projects. Also, they were of the view that senior management would be willing to commit to using the client components in construction projects in Oman. They also highlighted that, although the client components provide support for the enhancement of construction procurement performance, time would be needed for their implementation. However, they agreed that the key client activities are easy to follow and could be implemented together by the public sector.

8.8 Summary
The evidence from the interviews shows that construction delays and cost overruns can be reduced by improved client performance in activities that greatly affect procurement performance.

The responses from the interviewees validated the theory that construction delays can be substantially reduced by effective client performance in enhancing collaborative working activities, construction efficiency activities, the accuracy of projects’ objectives and requirements, and in scrutinizing contractor cash flow before the award of any construction contract. The interviewees also expressed their agreement on the importance of the client’s role in resolving difficulties in obtaining planning and permit approval. However, the feedback
from the interviewees indicates that very little attention has so far been given to regulating and organising planning and permit approval.

Additionally, the validation results show that key client activities effects on cost overruns reflect the interviewees’ organisations’ practices and circumstances. However, past research on construction procurement has given limited attention to the investigation of their effects on construction cost overruns. While the validation results confirm the research findings, they also highlight six critical aspects:

- The difficulties involved in achieving high collaboration between stakeholders.
- The need for better regulation and processes for planning and permits approval.
- The limited nature of client team engagement with other government organisations regarding the development of nationals and SMEs.
- The development of individuals within client organisations is mainly dependent on self-assessment and individuals’ courage, rather than structured competency reviews.
- The difficulties in incorporating results from workshops with bidders into tenderers’ final evaluation scoring.
- The difficulties faced by clients in trying to control construction delays and cost overruns in cases of variations to major contracts.

Therefore, particular consideration must be given to these aspects when developing construction projects in Oman. While this research highlights key activities that require greater attention from clients, further in-depth research needs to be undertaken with client organisations to develop and pilot a rigorous and robust system for each of these aspects.
9 CHAPTER NINE: DISCUSSION

9.1 Introduction
This research aims to define the key public client activities that can substantially minimise delays and cost overruns in construction procurement. This chapter discusses the findings from the analysed data presented in Chapters 6 and 7. Specifically, the chapter provides important links between Chapters 2, 3, 4 and 7.

The first section of this chapter outlines discussions on delays and cost overruns in design bid build (DBB) and design-build (DB) construction projects. Then the following sections discuss each of the groups (components) of successful client activities extracted from the PCA and define from the regression findings which of these components were found to be key to minimising delays and cost overruns.

9.2 Delays and Cost Overruns in Construction Projects
The analysis of the data in Chapter 6 shows that more than three-quarters of the projects were not completed in the time stipulated in the contract. What is more, almost half of the delays in the DBB projects were more than 45% of the time allowed and almost half of the delays in the DB projects were more than 25% of the time allowed. In general, delays in DB projects is shorter compared with DBB projects, however, the longest delays recorded (252%) appeared in a design-build procurement systems, compared with 200%, which was the longest recorded in design bid build. Thus, clients must be very careful when adopting DB procurement, because the delays could be excessive.

Similarly, the analysis shows that more than half of the projects were not completed within the cost stipulated in the contract. In other words, approximately 55% of projects in both procurement systems were completed beyond the project contingency limit (5%) usually included in the construction contract. While fewer DB projects seem to suffer from delays, cost overruns is more common in DB than in DBB. Cost overruns appears in about 65% and 59% of the DB and DBB projects respectively.
The analysis results show extensive delays and cost overruns in construction procurement. Not completing public construction projects on time delays the delivery of services, thus public clients' failure to provide benefits to the community. Similarly, cost overruns incurs additional funds from public clients, which could have been used for developing new projects, thus providing more or better services to the public. So there is a clear need to find out what activities clients should focus on when developing construction projects and client teams’ knowledge and skills.

9.3 Design Efficiency (Component 1)
Design efficiency accounts for the greatest variance (27.7%) in public client procurement. Therefore, design efficiency, as the analysis suggests, is the backbone of public client procurement. More importantly, the regression analysis indicates changes in the level of the design efficiency significantly affect cost overruns in both DBB and DB procurement systems. This finding is generally consistent with previous research which suggests the innovation and accuracy of design stage output greatly influence the competitiveness of construction package proposals (Salter and Gann, 2003) and overall project time, cost and quality (Chua et al., 2003). However, this research finding does not support the argument that changes in the level of design efficiency significantly affect project delays. This could be due the fact that the contractor and consultants, rather than the client, are the parties responsible for managing construction time during the construction stage. Another important justification could be that lack of efficiency in the project design is addressed early during the construction stage, with limited effect on project time. In contrast, lack of efficiency in the design could incur additional cost for the client, regardless of the time at which it appears during the construction stage. Thus, clients should be aware of those elements that affect design efficiency in order to minimise construction cost overruns in both DBB and DB projects.

PCA analysis identified nine client activities that could foster design efficiency. With the exception of the project quality level, the client’s ability to assess consultant performance and the accuracy of construction documents, all the other activities come at the planning stage of the procurement lifecycle. This finding stresses the importance of the planning stage for design efficiency and
overall public procurement performance. Furthermore, three out of the six activities within the planning stage come before the appointment of the consultants, while the other three (consultants’ personnel’s key management abilities, consultants’ personnel’s technical ability and consultants’ past performance records) are aspects that mainly target the consultant selection phase of the planning stage. This is because the client’s decision on the selection of consultants generally forms an integral part of the procurement strategy. This finding is in line with the ICE (2009) best client guide, which recommends making a decision about the need for external team involvement at the outset of the project and the client appointing a team with proven capabilities and excellent past performance records. Thus, the discussion in this section will first cover the elements that clients are required to carry out before appointing consultants, which include developing an accurate scope of consultancy services and accurate project requirements, and using suitable consultancy services’ terms and conditions. Then the discussion covers activities that run from project initiation up to the appointment of all consultants, which include the selection of consultants with excellent management and technical personnel and excellent past performance record. The third important part covers client activities during the delivery of design services, which include continued assessment of consultants’ performance, ensuring the technical specifications meet the desired quality level, and finally, ensuring the overall construction tender document is accurate.

Early in the project lifecycle, the client has to identify the scope of the services that need to be outsourced to external teams (ICE, 2009; Cheung et al., 2002; Ng and Chow, 2004; Cheung et al., 2002). According to Greiner and Metzger (1983), organisations outsource services to specially trained and experienced people who help the client team to achieve a specific outcome, such as identifying management problems, analysing these problems, developing solutions to these problems and in some cases, helping in the execution of proposed solutions. Therefore, consultancy services are much wider than the development of project drawings and specifications; these services could be investigating possible risks or providing training to the client team. Furthermore,
consultants can provide valuable support to the client team during the construction stage of the project or even the operation stage. According to Schiele and McCue (2006), within public construction projects, consultants can provide advice concerning various tasks, such as public communication, environmental planning, ongoing management of governmental departments, engineering, architectural planning etc. Therefore, if public clients would like to more fully utilise the capabilities of external experts and consultant firms, they must first understand what required activities or training those external parties could be meaningfully involved in. However, what can be noticed is that clients often lack the capability to manage private partners (Akintoye et al., 2003; Britua et al., 2009). Therefore, clients first need to give more attention to developing their teams’ capabilities to be efficient when working with external parties.

Here, in addition to the development of the required scope of services, the use of suitable contract terms and conditions could be another important activity in establishing better relations between client teams and consultants. In fact, the analysis shows the use of suitable terms and conditions is the most important element and can greatly enhance design efficiency in public procurement. Alnuaimi et al. (2010) argued that the consultancy terms and conditions used in Oman do not suit the current construction working environment. Good terms should allocate risks to the parties that are best able to manage them, and overall, the contract should offer considerable clarity, which supports better understanding between the involved parties. The ICE suggests using a contract that encourages a collaborative working environment.

Another important activity clients must perform early in the project lifecycle is the development of accurate project requirements. Yu et al. (2004), Aritua et al. (2011), Berry and McCarthy (2011) and Balson et al. (2012) all argued that public clients should establish their requirements and select competent private partners to fulfil the successful delivery of the construction scheme and maximise value. In line with this view, the PCA indicates that the identification of accurate procurement requirements is the third most important activity within the design efficiency component. In particular, Yu et al. (2010) stress the importance of defining requirements that take into account the stakeholders’
needs and what the end product must offer in order to satisfy those needs. Therefore, the actual requirements of a project can be highly dependent on the clarity of end users' needs and interaction between the client team and stakeholders.

It is quite clear that the client needs to have a good understanding of the objectives and issues associated with stakeholders’ involvement before seeking advice from external parties. Subsequently, decisions can be taken on the scope of consultancy services required and the minimum external party capabilities required to efficiently deliver these services. PCA analysis identified three key items for ensuring the selection of competent consultants, namely: key management and technical personnel’s abilities and excellent past performance records. Therefore, the client needs to appropriately consider these elements when developing consultant selection criteria. Particular attention should be paid to the characteristics of the project and the required services (see Section 2.4.4) when allocating the quality/price score and identifying the quality selection parameters for consultants (see Section 2.4.4.1). Therefore, it is important that the quality criteria and item scoring should be designed to consider these three elements. As noted by Wong et al. (2001), the importance of each of the quality parameters can vary from project to project. In other words, there is no standard scoring applicable to all projects, and the score allocated for each parameter may vary based on the client team’s judgement. Therefore, clients’ knowledge, skills, and understanding of the scope of the project are critical in defining the parameters, the scoring of each parameter and finally, the selection of the most advantageous consultants.

The selected consultants can provide various services as discussed earlier in this section. The RIBA Plan of Work (2013) specified client involvement as a very crucial element in the development of construction projects and the achievement of project objectives. Chan and Kumaraswamy (1997) argued that, for project objectives to be achieved, the tender document, including drawings and specifications, should provide the contractor with clearly defined information from which to estimate the project’s cost and plan the resource needs of the construction. Therefore, the accuracy of the tender document dictates the performance of the project in terms of the extent to which the
DISCUSSION

project outcome meets the set objectives. PCA analysis confirms Chan and Kumaraswamy's (1997) argument regarding ensuring the accuracy of the construction tender document, and more importantly, ensuring the technical specification meets the required quality level. Additionally, the analysis shows that achieving high design efficiency is closely associated with the continued assessment of consultancy performance. It is, therefore, necessary for these three elements to be given the appropriate attention during the design delivery stage. However, it is important to note at this stage that, while consultancy firms have experts that can help clients, client teams are frequently seen to lack skills and knowledge (Sturdy et al., 2009). Therefore, client teams need to develop high levels of skills and knowledge to enable them to have meaningful involvement in the design stage and enhance design efficiency.

Grouping all the nine activities under one component based on the PCA analysis indicates they are interrelated; any change in the client’s performance of any activity could significantly impact the performance of other activities. Therefore, improvement in all nine activities within the design efficiency component could positively affect construction cost overruns in both DBB and DB projects.

9.4 Collaboration

With the exception of delays in DB, the regression analysis shows that collaboration significantly contributes to DBB and DB performance in terms of delays and cost overruns. As argued by Murray (2011), collaboration in construction procurement takes different forms, such as access to resources, reducing risk, efficiency, coordination and learning. Therefore, in addition to its positive effect of collaboration on construction project success, as pointed out by Phua and Rowlinson (2004), collaboration is a valuable source of knowledge development and innovation (Section 3.3). This finding suggests that knowledge development and innovation activities can be integral parts of the overall procurement process. Thus, client teams can acquire new knowledge and be more innovative in project delivery by adopting the collaborative approaches included in this component. In this research, collaboration in public procurement encompasses seven public client activities, namely: sharing learned lessons between stakeholders, use of information communication
technology, efficient communication between stakeholders, collaboration in solving difficulties, scope change control, encouraging trust between stakeholders, and the use of pre-defined goals. These seven activities share common links to collaboration and account for 8.448% of the total variance in public client procurement.

The sharing of learned lessons between stakeholders appears to be the most important element in clients fostering collaboration. This is in line with research findings and the recommendations of many studies that client organisations should be involved in a continuous learning process, with knowledge enhancement and improvement becoming core elements in their operations (Albogamy and Dawood, 2015; Bessant et al., 2003; Chinowsky et al., 2007; Ling et al., 2014). Therefore, maximising the value of learning of the client team depends on the level of interaction with professionals within each project and the public client team members, because knowledge is spread among a wide range of individuals and organisations.

Subsequently, the PCA results stress the importance of maximising the efficiency of communication between stakeholders as a significant tool to increase collaboration between stakeholders. Lack of communication efficiency has been continually addressed as one of the major issues in construction projects (see Section 3.4). It is not strange that greater utilisation of ICT in construction has been shown to be related to collaboration. This is because ICT can facilitate information sharing and communication between stakeholders and makes information available for more than one party at the same time.

The point is that, while ICT is increasingly becoming important and well utilised in other sectors, the adoption of ICT in the construction sector is proving challenging. According to Chen and Rankin (2006) and Cheng et al. (2010), there are still no e-procurement solutions suitable for the construction industry. The adoption of e-procurement by construction clients is lagging behind other sectors such as the manufacturing sector (Beauvallet et al., 2011; Ruddock, 2006; Uzoka et al., 2007). It appears that the use of ICT in construction is still in its infancy, but some awareness of the need for higher utilisation of ICT is evident. The positive effect of ICT on minimising construction delays and cost
overruns bring the client’s attention to the importance of playing a critical role. In fact, client involvement is not only limited in utilising ICT in construction procurement, but also in planning and implementing e-procurement systems that cover different procurement phases: pre-contract activities and delivery activities. Thus, the construction industry, along with IT experts, has a lot more to do in planning and developing ICT systems that suit the construction procurement environment.

The adoption of collaborative approaches to solving projects issues emerged as the fourth most significant activity in this component. In fact, problem-solving on the Toyota working model has been critical in sustaining performance improvement (Gao and Low, 2014). This indicates that collaboration between stakeholders in problem solving does not just temporarily benefit the organisation of a project, but extend to benefit the wider construction sector, including the client organisation. Furthermore, problem-solving is considered a valuable source of innovation, as parties are required to identify new ways to overcome problems and achieve the set objectives. Here, top management could support innovation in public works by encouraging collaborative working environments, managing tension within their teams, and explaining the value of innovation to other stakeholders (JRF, 2012; Rolfstam, 2009). It is therefore recommended that top management focus should be on managing the tension between stakeholders and encouraging collaborative working approaches to solving issues in the project.

Control of scope changes during the construction phase is a cooperative effort. Previous studies have noted that scope changes are a major cause of conflicts and disputes in construction procurement (Alnuaimi et al., 2010). Cheng (2014) claimed that construction companies’ ability to effectively formulate strategies to prevent scope changes not only avoids cost overruns but also increases the overall profits of the project. Findings by Cheng (2014) stress that the client is not the only party that benefits from better control of scope changes; it also increases construction contractors’ profits. Therefore, collaboration between the two partners in maximising change control is a mutual interest, whereby the construction company can increase its profit and the client organisation can minimise cost overruns.
Another important approach to fostering collaboration is to create higher levels of trust among public stakeholders. This is in agreement with Dirks et al. (2001), who found that trust provides a multitude of benefits to collaboration partners that stem from its direct effects on a variety of desired performances. The continuing nature of public stakeholders can create a good working relationship because all public stakeholders exist to provide services to the community. The willingness and ability of these stakeholders to develop shared objectives and good intent and operate collectively can foster collaboration and enhance performance. Therefore, these findings reinforce the need for a fundamental, comprehensive trust-building approach between public stakeholders. Gajendran and Brewer (2012) assert that trust-building can be achieved through mutual confidence, authentic and constructive relationships, and honest interactions. It is, therefore, important for public client teams to adopt constructive approaches to solving issues throughout the procurement lifecycle and recognise other parties’ interests and views.

The seventh most important approach to fostering collaboration in public procurement is the use of pre-defined goals and targets to measure project performance. Benchmarking is well known as a tool for performance assessment; however, as seen in Section 3.5.1, performance assessment can also be a learning and innovation tool. Unlike the private sector, the public sector is required to involve more than a single department when thinking about project development. Therefore, benchmarking actual progress against pre-defined goals and targets is a powerful vehicle for efficiently managing construction projects (see Section 2.4.8).

All the seven activities grouped under this component (collaboration) load positively. In other words, increases in their performance could positively affect the overall client performance level. Therefore, improvements in all the seven activities within the collaboration component could positively affect construction performance in both DBB and DB projects.
9.5 Construction Efficiency
The results of regression analysis reveal that construction efficiency only contributes to delays in design-build projects. This finding indicates that higher levels of construction efficiency could help clients reduce construction delays. While this finding agrees with Gransberg and Windel’s (2008) argument that optimum delivery time can be achieved by adopting a design-build procurement system, the regression analysis does not indicate a significant effect of construction efficiency on cost overruns. Therefore, when the client is aiming to achieve better cost certainty, more attention should be given to other activities that could reduce cost overruns, such as design efficiency (Section 9.3), collaboration (Section 9.4) and client team development (Section 9.10.1).

Therefore, to reduce delays in design-build procurement, the client should maximise construction efficiency. This can be achieved by enhancing the six client activities included within the construction efficiency component, which are:

- Use of suitable standard contract terms and conditions.
- Client team involvement in construction progresses review.
- Governance of public stakeholders’ commitment to achieving the project goals
- Scrutinising contractors’ understanding of technical challenges associated with the special features of the project.
- Scrutinising subcontractors’ ability to deliver the scope allocated to them.
- Stakeholders’ commitment to implementing corrective actions in order to enhance project performance.

It is not surprising to see that the suitability of standard contract terms and conditions for the project as the most important element within construction efficiency in design-build projects. These terms and conditions were prepared in 1981 to be used for design bid build procurement systems in Oman. Then, because of the complexity of approving new terms and conditions for the design-build system, clients in Oman made the decision to use the same terms and conditions for both systems. Thus, there are actually no terms and
conditions that govern the relationship between partners with regards to design services.

The PCA strongly suggests that greater involvement of the client team in construction progress reviews could help the client maximise construction efficiency. Meeting the set deadlines and staying within cost are two constant concerns to project managers, but progress reviews go beyond these issues and cover issues related to quality, collaboration, and the correct interpretation of the information in the contract. In fact, completing projects on time and within cost are most likely to be realised when the project team works collaboratively to solve underlying problems, whether these problems related to team abilities, communication, effort, or authority. Thus, clients’ project managers must continually look for all possibilities and work with other project team members in solving problems before they get out of hand and affect project performance. Identifying the real problem and then taking corrective action to solve it are two areas where project stakeholders’ commitment to enhancing project performance can be severely tested.

The high loading of public stakeholders’ (intra-organisation) commitment to implementing corrective actions on the construction efficiency component reinforces the findings of the importance of the progress review. The results further indicate that public stakeholders’ (intra-organisational) commitment is more important than overall stakeholders’ (inter-organisational) commitment. This finding is in line with the earlier finding in Section 9.4, which emphasises the importance of public stakeholders’ intra-collaboration. These findings (Sections 9.4 and 9.5) clearly demonstrate that having high levels of public stakeholder collaboration and commitment is a very critical element that supports cost overruns reduction. Issues related to collaboration and commitment can be more manageable within public sector organisations than issues between project partners. However, as noted by Dong et al. (2009) and Young and Jordan (2008), top management needs to be transparent in resolving issues and flexible in adjusting its actions to achieve the desired procurement outcomes.

The PCA analysis results stress the importance of scrutinising not only the main contractor’s understanding of the technical challenges associated with the
special features of the project but more importantly sub-contractors’ ability to deliver the scope allocated to them. This finding is in agreement with Doloi (2012), who showed that the selection of the right contractor lies with the client in most projects. Various contractor selection approaches cover this aspect (Section 2.4.4.2): for example, Watt et al. (2010) identified construction methods and solutions as one of the key contractor selection parameters while Wong et al. (2001) mentioned contractors’ execution capabilities as an important contractor selection parameter. Agreement on single selection criteria does not seem to be viable, because clients’ objectives can change from project to project, as can projects’ complexity. An example directly linked to the findings of this research is the need for sub-contractors in projects. For example, sub-contractors can be nominated by clients or it can be left to the main contractors to decide whether any special sub-contractors are needed in the project.

However, as suggested by Eriksson and Westerberg (2011), a large part of the scope can be allocated to subcontractors, therefore, clients’ involvement in their selection could enhance project performance. Subsequently, the client has various options for getting involved in sub-contractor selection. This research stresses the importance of multiphase stakeholder involvement (Section 9.7); the client could involve subcontractors early in the project lifecycle to gain a better understanding of the need for sub-contractors in the project. Then, subcontractors’ abilities could be scrutinised during the tender evaluation stage.

Finally, the analysis brings the attention of the client to the importance of stakeholders’ (inter-organisational) commitment to implementing corrective actions in order to enhance project performance. Interestingly, Chan et al. (2001) noted that stakeholders’ commitment is important to the success of construction projects. Therefore, the extent of stakeholders’ willingness to work collaboratively throughout the project life cycle can maximise construction efficiency and subsequently minimise delays in design-bid projects. The reality may be too complex to get all stakeholders’ commitment, but as suggested by Jang and Lee (1998), differences between stakeholders could facilitate creativity. This stresses the importance of developing the client’s ability to turn difficulties into creative solutions that maximise construction efficiency. As argued by Zeffane (1994), commitment is largely affected by management style, which can be classified into two: rules and regulations (more common in the public sector) and flexibility and adaptation (more common in the private sector).
It is, therefore, important for public clients to adopt both management styles in order to maximise construction efficiency. In fact, flexibility and adaptation are also critical aspects of the best utilisation of standardisation in construction procurement (Section 9.10.2).

Overall, the efficiency level of client involvement is closely related to the client’s ability to ensure the selection of capable contractors and sub-contractors, the use of suitable terms and conditions, continued involvement in progress reviews and finally, ensuring stakeholders’ commitment; in fact, more importantly, public stakeholders’ commitment. Maximising the levels of performance of all six activities could help in minimising delays in DB projects.

9.6 Site Management
The regression analysis does not indicate that client involvement in site management has any great effect on either delays or cost overruns in design bid build or design-build procurement. This finding contradicts Doloi (2012), who suggested effective site management as one of the most critical factors affecting construction cost overruns, and that both client and contractor share the responsibility for site management. A possible explanation for these contradictory results may be that Doloi’s (2012) study is based on success factors related to projects rather than clients. Therefore, outsourcing site management to external parties would be a viable option, or an even more appropriate option for effective site management, because these parties are more engaged with site activities than the client. Furthermore, outsourcing aspects related to site management could allow the client team to give more attention to other, more important activities.

The six elements extracted for site management account for 5.067% of public client procurement. These six elements could be outsourced to other parties that are capable of providing the required services. In other words, all six aspects need to be considered early in the project lifecycle as part of the overall project scope. Therefore, the following six aspects should be appropriately addressed by the client in the project scope:
- Management of difficulties due to protests by the public against the project
- Difficulties faced by the contractor in gaining access to the project site
- Difficulties in sourcing construction materials
- Variation orders requested by the contractor
- Changes in law and regulations
- Difficulties in handing over the project site to the contractor

Generally, experienced consultants and contractors should anticipate such difficulties and develop appropriate plans to manage the uncertainties associated with each of the six elements. Here, it is important to note that in situations such as changes in laws or regulations, the contractor may need to be compensated if changes take place after the contract is awarded.

9.7 Multiphase Involvement of Stakeholders

The regression analysis shows that multiphase involvement of stakeholders is one of the most important client success components contributing to the cost performance of design bid build procurement projects. The regression results show that for every one unit increase in the level of multiphase involvement of stakeholders, there is 4.620% reduction in the cost overruns.

Stakeholders’ involvement in projects can take place at different phases of the project and cover different objectives. PCA indicates six elements within public client procurement that could maximise the effect of multiphase stakeholder involvement, namely:

- Technical and financial training support (from the concerned authorities) for small and medium enterprises to help them cope with construction market conditions
- Use of workshops with main stakeholders to identify possible issues and solutions before inviting construction bids
- Use of workshops with bidders during the tender evaluation stage to resolved possible issues
- Attention is given to identifying possible risks during the planning phase
- Information availability for accurately defining the project’s scope
- Use of brainstorming sessions in the planning phase to identify possible issues and solutions

The PCA analysis indicates that technical and financial training support for small and medium enterprises to cope with construction market conditions is the most important element within the stakeholder involvement component. This finding seems to be consistent with Preuss (2009) GHK (2010) and Al Shanfari et al. (2013), who argued that public clients should take major responsibility for the development of SMEs and involving them at the early stages of the procurement lifecycle (Section 3.6.2). Most recently, Oman mandated the Authority of Small and Medium Enterprises to provide support for SMEs, but based on Al Shanfari et al. (2013) and Al Barwani et al. (2014), SMEs' contribution to the public sector is very limited due to lack of understanding of corporate social values. Therefore, the enhancement of SMEs' contribution to public procurement requires training them to cope with the construction market and public sector in order to better understand the wider national objectives of the construction projects such as SMEs support and national employment.

Another stakeholder activity is the use of workshops with both the main stakeholders and bidders. Workshops with the main stakeholders before inviting construction bids could help clients to identify possible issues and solutions. Rischmoller et al. (2006) argued that early stakeholder involvement allows early identification of errors; similarly, Magent et al. (2005) and Lloyd-Walker and Walker (2012) highlighted that the early involvement of contractors allows the client to get valuable advice. This suggests that public clients can resolve possible construction issues by conducting workshops with stakeholders and bidders before awarding the construction contract. However, it is important to involve knowledgeable personnel who can provide meaningful advice.

Additionally, the findings of this research stress the importance of identifying possible risks at the planning stage and involving other stakeholders to minimise these risks' effects on cost overruns. The significant loading of the fourth activity on this component emphasises this finding and concurs with
previous literature (Section 2.4.7). For example, several studies have noted that lack of risk management is one of the causes of cost overruns in construction projects (Chan et al., 2011; Al-Jibouri and Ogink, 2009; Edwards and Bowen, 1998; Cooke-Davies, 2002).

Information availability in the early stages of a project can dramatically influence the accuracy of its scope of work. The PCA and the regression results demonstrate that a wider availability of information helps the client team to accurately define project scope and subsequently mitigate the construction cost overruns. As argued by Yu et al. (2004), a project’s scope may not be comprehensive, because it is usually prepared by a small group from the client organisation or by external consultants. Therefore, better information could be made available to the client by other stakeholders (see Section 9.4). Here, it is important to note that involvement must be appropriately controlled to avoid prolongation of the project’s duration.

The last activity that highly loads on early stakeholder involvement is the use of brainstorming sessions in the planning phase to identify possible issues and solutions. This supports previous research that emphasises the need for brainstorming to identify possible risks and associated solutions (for example Shen et al., 2007; Osipova and Eriksson, 2011). It is clear that brainstorming could help the client to define issues early in the project lifecycle and prevent construction cost overruns.

The findings of this research indicate that multistage involvement of stakeholders is one of the most significant components supporting preventative actions by the client, and overall, it is the second most significant component affecting cost overruns in design bid build procurement. The client can benefit greatly from involving stakeholders in identifying possible risks and getting more information to enhance the accuracy of the project scope.
9.8 Review of Past Project Difficulties
This client success component represents some key issues in construction procurement, namely budget constraints, the sharing of learning, changes due to geological conditions and repetition of past projects’ difficulties. As indicated by the regression findings, this component does not feature in any of the developed models. This finding contradicts Schindler and Eppler’s (2003) findings, which suggested that client organisations should adopt a systematic approach for gathering learning from different construction projects and integrating it into its own knowledge. Given the fact that limited resources are available for the client to develop each project, and as argued by Bessant et al. (2003), improvement depends on the ability of an organisation to build knowledge and learn alongside other activities. Therefore, this research finding suggests collaboration is the most appropriate approach to the development of client knowledge and solving difficulties throughout the procurement lifecycle. In fact, collaborative working (see Section 9.4) in solving live difficulties could be more practical than looking at knowledge development as a separate activity that requires additional effort or even resources. Additionally, it could be more appropriate for the client organisation to involve specialised external parties to investigate past difficulties and recommend solutions for future projects.

9.9 Change Control

9.9.1 Accuracy of Objective and Requirements
There was a consensus in the literature that failing to appropriately manage project objectives and requirements can highly affect project performance (Sections 2.4.1 and 2.4.2). The regression findings clearly demonstrate that objective and requirement changes in both procurement systems significantly affect construction delays and critically contribute to cost overruns in DB procurement. It is important to note in this research that design efficiency (see Section 9.3) has a greater effect on DB cost overruns than on DBB. Similarly, requirement modification by the client (Section 9.9.2) and objective and requirement changes (this section) greatly affect DB cost overruns, rather than DBB cost overruns. These findings bring the client’s attention to two important aspects. First, early project activities are more critical in DB than DBB projects.
Secondly, unlike in DBB projects, changes in DB could significantly affect construction cost.

The Strategic Forum for Construction (2003) recommended the establishment of a client team from the early stages of the procurement process as a proactive activity for managing project requirements and end users’ expectations. According to Yu and Shen (2013), this can only be achieved by developing and practising systematic approaches and continuously developing client team capabilities to meet performance expectations. Support by private partners is mainly motivated by economic incentives and hence the role of the public client in managing changes to requirements is highly significant. This is in line with recent research findings which recommend the public sector acquires the capabilities that will enable public clients to efficiently manage the private partners (Akintoye et al., 2003; Britua et al., 2009). However, this research encourages collaborative working approaches and the efficient involvement of stakeholders, rather than managing them. Therefore, as indicated by Ndekugri and Turner (1994) and Ying et al. (2015), when clients are educated on the importance of identifying the requirements and objectives, they can get professional advice from external partners and other stakeholders (see Section 9.4).

9.9.2 Requirement Modifications Initiated by the Client
The multiple regression results report the significant effect of requirement modification initiated by the client on DBB delays and DB cost overruns. This finding is consistent with the findings of past studies such as those of Chan et al. (2001), Thomson (2011) and Yu and Shen (2013), who argued that requirement changes during construction cause delays and cost overruns. However, this research shows that the effect of requirement modification might vary depending on the selected procurement system. For example, the effect of requirement modification on cost overruns does not appear to be significant in the case of DBB procurement, while it is one of the most significant factors in the case of DB procurement.

The minimisation of requirement modifications initiated by the client was shown to be the second most important client component in reducing delays in DBB
projects while it is the fourth most important component in reducing DB cost overruns. However, the effects of minimising requirement modification by the client on DBB cost overruns should not be ignored. The role of the client team as the synthesiser of the project requirements means they should acquire the appropriate capabilities to accurately identify the project requirements in collaboration with other stakeholders. In fact, requirements can be subverted by stakeholders in a client body who find their emergent requirements have not been acknowledged by the project team (Thomson, 2011). Even though construction projects are claimed to be temporary organisations, the duration of a project can be long enough to develop a long-term relationship between the stakeholders, and working collaboratively can minimise requirement changes and subsequent delays and cost overruns. This is clear in the case of DBB projects, where required changes could be incorporated before inviting construction bids and thus, interpretation of these requirements during the construction stage becomes a matter of time rather than cost.

9.9.3 Difficulties in Project Planning and Permit Approvals
Researchers have identified obtaining the relevant authorities’ approval as one of the key risks that influence construction procurement performance (Wang et al., 2004; Lee et al., 2007; Luu et al., 2009). However, the regression analysis findings indicate that this might not be the case in all procurement systems. The analysis shows that difficulties in obtaining planning and permit approval only significantly affect delays in design-build procurement. This result may be due to the fact that planning and permit approvals are obtained after the awarding of the contract and design completion by the contractor. In contrast, planning and permit approvals in the design bid build are obtained before the awarding of the construction, thus their impact on construction time is not significant.

9.10 Human Resources Optimisation

9.10.1 Client Team Development (Training)
The PCA and multi-regression analysis results demonstrate that client team development is one of the important success components that significantly affect cost overruns in both DBB and DB procurement. The analysis shows that
providing the required training for clients reduces cost overruns. The PCA highlights two important training areas that could significantly enhance client teams’ capabilities. The first one is training on knowledge and skills needed for the efficient delivery of the project, and the second key training area is related to contractors’ financial capabilities. The findings indicate that better knowledge and skills training can significantly reduce construction cost overruns while in contrast, greater attention to contractors’ financial capabilities could increase construction cost overruns. This finding is in agreement with Section 9.10.3, which showed that higher contractor difficulties can reduce construction cost overruns. It could be inferred from the two sections (Section 9.10.3 and this section) that contractors facing cash flow difficulties could be in weak positions to negotiate with clients. In contrast, contractors who are financially strong have higher capabilities of increasing their revenues from project costs. Even though greater financial difficulties on the part of contractors appear to reduce construction cost, they simultaneously raise concerns about the public sector’s responsibility towards the development of the private sector, especially SMEs. Similar concerns have been raised by Al Shanfari et al. (2013) and Al Barwani et al. (2014), and Yafai et al. (2014) argued that abuse is one of the key risks in construction projects in Oman. The more in-depth investigation could further clarify any weaknesses in the commitment of the public sector to social responsibility. However, as seen in the case of SME support, understanding of public client responsibility needs further development in Oman.

Overall, client team development could cover many aspects, including all of the fourteen client activity components. Additionally, a better understanding of public client social responsibilities seems to be important, at least for SMEs with regards to getting the appropriate support. These SMEs could then, as subcontractors, perform better and subsequently enhance project performance (see Section 9.5).

9.10.2 Availability of Construction workforce
The PCA and regression analysis results uncover important views about standardisation. Prior studies have noted that standardisation is a tool for organisations to ensure consistency and reduce unnecessary use of resources on repeated tasks (Santos et al., 2002; Ungan, 2006), thus improving overall
project performance. However, the findings of this research indicate very high use of standardisation in DBB procurement could significantly increase construction cost overruns. Two important standardisation prerequisites have been identified in previous studies: firstly, the knowledge and skills needed to create a standard operating process or procedure (Lillrank and Liukko, 2004) and secondly, flexibility and the ability to adapt when using standards to add value to the client organisation (Watermeyer, 2011). The findings of this research show the definite need for client team knowledge and skill development (Section 9.10.1). Otherwise, as suggested by Ungan (2006), actions by individuals vary because of experience and skill differences which in turn can influence overall performance. In Oman, there is no formal standardisation process or strategy within the public sector. Thus, the negative effect of standardisation on construction cost calls for further investigation and stresses the criticality of developing client team knowledge and skills, not only on technical aspects but also on nontechnical aspects such as standardisation.

Another important aspect of this success component is public clients’ involvement in resolving difficulties faced by contractors in recruiting labour and professionals for projects. As seen in Section 4.9, the private sector in Oman is heavily reliant on expatriates; getting the required approval for external recruitment can take a long time and incur high costs for the private sector. At the same time, the public sector is required to create new jobs for locals, and changes in regulations in Oman in 2011 created more constraints on external recruitment. As per the existing regulation, construction contractors are required to employ Omanis as at least 30% of the project workforce, which might not be achievable because of the negative attitudes of nationals towards working in the private sector and society’s mindset, which focuses on public sector employment. Although this requirement has existed since 2001, actual national employment in construction companies does not exceed 20%. High reliance on expatriates, according to Rees (2007), has long-term political, economic and social consequences. Recommendations to overcome employment issues, as suggested in Section 4.9, include control on expatriates coming into the private sector and supporting Omanis to establish small and
medium enterprises through training and suitable incentives. This study’s findings (Section 9.4) and previous studies (4.9) indicate that the public sector needs to take additional actions to fulfil its obligations, not only in terms of projects’ times and costs but also by ensuring the availability of skilled nationals, which could enhance construction projects’ performance.

9.10.3 Contractor Difficulties
The PCA reported that cash flow difficulties and conflict between the main contractor and sub-contractors are the two most important difficulties facing contractors. However, the results of regression analysis show no significant effect of contractor difficulties in DB procurement on construction delays and cost overruns, while it appeared to be one of the most significant success components affecting delays and cost overruns in DBB projects. The analysis shows that increases in contractor difficulties could minimise delays and cost overruns in DBB projects. This finding seems to contradict those of other studies (Abdul-Rahman et al., 2009; Elazouni and Gab-Allah, 2004; Görög, 2009), which concluded that cash flow difficulties are very significant causes of delays in construction projects.

Although the selection process for contractors at present gives a lot of attention to the financial capabilities, and public project contractors take the lengthy payment process into consideration while estimating project costs, contractor payment in Oman can currently take up to 90 days.

While the above studies show a relationship between contractor cash flow difficulties and construction delays, very little was found about cash flow difficulties and cost overruns. The findings of this research clearly indicate that contractor cash flow difficulties to have an impact on cost overruns. The regression result indicates that the higher the contractor's capabilities in handling cash flow difficulties, the higher the construction delays and cost overruns. The results show that for every one unit of decrease in contractor difficulties, there is about 8.3% increase in delays and about 4.3% increase in cost overruns. Therefore, higher contractor ability in managing its financial difficulties is important but may not contribute to lower the construction cost.
(Chan and Park, 2005). This finding indicates a higher need to enhance the client capability to deal with highly financial capable contractors. Sturdy et al. (2009) also had a similar view: when dealing with consultants, consultancy members have shown to include experts that could help clients; however, client teams are frequently seen to lack skills and knowledge. When dealing with the construction business, negotiation abilities are absolutely core to achieving success in terms of minimising cost overruns. Public client teams must be able to negotiate effectively with contractors to come to mutual agreements and manage cost. Demonstrating to contractors and consultants that client teams have widespread expertise could help convince contractors that collaborative working is best for projects and for their own benefit. Therefore, extending client team development to cover aspects specific to working with major contractors is essential for minimising delays and cost overruns in DBB projects.

9.11 Decision-Making During Construction
Client teams’ understanding of decisions they can make alone and decisions that require the involvement of others is an important aspect in decision making. Clarity in the decision-making process allows the client team to appropriately decide when it is time to get approval from others when required throughout the procurement lifecycle. Doloi (2012) argued that slow decision making is one of the factors that influence project site management and subsequently project performance. In contrast, the regression analysis of this research does not show any significant relationship between decision making and either delays or cost overruns in construction projects in Oman. This contradictory finding seems to be logical because Doloi’s (2012) study included factors without allocating them to a specific controlling party while this research focuses on factors related to the client. As indicated in Section 2.6, client involvement during the construction stage is very limited, thus, clients’ decisions become less significant compared to those of contractors or consultants. It is further clarified by Iyer and Jha (2005) that timely decision making by the client or his engineer is one of the critical success factors in construction projects in India. Thus, client engineer decisions on the site could be one of the factors that affect time during construction. Overall client decision making (component 12) does not appear to affect either delays or cost overruns in construction projects in
Oman. Additionally, client decision making during construction is limited and the client’s consultant and the contractor may be the most relevant parties.

9.12 Information Coordination Process
A construction project includes a large number of stakeholders or parties, and the more parties and/or stakeholders, the more complex and important the information coordination becomes. While PCA identified the information coordination process as one of the public client procurement elements, the regression results do not show that this success component has a significant effect on either delays or cost overruns in construction projects in Oman. Here, it is important to note that recent research (Porwal and Hewage 2013; Kelle and Akbulut, 2005; Chang et al., 2013) focuses more on information communication and the use of information communication technology (ICT) in construction projects. In other words, most of the attention is directed toward the use of ICT for more efficient information communication, rather than information coordination.

9.13 Implication of Research Findings
Two main groups of client activities emerged from the analysis results and discussion. The first group includes client activities that substantially affect schedule delays and cost overruns, namely Human Resources optimisation, collaboration, design efficiency, the multiphase involvement of stakeholders, construction efficiency and the accuracy of objectives and requirements. In contrast, the second group of activities includes activities with minimal or no influence on construction delays and cost overruns and include: site management, review of lessons learned from past experience, the decision-making process and the information coordination process. These findings suggest that good practices exist within construction procurement in Oman, but have not been adopted to make improvements in construction performance. The findings also highlight that client engagement in activities at various stages of the procurement lifecycle can help clients improve construction performance. However, the greater effects of some activities may entail changes in their relationships with other stakeholders, particularly consultants and contractors. Therefore, amongst the client activities, it is important to note that these
activities’ impacts on the consultant and contractor roles require further investigation.

Ultimately, clients have to give more attention to and efficiently deliver those activities in the first group. To do so, they have to build their teams’ knowledge and skills to clear the way for higher levels of performance in these activities. Knowledge about the need for other stakeholders’ involvement and their objectives and expectations will need to be developed to lead to efficient delivery of these activities. Basically, clients can undertake structured reviews to determine whether their teams and processes are capable of efficiently delivering the defined activities. Then they can design and implement remediation plans to build, enhance or redesign current practices and processes in light of the changes suggested by these reviews.

Eventually, less attention can be given to the second group of the client activities, and they are even candidates for outsourcing to other parties, either industrial partners, as is the case with activities related to site management, or industrial and/or research centres in activities related to decision making process, information coordination processes and reviews of lessons learned from past experience. In these situations, the client must take note of the need for quality assurances, which might be delegated to junior ranking engineers within client organisations. Further studies on how to deal with less influential activities will provide insight into how client organisations can structure their project teams and better define their responsibilities.

In developing countries such as Oman, consultants have always played an important role in construction project development. The great effect of client activities related to design efficiency further brings forward the important role of the consultant in construction projects. While this research has investigated client activities throughout the procurement lifecycle, and a wealth of research has focused on contractors’ roles in the past, further investigation of the roles of the consultant can improve knowledge on new ways to enhance construction performance. Then the interrelated related activities between the three main parties (clients, consultants and contractors) can be established and efforts can be directed toward clearing the path for project teams to do their work instead of
so much effort being wasted on managing the project team itself. Recognising each party’s role and being collaborative can support all parties’ efforts to achieve their objectives.

Finally, it is worth noting that, although this study was undertaken in the context of Oman, the geographical focus of the study does not render the results inapplicable to other countries. The study used generic client activities addressed worldwide; the construction industry worldwide shares some essential common characteristics. Oman was used as a case to examine broader construction performance issues and problems. If anything, the Oman case represents a particularly exciting example, because it is a highly multicultural construction industry that involves international consultants, contractors and individuals with different backgrounds, languages, religions, and attitudes.
10 CHAPTER TEN: CONCLUSION AND RECOMMENDATIONS

10.1 Introduction
Data was collected using a questionnaire survey and the responses mainly covered projects related to highways, roads, water transmission and distribution and electricity transmission and distribution. Chapter six presented a descriptive analysis of the responses, while chapter seven explored the relationship between client activities and construction performance in order to address the key research question. Validation of the results through interviews was discussed in chapter eight. Finally, the findings of the analysis were discussed in chapter nine.

This chapter focuses on drawing out conclusions and recommendations from the findings of the research. The first section of the chapter discusses the achievement of the established research aim and objectives. The subsequent section highlights the contribution of the research. The main research limitations are also discussed. Finally, the chapter concludes with a number of recommendations for public clients and policy makers and further research suggestions.

10.2 Achievement of Research Aim and Objectives
Six objectives were established in section 1.3 for achieving the aim of the research. The fulfilment of each of the activities is discussed in the following sections.

10.2.1 Objective 1: To Identify Client Activities throughout the Procurement Lifecycle
The research began with a review of client activities at various stages of the procurement lifecycle, namely the planning, design, construction and operation stages. This review enabled the researcher to gain insight into client involvement at various stages of construction procurement. One observation in the area of client activities and practices clearly was that no studies had yet investigated client success in construction procurement as a whole; nor had any investigated the impact of client involvement throughout the procurement lifecycle on construction delays and cost overruns.
The review highlighted the importance of planning stage activities for reducing the risk of construction delays and cost overruns. This is because the planning stage activities establish the basis for all subsequent activities, specifically design and construction. Another important finding of the review was that client involvement during the design and construction stages is not well defined. In fact, the review indicates a tendency to outsource these two stages’ activities to private sector parties, which, it is argued, have better knowledge and skills than the public sector.

Finally, the review highlighted the procurement lifecycle stages which involve client activities, such as the development of the project’s objectives and requirements, the establishment of a project team, stakeholders’ involvement, risk management, the development of KPIs, the selection of a procurement system, the selection of consultants and contractors, defining the consultants’ scope and deliverables and the involvement of the O&M team. Furthermore, Chapter 3 highlighted client organisation success factors and investigated practices within other industries (automotive and aerospace) in order to establish good practice and identify opportunities for improvement in client organisation activities. This enabled a clear definition of the activities that a client must focus its effort on in order to meet a construction project’s objectives.

10.2.2 Objective 2: To Identify Client Organisational Success Activities and Learning from Other Industries

A review of the client organisation success factors highlighted the importance of those day-to-day elements that must be carried out efficiently when developing a construction project. It was revealed that the integration of these elements, along with other procurement activities at various stages of the procurement lifecycle, can be very helpful in improving construction performance, particularly in minimising the risks of delays and cost overruns. Learning from other industries stresses the importance of developing key working practices for the success of an organisation. Furthermore, long-term strategies in these two industries form important elements in their day-to-day operation, and well-structured processes and greater collaboration between parties improves organisations’ performance.
Finally, the review highlighted a lack of consensus on the factors that affect project success, and more importantly, factors that can help client organisations to structure its processes and strategies for the efficient development of construction projects. Consequently, the review findings in the area of construction procurement clearly showed that no studies had yet investigated either client success factors or how construction delays and cost overruns are affected by them.

10.2.3 **Objective 3: To identify features of construction procurement in Oman**

The review highlighted the lack of research into construction management in Oman and also showed that efforts to develop construction performance focus on the causes of variation orders, information management, and SMEs (Section 4.11). The findings of this review also gave an indication of the weaknesses in the private sector in Oman, along with the lack of understanding of public clients’ wider responsibilities. This gave indications that client teams involved in construction projects are disconnected from the government’s wider objectives, mainly the employment of nationals in the private sector and the support of SMEs.

10.2.4 **Objective 4: To Identify the Important Client Activities**

The review reported that 75 client activities (success factors) have the potential to minimise construction delays and cost overruns (Appendix 1). The fourth objective was to identify associations between client activities and determine the important client activities that required further analysis. Therefore, out of the 75 client activities identified, PCA extracted 51 important client activities that significantly contribute to clients’ construction procurement. These client activities explain about 74% of public client procurement variance. Furthermore, the 51 important client activities were grouped into 14 client components: design efficiency, collaboration, construction efficiency, site management, multiphase involvement of stakeholders, review of past projects’ difficulties, accuracy of objectives and requirements, Human Resources optimisation, decision making during construction, and information coordination.
10.2.5 Objective 5: To Model the Relationship between the Important Client Activity Components and Delays and Cost Overruns

The modelling of the relationship between key client activities and construction schedule delays and cost overruns revealed that delays is greatly affected by five client components, namely collaboration, construction efficiency, the accuracy of objectives and requirements, planning and permit approval and contractor difficulties. Furthermore, the modelling disclosed a substantial relationship between eight client activity components and cost overruns, namely design efficiency, collaboration, multiphase involvement of stakeholders, the accuracy of objectives and requirements, the availability of a construction workforce, and contractor difficulties.

The modelling presented client activities that need to be addressed throughout the whole procurement lifecycle. The central point is the importance of improved client performance throughout the whole procurement lifecycle to ensure the achievement of not only project objectives, but also wider government objectives. While proactive action by the client before the construction stage has received some attention in past research, this research stresses the interrelationship between a number of activities and presents a set of activities that merit greater attention and effort from client teams in order to minimise the risks of delays and cost overruns.

10.2.6 Objective 6: To Validate the Findings

Validation was achieved through testing the extent to which the findings of objective five reflect client organisation practices and circumstances. The validation presented in chapter eight was carried out through interviews with leaders within the client organisations from which data were collected. The validation interviews concluded that the key activities adequately highlight essential areas affecting construction delays and cost overruns. The defined activities also provided a sufficient basis for benchmarking current client practices and identifying possibilities for further capability development and the restructuring of processes.

The defined components were viewed as easy to understand and offering better knowledge of activities that can affect construction delays and cost overruns. Finally, the activities may well be supported by top management; however,
implementation might take time. Thus, it was concluded that the enhancement of construction procurement performance can be achieved through greater and more efficient client participation.

10.3 Contribution of the Research
The research’s outcomes contribute to both existing industry practices and theory. Therefore, the following sections present the research’s contributions in two main categories: industry and theory.

10.3.1 Contribution to the Industry
Efforts to improve the performance of construction procurement have generally focused on elements other than the client. The findings from this research have revealed the substantial effects of a number of client activities on delays and cost overruns, thereby providing a pathway for client organisations to improve their practices. These activities have brought client procurement lifecycle activities together, suggesting specific ways and means to minimise the risks of delays and cost overruns in public construction.

The research has emphasised the primary role of client organisations in construction procurement and established the basis for efficient client involvement in minimising the risks of delays and cost overruns in DBB and DB projects within the construction industry. Rather than limiting the client’s focus to a single stage of the project, the current research has identified client activities at various stages of the procurement lifecycle (Chapter 2). The interactions of the key client activities and practices emerging from this study provide important factors that need to be incorporated into clients’ daily practices. This will potentially help to develop the current state of procurement practice, as well as client team development plans, public sector guidelines, and strategies. Thus, the contribution of this research to the industry can be viewed as including three main aspects:

- The key client activities can help the public sector prioritise activities and give greater attention to those specific activities that substantially affect time or cost, or all activities affecting time and/or cost (Section 8.8 and Section 9.13).
- The key client activities can be used by client organisations as a baseline for benchmarking their current team competency levels and identifying gaps for further training. Subsequently, the findings can help client personnel who lack the relevant knowledge and skills to strive to secure the relevant training (Section 8.8 and Section 9.13).

- The research findings provide empirical evidence of aspects that need to be given more attention by organisations seeking to develop and implement construction procurement guidelines, policies and strategies (Section 8.8 and Section 9.13).

10.3.2 Contribution to Knowledge

The research has given a novel perspective on the effect of client organisations on construction procurement performance. As demonstrated in section 3.2.3, there are an increasing number of studies on success in construction projects; however, the focus of this research has been on the introduction of key client activity components which can significantly improve construction performance. The analysis demonstrated that significant construction procurement performance improvements can be attained through more efficient delivery of a number of client activity components (Section 8.3). Table 8.1 and Table 8.3 provide specific client activities that can significantly improve construction performance in DBB and DB projects.

The most important research contribution by this study is the holistic, systematic and quantitative modelling approach for the relationship between the client activities and procurement performance. Research provides statistical models for the quick and comprehensive understanding of the client efficiency as well as procurement performance. Modelling the relationship between the client activities and procurement performance has helped in not just capturing the dominant client activities in DBB and DB procurement, but also provided other interesting insights into two important client priorities. Therefore, also this research contributes to the body of knowledge by identifying the various client activities that influence the procurement performance in terms of time and cost. The data analysis led to the identification of the dominant client activities and recessive activities for minimising risks of delay and cost overrun in Oman context. The research shows that different client priority in terms of time and
cost has an effect on the key client activities associated with the selected procurement route. These contributions are made through the development of the statistical models described in equations 7.1 to 7.4 of Chapter 7. These models indicate the extent to which each client activity component affects construction delays and cost overruns within DBB and DB procurement systems. Therefore, these equations describe client practices for improvement of procurement performance in terms of time and cost within the DBB and DB procurement.

10.4 Research Limitations
As with other research, this research had limitations in its conduct and scope. This research had the following limitations:

- The research was based on a survey; the reader is reminded of the potential effect of sampling and measurement errors and their likely impact on the data analysis undertaken.
- While emphasising the significance of the components in reflecting client activities throughout the procurement lifecycle, it is important to remind the reader that these components focus on improving construction performance in terms of minimising construction delays and cost overruns.
- The study covered activities and practices related to the client organisation, which might not be known by other stakeholders. This was a key reason to focus the research on the client side of the project team and not include participants from contractor or consultant teams. However, the influence of consultants, contractors, and stakeholders on construction performance was considered.

10.5 Recommendations
The research outcomes open up a wide range of opportunities for future research related to the enhancement of client involvement in construction procurement performance. Considering the findings and research limitations, a
number of key recommendations can be made to clients, policy makers and those who might wish to carry out future research.

10.5.1 Clients
The research defined the key client activities which can provide client organisations with better knowledge of activities that, when efficiently carried out, can minimise the risks of construction delays and cost overruns. Based on the present research, more efficient delivery of specific client activities is essential for the minimisation of the risks of construction delays and cost overruns. Therefore, this research recommends that the government is used as a role model by other parties incorporating performance improvement aspects. Such initiatives can help to propagate better practices among other clients and the private sector as well, thereby establishing much-needed cultural changes. It also recommended continually reviewing and improving government initiatives to cope with the dynamic nature of the construction industry and enhance the awareness of public stakeholders of various procurement systems, with particular focus on collaborative working practices.

Thus, the study suggests clients take action on the key activities for minimising the risks of construction delays and cost overruns when procuring construction projects. This study emphasises client-driven initiatives and commitment as the cornerstones for achieving a project's objectives and minimising the risks of construction delays and cost overruns. Integrating these key activities into clients’ day-to-day work practices can empower clients to be proactively involved in the planning, design and construction stages. A better understanding of these activities supports the fulfilment of the public sector’s wider strategic objectives. It is recognised that the level of awareness about issues such as nationals’ employment and standardisation hinders opportunities for minimising the risks of construction delays and cost overruns. Therefore, client-led commitment to the proactive engagement of professionals from other stakeholders is necessary, particularly with reference to collaboration activities, which suggest working collaboratively with other stakeholders to solve difficulties.
It is recognised that the key activities identified will be influenced by top management's willingness to adopt them in project delivery. Subsequently, top management's task is to ensure that these activities receive careful and continuous scrutiny. Simultaneously, top management should encourage the adoption of these activities within the public sector and seek reports on each one of them. This suggests that top management should be in constant flux, with new reports being developed as needed to accommodate changes in public sector strategies, policies, and organisation structure. Thus, rather than issues of project delivery being looked at only as an indication of the causes of delays or cost overruns, they must be viewed as an inevitable and productive part of the client team’s techniques and process development. Therefore, improvement measures identified should be put in place not only for the running of a project; more importantly, they should be incorporated within the client organisation’s day-to-day practices.

10.5.2 Policy Makers
This study reports that the development of construction projects in the public sector is associated with a wide range of objectives not necessarily clearly understood by the project team. Furthermore, the findings suggest that collaboration within the public sector has a considerable impact on minimising the risks of construction delays and cost overruns. Thus, policymakers should focus on a wider cultural change, specifically within public sector organisations.

While this research’s findings define key client activities, at present, procurement legislation in Oman mainly focuses on the bidding process. Thus, the enhancement of public procurement requires a review of the legislation in order to encourage the implementation of the key client activities. This research has highlighted the key client activities in various stages of the procurement lifecycle. As such, the researcher recommends that these activities should be clearly emphasised in revised or new procurement legislation. This legislation would mean that the public sector would demand innovation through efficient involvement in important activities, rather than innovation that is focused on the bidding process. Therefore, the revised or new legislation could be expanded to cover client activities and a wider range of objectives. Subsequently, in addition to the bidding process, attention would be given to those activities that
might not otherwise be considered, but are significant for better construction performance.

10.6 Further Research
The research outcomes could form the basis for future research in more than one subject. The successful development of models for construction delays and cost overruns suggests there is the potential for the adoption of a similar approach in estimating the effects of client activities on other performance parameters, such as general public satisfaction, health, and safety.

The study has defined the key client activities that, when efficiently adhered to, can minimise the risks of construction delays and cost overruns. It is recognised that the activities established will be influenced by political and individual organisations’ interests, priorities and goals. There is, therefore, the opportunity for a more in-depth investigation to identify the key issues that affect the efficient performance of each of the components defined. Subsequently, the key client activities could then be properly managed to help engender high-performance levels in each of them. Specific attention needs to be given to the investigation of the difficulties involved in achieving higher collaboration between stakeholders, the engagement of client team with other government organisations regarding the development of nationals and SMEs and the development of clients’ competency for the delivery of major projects.

The ratings from the validation interviews indicated a lack of clarity about the effect of selecting highly capable contractors on delays and cost overruns. Therefore, it is recommended that a historical data analysis be conducted in order to establish the relationship between the award amount and the magnitude of changes in terms of cost. Such a study would provide empirical evidence on the relationship between the level of the contractor and the magnitude of cost changes.

Also, having done this research and discovered that there is limited collaboration in the development of nationals and SMEs to cope with the construction industry environment, further research might investigate how to develop nationals’ interests in the private sector. Such a study might explore ways to engage client teams in the development of nationals and SMEs and
CONCLUSION AND RECOMMENDATIONS

identify means for increasing the proportion of national workforce within the construction industry in Oman.
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Appendix 1: Publication


Abstract

The need to improve performance of procurement in construction has resulted in several structural changes and re-arrangements for the acquisition of the client’s development scheme. Much of these changes have focused on the contribution and roles played by parties other than the client to the delivery of projects. The role of the client during these changes has evolved from one of a passive fund provider to an increasingly active participant and hands-on management in some of the procurement arrangements. However, there is little evidence that these evolving roles have been met with a commensurate progress in project delivery performance for client organisations. There is evidence that lack of progress is hindering project performance. Simultaneously, research has so far given less attention to the changes in client’s roles over time. This does not only call for a clarification of contribution the client makes in delivery of projects, but also highlights the need to re-visit the client roles under different procurement systems, and at different project phases, including pre-construction, construction and operational. This paper presents a review of common procurement arrangements in the construction industry and the changing roles of the client’s organisation. The paper also explores the client’s role in each of these arrangements to establish what capabilities enable effective project delivery and performance. The identification of the capabilities is achieved by mapping client roles against procurement arrangements. The analysis of mapping exercise shows that the client has two types of capabilities for the delivery of every project: a primary capability required by all clients; and secondary one that is specific to a particular procurement case. The primary capability could serve as the minimum threshold for self-evaluation by client organisations.

Key words: Revisiting, Client Roles, Capabilities, Construction, Procurement.

Abstract

The public sector obligation to improve the performance of construction procurement has resulted in several changes to the organisation, roles and systems adopted for development schemes. For example, a less than expected outturn performance of traditional arrangements and the increased demand for public services led to the adoption of integrated procurement systems. These changes have seen a transition of client’s role from merely a funder to an active player working collaboratively alongside the private sector (as service providers) at different periods over the last three decades. These changes were expected to improve construction procurement performance dramatically as they allow the clients to enhance their organisational capabilities by assigning major part of their roles to the private sector. However, the literature does not show that the procurement performance has improved as a result of the changes in the client organisation. While research continues to emphasise the importance of the client role in the construction procurement, so far limited attention has been given to the development of the client’s internal organisation for better procurement performance. This paper reports a comprehensive review of the role of the client in construction procurement identified by various researchers to establish the role that the client has been performing over the last three decades. This has been achieved by applying a chronological mapping method of materials published on the subject over the last three decades. The analysis indicates that there are critical elements within the client role which have been consistently addressed over the last three decades. In addition, there are elements which have emerged as a consequence of the shift towards integrated systems. An understanding of critical and emerging elements will allow the clients to identify the gap between the required and the existing capabilities within their organisations, and to assess their procurement arrangement.

Keywords: client, construction, procurement and role.
Questionnaire Survey

Modelling the Relationship between the Client Activities and Construction Performance in Oman

The performance of construction projects in terms of cost and time is influenced by various factors starting at the planning stage and going through to construction completion. Reviewing the practice in various construction projects will allow us to establish the relationship between these elements and construction performance. The analysis of this relationship will provide the client organisation with information as to the extent to which each element impacts on the cost and time changes of the project. This will allow the client to develop appropriate strategies and the capabilities needed for the efficient delivery of those elements.

The client organisation is the only party that is involved from the project initiation stage. All other parties and stakeholders become involved at later stages. This survey aims to obtain the client organisations’ assessments of the actual situation in several construction projects. The questionnaire is part of a doctoral research study which is intended to develop a model of public client construction procurement which can be used to understand and improve procurement capabilities that satisfy the dynamic nature of construction procurement in Oman. Your response is important in enabling me to establish a good understanding of aspects related to public sector procurement practices based on your experience in the identified project.

Appreciate providing me with your assessment for all projects completed between 2010 and 2015.
Note:

If you have any questions or concerns about completing the questionnaire or about participating in this study, you may contact me (Ali Al Harthi) at 99380020 or at: a.al-harthi@lboro.ac.uk

It is estimated that the questionnaire should take no longer than 20 minutes to complete, and all information provided will be completely confidential.

If you would like to be told of the results of this research questionnaire, please write your E-mail: .................................................................

.......... I will send a summary of the findings by December 2015.

Thank you for your support.
## Questionnaires

### Project (optional):

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<th>Tender No. (optional)</th>
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<th>Contractor (optional):</th>
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### Percentage of construction time change (Additional time/Original time):

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<th>Percentage of construction cost change (Additional cost/award amount):</th>
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Please recall the possible causes of cost and time changes in the project identified above, and rate the following tasks by indicating how closely each statement correspond to the actual situation in the project, on a scale of 1 to 5 (1= Very Low, 2=Low, 3= Moderate, 4=High, 5= Very High).

### Project Strategies (1= Very Low, 2=Low, 3= Moderate, 4=High, 5= Very High)

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<th>Project Strategies</th>
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<tbody>
<tr>
<td>1. Consideration of feedback from past projects to anticipate the performance on this project</td>
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<td>2. Control of scope changes during construction phase</td>
<td>1</td>
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<td>3. Consideration of historical records of past projects for the control of this project’s risks</td>
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<td>4. Budget estimate compared to the construction tender scope cost</td>
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<td>5. Difficulties in obtaining planning and permit approvals</td>
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<td>6. Significance of project’s knowledge and skills trainings needs not provided to the client team</td>
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<td>7. Top management support to translate difficulties faced in the project into actions, such as establishing guidelines and employee training</td>
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<td>8. Top management encouragement of the implementation of new ideas in the project</td>
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<td>9. Extent of using standardised process, documents and templates to reduce unnecessarily use of resources on repeated tasks</td>
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<td>10. Extent of sharing learning from this project with other team members within the public sector</td>
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<td>11. Repetition of past projects’ difficulties in this project</td>
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<td><strong>Project planning stage</strong></td>
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<td>12. The efficiency of the information coordination process between stakeholders</td>
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<td>13. The accuracy of information exchanged between stakeholders</td>
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<td>14. Information availability to accurately define the project scope</td>
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<td>15. Client team understanding of decisions which they could make alone and decisions which required the involvement of others</td>
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<td>16. Time given to the client team to define the project scope</td>
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<td>17. Difficulties due to changes in statutory and permit requirements during the construction phase</td>
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<td>18. Changes in the project objectives during construction</td>
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<td>19. Changes in the project requirements during construction</td>
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<td>20. Participation of the operations team in identifying the project requirements</td>
<td>1 2 3 4 5</td>
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<td>21. Use of pre-identified goals and targets for various project phases to measure project performance</td>
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<td>22. Extent of implementing corrective actions to maintain the original project cost and time</td>
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<td>23. Attention given to identifying possible risks at the planning phase</td>
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<td>24. Attention to activities that are required to publish the tender compared with those which actually contribute the most to project success</td>
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<td>25. Attention to investigating new ways to improve project performance</td>
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<th><strong>Design efficiency</strong></th>
<th><strong>(1= Very Low, 2=Low, 3= Moderate, 4=High, 5= Very High)</strong></th>
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<tr>
<td>26. Accuracy of project requirements when consultancy services bids were invited</td>
<td>1 2 3 4 5</td>
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<tr>
<td>27. Accuracy of consultancy scope of services when consultancy services bids were invited</td>
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<td>28. To what extent the technical specifications met the required quality level</td>
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<td>29. Ability of consultants’ key management personal to deliver the required services</td>
<td>1 2 3 4 5</td>
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<tr>
<td>30. The ability of consultants’ technical personal to deliver the</td>
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</table>
31. Consultant selected based on *(select one from the list below)*:

- a. Consultants with the best (technical + commercial) score were selected
- b. Consultancy services awarded to the lowest bidder
- c. Consultants were initially prequalified and then consultancy services were awarded to the lowest bidder
- d. Consultants were initially prequalified and then consultancy services were awarded to the best (technical + commercial) score
- e. Negotiation

32. Accuracy of design deliverables

33. Accuracy of the construction tender documents

34. Consideration of consultant past performance records for the award

35. Client ability to assess consultant performance during the pre-construction phase

36. Suitability of the consultancy service’s terms and conditions for the defined services

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**Effective site management (1= Very Low, 2=Low, 3= Moderate, 4=High, 5= Very High)**

37. Accuracy of the site document management

38. Significance of changes due to geological conditions at the project site

39. Frequency of timely approval of contractor’s payments

40. Frequency of sending back the contractor’s invoices due to incomplete submission

41. Contractor’s performance level in past projects

42. Difficulties in sourcing construction materials

43. Conflicts between the main contractor and subcontractors in the project

44. Subcontractors’ ability to deliver the scope allocated to them

45. Client team ability to assess the site situation before taken decisions

46. Involvement of the client team in construction progress review
### Collaboration

(1= Very Low, 2=Low, 3= Moderate, 4=High, 5= Very High)

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<tr>
<td>51.</td>
<td>The level of collaboration between client, consultants and contractors</td>
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<td>52.</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<td>53.</td>
<td>The level of collaboration between stakeholders in solving difficulties</td>
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<td>54.</td>
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<td>5</td>
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<td>55.</td>
<td>The efficiency of communications between stakeholders</td>
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<td>56.</td>
<td>Use of Information Communication Technology (ICT)</td>
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<td>57.</td>
<td>Stakeholders’ commitment to implementing corrective actions in order to enhance project performance</td>
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<td>2</td>
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<td>5</td>
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<td>58.</td>
<td>Conflict between main stakeholders during construction</td>
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<td>5</td>
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<tr>
<td>59.</td>
<td>Public stakeholders’ commitment to achieving the project goals</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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</tbody>
</table>

### Construction efficiency

(1= Very Low, 2=Low, 3= Moderate, 4=High, 5= Very High)

<p>| | | | | | | |</p>
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<td>Level of contractor understanding of technical challenges associated with the special features of the project</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>61.</td>
<td>Which of the following methods was used to select the contractor (select one from the list below):</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>a. Contractor with the best (technical + commercial) score was selected</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>b. Contractor services awarded to the lowest bidder</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Contractors were initially prequalified and then contact was awarded to the lowest bidder</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. Contractors were initially prequalified and then contact was awarded to the one with the best (technical + commercial) score</td>
<td></td>
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</tbody>
</table>
APPENDICES: Appendix 2 Questionnaire survey

<table>
<thead>
<tr>
<th></th>
<th>e. Negotiation</th>
</tr>
</thead>
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<tr>
<td>62.</td>
<td>Contractor cash flow difficulties during construction</td>
</tr>
<tr>
<td>63.</td>
<td>Consideration of contractors’ financial capabilities and track records for the contract award</td>
</tr>
<tr>
<td>64.</td>
<td>Degree to which the technical/price evaluation criteria matched the project’s special features, objectives and goals</td>
</tr>
<tr>
<td>65.</td>
<td>Which of the following Procurement system was used for the project <em>(select one from the list below)</em>:</td>
</tr>
<tr>
<td></td>
<td>a. design bid built/lump sum</td>
</tr>
<tr>
<td></td>
<td>b. design bid built/unit rate</td>
</tr>
<tr>
<td></td>
<td>c. design and build/ lump sum</td>
</tr>
<tr>
<td></td>
<td>d. design and build/ unit rate</td>
</tr>
<tr>
<td>66.</td>
<td>The contractor’s technical ability to deliver the required scope of work</td>
</tr>
<tr>
<td>67.</td>
<td>Significance of variation orders requested by the contractor</td>
</tr>
<tr>
<td>68.</td>
<td>Suitability of standard contract terms and conditions for the project</td>
</tr>
<tr>
<td>69.</td>
<td>Consideration of references from other clients about the contractor’s past performance for the award of the construction contract</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Social environment</th>
<th>(1= Very Low, 2=Low, 3= Moderate, 4=High, 5= Very High)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70.</td>
<td>Difficulties due to protests by the public against the project</td>
</tr>
<tr>
<td>71.</td>
<td>Difficulties faced by the contractor in recruiting labour and professionals for the project</td>
</tr>
<tr>
<td>72.</td>
<td>Pressure from the public to expedite the project</td>
</tr>
<tr>
<td>73.</td>
<td>Assistance provided to small and medium companies</td>
</tr>
<tr>
<td>74.</td>
<td>Difficulties due changes in laws and regulations</td>
</tr>
<tr>
<td>75.</td>
<td>Use of brainstorming sessions in the planning phase to identify possible issues and solution</td>
</tr>
<tr>
<td>76.</td>
<td>Use of workshops with main stakeholders before inviting construction bids to identify possible issues and solutions</td>
</tr>
<tr>
<td>77.</td>
<td>Use of workshops with bidders during the tender evaluation stage to resolved possible issues</td>
</tr>
<tr>
<td>78.</td>
<td>Technical and financial training support (by the concerned authorities) to Small and Medium Enterprises to cope with the construction market conditions</td>
</tr>
</tbody>
</table>
### Socio-demographic Questions

79. Which of the following best describes your professional role?

- Civil Engineer
- Project Manager
- Quantity Surveyor
- Construction Manager
- Design Manager
- Site Manager
- Project Engineer

80. What is the highest level of qualification you have attained?

- University degree
- Master’s degree
- PhD/EngD
- Other (please specify)

81. Which age range do you fall into?

- Under 20 years
- 21-30 years
- 31-40 years
- 41-50 years
- 51-60 years
- Over 60 years

82. How many years of experience do you have in your current position?

- 1-3 years
- 4-6 years
- 7-10 years
- 11-15 years
- 16-20 years
- More than 20 years
- Other (please specify): ............... years

83. Further comments

Please use the space below to add any other aspect that could be implemented to enhance the public construction procurement:

----------------------------------------
----------------------------------------
----------------------------------------
----------------------------------------
----------------------------------------
## Appendix 3 List of variables with commonality values

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Question</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Consideration of feedback from past projects to anticipate the performance of this project</td>
<td>.787</td>
</tr>
<tr>
<td>2</td>
<td>Control of scope changes during construction phase</td>
<td>.735</td>
</tr>
<tr>
<td>3</td>
<td>Consideration of historical records of past projects for the control of this project’s risks</td>
<td>.849</td>
</tr>
<tr>
<td>4</td>
<td>Budget estimate compared to the construction tender scope cost</td>
<td>.802</td>
</tr>
<tr>
<td>5</td>
<td>Top management support to translate difficulties faced in the project into actions, such as establishing guidelines and employee training</td>
<td>.789</td>
</tr>
<tr>
<td>6</td>
<td>Top management encouragement of the implementation of new ideas in the project</td>
<td>.769</td>
</tr>
<tr>
<td>7</td>
<td>Extent of using standardised processes, documents and templates to reduce unnecessary use of resources on repeated tasks</td>
<td>.769</td>
</tr>
<tr>
<td>8</td>
<td>Extent of sharing learning from this project with other team members within the public sector</td>
<td>.753</td>
</tr>
<tr>
<td>9</td>
<td>The efficiency of the information coordination process between stakeholders</td>
<td>.776</td>
</tr>
<tr>
<td>10</td>
<td>The accuracy of information exchanged between stakeholders</td>
<td>.843</td>
</tr>
<tr>
<td>11</td>
<td>Information availability for accurately defining the project’s scope</td>
<td>.797</td>
</tr>
<tr>
<td>12</td>
<td>Client team understanding of which decisions they can make alone and which decisions require the involvement of others</td>
<td>.811</td>
</tr>
<tr>
<td>13</td>
<td>Time given to the client team to define the project’s scope</td>
<td>.863</td>
</tr>
<tr>
<td>14</td>
<td>Participation of the operations team in identifying the project requirements</td>
<td>.825</td>
</tr>
<tr>
<td>15</td>
<td>Use of pre-identified goals and targets for various project phases to measure project performance</td>
<td>.806</td>
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<tr>
<td>16</td>
<td>Extent of implementing corrective actions to maintain the original project cost and time</td>
<td>.698</td>
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<td>17</td>
<td>Attention given to identifying possible risks at the planning phase</td>
<td>.782</td>
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<tr>
<td>18</td>
<td>Attention to investigation of new ways to improve project performance</td>
<td>.861</td>
</tr>
<tr>
<td>19</td>
<td>Accuracy of project requirements when consultancy services’ bids were invited</td>
<td>.853</td>
</tr>
<tr>
<td>20</td>
<td>Accuracy of consultancy scope of services when consultancy services’ bids were invited</td>
<td>.843</td>
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<tr>
<td>21</td>
<td>Extent to which technical specifications met the required quality level</td>
<td>.849</td>
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<td>22</td>
<td>Ability of consultants’ key management personnel to deliver the required services</td>
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<tr>
<td>23</td>
<td>Ability of consultants’ technical personnel to deliver the required design services</td>
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<td>24</td>
<td>Accuracy of design deliverables</td>
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<td>25</td>
<td>Accuracy of construction tender documents</td>
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<tr>
<td>26</td>
<td>Consideration of consultant’s past performance records</td>
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<td>27</td>
<td>Client’s ability to assess consultant performance during the pre-construction phase</td>
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<td>28</td>
<td>Suitability of the consultancy service’s terms and conditions for the defined services</td>
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<td>29</td>
<td>Accuracy of the site’s document management</td>
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<td>Frequency of timely approval of contractors’ payments</td>
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<td>Contractors’ performance levels in past projects</td>
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<td>Subcontractors’ ability to deliver the scope allocated to them</td>
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<td>Client team’s ability to assess the site situation before making decisions</td>
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<td>Item No.</td>
<td>Question</td>
<td>Value</td>
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<td>Involvement of the client team in construction progress reviews</td>
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<td>Extent of responsibility and accountability acceptance by stakeholders</td>
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<td>Level of trust between public sector stakeholders</td>
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<td>53</td>
<td>Level of collaboration between stakeholders when solving difficulties</td>
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<td>54</td>
<td>Extent of sharing lessons learned between stakeholders</td>
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<td>55</td>
<td>Efficiency of communication between stakeholders</td>
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<td>56</td>
<td>Use of Information Communication Technology (ICT)</td>
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<td>63</td>
<td>Consideration of contractors’ financial capabilities and track records when awarding contract</td>
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<td>64</td>
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<td>Contractor’s technical ability to deliver the required scope of work</td>
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<td>75</td>
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<td>Use of workshops with main stakeholders to identify possible issues and solutions before inviting construction bids</td>
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<td>Technical and financial training support (by the concerned authorities) for small and medium enterprises to help them cope with construction market conditions</td>
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<td>Difficulties in obtaining planning and permit approval</td>
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<td>Significance of the knowledge and skills training needs not provided to the client team</td>
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<td>Changes in project objectives during construction</td>
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<td>19</td>
<td>Changes in project requirements during construction</td>
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<td>24</td>
<td>Attention to activities that are required to publish the tender compared with those which actually contribute the most to project success</td>
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<td>38</td>
<td>Significance of changes due to geological conditions at the project site</td>
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<td>Frequency of sending back contractors’ invoices due to incomplete submission</td>
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<td>Difficulties in sourcing construction materials</td>
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<td>Conflicts between the main contractor and subcontractors working on the project</td>
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<td>Question</td>
<td>Value</td>
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<td>---------</td>
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<td>Significance of requirement modifications initiated by the client</td>
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<td>Difficulties in handing over the project site to the contractor</td>
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<td>Difficulties faced by the contractor in gaining access to the project site</td>
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<td>Conflict between main stakeholders during construction</td>
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<td>62</td>
<td>Contractor cash flow difficulties during construction</td>
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<td>67</td>
<td>Significance of variation orders requested by the contractor</td>
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<td>70</td>
<td>Difficulties due to protests by the public against the project</td>
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<td>71</td>
<td>Difficulties faced by the contractor in recruiting labour and professionals for the project</td>
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<td>72</td>
<td>Pressure from the public to expedite the project</td>
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<td>74</td>
<td>Difficulties due to changes in laws and regulations</td>
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</table>
Appendix 4: Validation Interview

Modelling the relationship between the client activities and construction procurement performance in Oman

The purpose of this interview session is to validate the key findings of a study into the relationship between client activities and construction procurement performance in terms of schedule delays and cost overruns. The results from the study revealed that the effect of client activities on schedule delays and cost overruns is substantial and high for a number of specific activities. Table 1 presents the contribution of those activities that affect schedule delays and cost overruns to a significant level. In contrast, the shaded area of Table 1 shows activities with minimal or no influence (defined Beta values below 0.197 in term of schedule delays and 0.218 in term of cost overruns) on procurement performance. The interview session is to check the extent to which these findings reflect your own practice and organisational circumstance.

It is estimated that the interview should take no longer than 30 minutes, and all information provided will be completely confidential. I will be grateful if you could advise me of a suitable time to call for a discussion that would address the validation as well as the following aspects connected to the study findings.

- To assess the extent to which each client activity affects construction schedule delays and cost overruns.
- Appropriateness and practicalities of the client activities for the construction procurement in dealing with construction delays and cost overruns.
APPENDICES: Validation interview

- How the client activities can help improve knowledge of aspects required to be efficiently practiced in construction projects to reduce delays and cost overruns.
- Other comments

Thank you for your support.

Ali Al Harthi - PhD Student

School of Civil and Building Engineering, Loughborough University
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Design Efficiency (Component 1)</th>
<th>Collaboration (Component 2)</th>
<th>Construction efficiency (Component 3)</th>
<th>Site management (Component 4)</th>
<th>Early involvement of stakeholders (Component 5)</th>
<th>Learning from past experience (Component 6)</th>
<th>Accuracy of project objective and requirement (Component 7)</th>
<th>Lack of client team development (Component 8)</th>
<th>Difficulties in project planning and permits (Component 9)</th>
<th>Availability of construction work force (Component 10)</th>
<th>Decision making (Component 11)</th>
<th>Contractor difficulties (Component 12)</th>
<th>Information coordination process (Component 13)</th>
<th>Requirement modifications initiated by the client (Component 14)</th>
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<tbody>
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<td>-0.366</td>
<td>-0.276</td>
<td>-0.302</td>
<td>-0.246</td>
<td></td>
<td>-0.219</td>
<td>0.275</td>
<td>-0.234</td>
<td>0.282</td>
<td></td>
<td>0.226</td>
<td>0.341</td>
<td>0.244</td>
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<td>Design bid build procurement system cost overruns</td>
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<td>-0.276</td>
<td>-0.287</td>
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<td></td>
<td></td>
<td>-0.306</td>
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<td>Design-build procurement system delays</td>
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<tr>
<td>Design-build procurement system cost overruns</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>
### Questionnaires on construction delays

To what extent do you rate the following statement on the below scale:
(1= strongly disagree, 2=disagree, 3= Uncertain, 4=Agree, 5= strongly agree)
The following action by the client can reduce construction delays and cost overruns

<table>
<thead>
<tr>
<th>Design efficiency</th>
<th>Delays</th>
<th>Cost overruns</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Higher accuracy of <strong>project requirements</strong> before consultancy services bids are invited</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>2. Higher accuracy of <strong>consultancy scope</strong> of services before consultancy services bids were invited</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>3. Higher accuracy of the technical specifications</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>4. Selecting consultants’ with higher <strong>key management</strong> personal abilities to deliver the required services</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>5. Selecting consultants’ with higher <strong>technical personal abilities</strong> to deliver the required design services</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>6. Higher accuracy of the construction tender documents</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>7. Higher consideration consultant past performance records for the award</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>8. Higher client ability to assess consultant performance during the pre-construction phase</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>9. Enhancement of the consultancy service’s terms and conditions for the defined services</td>
<td>1 2 3 4 5</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Collaboration</th>
<th>(1= strongly disagree, 2=disagree, 3= Uncertain, 4=Agree, 5= strongly agree)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Higher collaboration between parties in control of scope changes during construction phase</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>11. Higher level of trust between public sector stakeholders</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>12. Higher level of collaboration between stakeholders in solving difficulties</td>
<td>1 2 3 4 5</td>
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</tbody>
</table>
## APPENDICES: Validation interview

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<tbody>
<tr>
<td><strong>13.</strong> Higher extent of sharing learning lessons between stakeholders</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><strong>14.</strong> Higher efficiency of communications between stakeholders</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><strong>15.</strong> Higher use of Information Communication Technology (ICT)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><strong>16.</strong> Higher effectiveness in using pre-identified goals and targets for various project phases to measure project performance</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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### Construction efficiency

(1= strongly disagree, 2=disagree, 3= Uncertain, 4=Agree, 5= strongly agree)

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<tbody>
<tr>
<td><strong>17.</strong> Higher level of public stakeholders’ commitment to achieving the project goals</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<tr>
<td><strong>18.</strong> Higher attention to ensure the contractor understanding of technical challenges associated with the project before the award</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<tr>
<td><strong>19.</strong> Higher stakeholders’ commitment to implementing corrective actions in order to enhance project performance</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td><strong>20.</strong> Higher attention to ensure subcontractors’ ability to deliver the scope allocated to them before the award</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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</tr>
<tr>
<td><strong>21.</strong> Higher level of involvement of the client team in construction progress review</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<tr>
<td><strong>22.</strong> Enhancement of standard contract terms and conditions for the future project</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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### Multiphase involvement of stakeholders

(1= strongly disagree, 2=disagree, 3= Uncertain, 4=Agree, 5= strongly agree)

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<tbody>
<tr>
<td><strong>23.</strong> The availability of more information to accurately define the project scope</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<tr>
<td><strong>24.</strong> Giving higher attention to identify possible risks at the planning phase</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<tr>
<td><strong>25.</strong> Higher use of brainstorming sessions in the planning phase to identify possible issues and solution</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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</tr>
<tr>
<td><strong>26.</strong> Higher use of workshops with main stakeholders before inviting construction bids to identify possible issues and solutions</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
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</tbody>
</table>
### Validation Interview

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<tbody>
<tr>
<td>27.</td>
<td>Higher use of workshops with bidders during the tender evaluation stage to resolved possible issues</td>
</tr>
<tr>
<td>28.</td>
<td>Higher involvement of SMEs authorities on issues related to the Technical and financial training support to Small and Medium Enterprises to cope with the construction market conditions</td>
</tr>
</tbody>
</table>

### Accuracy of Projects Objectives and Requirements

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<tbody>
<tr>
<td>29.</td>
<td>Higher accuracy of project objectives</td>
</tr>
<tr>
<td>30.</td>
<td>Higher accuracy of project requirements</td>
</tr>
<tr>
<td>31.</td>
<td>Higher control on requirements modifications initiated by the client during construction</td>
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</tbody>
</table>

### Lack of Client Team Development

1 strongly disagree, 2 = disagree, 3 = Uncertain, 4 = Agree, 5 = strongly agree

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<tbody>
<tr>
<td>32.</td>
<td>Development of client team capabilities to fill knowledge and skills gaps identified in previous projects and new projects needs</td>
</tr>
<tr>
<td>33.</td>
<td>Higher consideration of contractors’ financial capabilities and track records for the contract award</td>
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</tbody>
</table>

### Project Planning and Permits Approvals

1 strongly disagree, 2 = disagree, 3 = Uncertain, 4 = Agree, 5 = strongly agree

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<tbody>
<tr>
<td>34.</td>
<td>Higher involvement of client team in resolving difficulties in obtaining planning and permit approvals</td>
</tr>
<tr>
<td>35.</td>
<td>Higher involvement of client team in resolving difficulties due to changes in statutory and permit requirements during the construction phase</td>
</tr>
</tbody>
</table>

### Availability of Construction Workforce

1 strongly disagree, 2 = disagree, 3 = Uncertain, 4 = Agree, 5 = strongly agree

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<tbody>
<tr>
<td>36.</td>
<td>Higher involvement of client team in resolving difficulties faced by the contractor in recruiting labour and professionals for the project</td>
</tr>
</tbody>
</table>
### APPENDICES: Validation interview

<table>
<thead>
<tr>
<th>37.</th>
<th>Higher use of standardised processes, documents and templates to reduce unnecessary use of resources on repeated tasks</th>
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<th>1 2 3 4 5</th>
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</thead>
</table>

**Contractor difficulties (1= strongly disagree, 2=disagree, 3= Uncertain, 4=Agree, 5= strongly agree)**

| 38. | Higher involvement of client team in resolving contractor cash flow difficulties during construction | 1 2 3 4 5 | 1 2 3 4 5 |
| 39. | Higher involvement of client team in resolving conflicts between the main contractor and subcontractors in the project | 1 2 3 4 5 | 1 2 3 4 5 |