A FRAMEWORK FOR IMPROVING THE PERFORMANCE OF STANDARD DESIGN MODELS IN THE SAUDI MINISTRY OF INTERIOR PROJECTS

By

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ABSTRACT

The construction industry worldwide is under great pressure to deliver better value for money and a more sustainable built environment. There are reoccurring calls to improve its performance in line with other industries, such as the manufacturing industry, due to the global technological and financial changes and the development process of design and production. Improvement of performance has become ever more critical to construction project success and has been subject to a considerable amount of research and attention over the past two decades. A number of government reports and academic publications highlighted the need to improve the performance of the design and construction process and suggested that this could be achieved by reducing variations between projects with respect to allocated budget and schedule, quality standards and a series of complex and interrelated activities and confrontation between stakeholders in order to share learning. As such it was emphasised the importance of adopting standardisation in improving construction design and also focused on learning mapping from other industries. It is also well established that the construction industry still suffers from uncoordinated and highly variable processes due to its fragmentation and the complexity of construction projects.

The challenge to improving projects' performance continues to receive attention from both industry and academia. Not with standing a consensus in literature that standardisation of design and process is necessary to achieve sustained performance improvement very little has been published in the field of standard design project performance. In this regard, the Saudi Ministry of Interior (SMoI) has adopted a new approach - Standard Design Model (SDM) - for the development of its construction programme to successfully manage its complex project portfolio and improve project performance. The SMoI has a 20-year strategic budget of more than £4.5 billon for constructing governmental buildings such as police departments, civil defence, hospitals, etc. The SMoI-SDM approach is based on the standardisation of design, material specifications, contract documents and processes. It is anticipated that many lessons will be learnt due to the re-use of SDMs for future projects as well as sharing learning between on-going projects, thus leading to continuous project performance improvement. The aim of this research is to develop a framework for improving the performance of SDMs in SMoI projects.

An extensive literature review was conducted on project performance, learning and Knowledge Management (KM), Continuous Improvement (CI) and SDM projects in Saudi Arabia. Subsequently, a preliminary study was conducted to prioritise key issues related to the performance of SDM projects and provide robust foundation for this research. The following stage adopted a case study approach to provide an in-depth insight into the current performance of SDM projects and identify critical success factors (CSFs) affecting the process of improvement of SDMs project performance. Four case studies were selected involving two on-going and two completed projects. Three key themes were identified from the case studies analysis; these are: adaptability of SDMs to context; contract management; and construction management. Consequently, a framework was developed to improve SDM projects' performance as well as the expected performance improvement curve that results from the cumulative learning and experience. The framework validation was conducted through a workshop involving the same stakeholders who participated in the case studies, in which the feedback on possible improvements to the framework was obtained. The framework demonstrated its practicality, clarity and appropriateness for use across the SDM projects.

The developed framework is an important contribution to identifying CSFs related to each phase of the SDM projects. It places the three main phases (design modification phase, pre-construction phase and construction phase) in one integrated structure and organises and manages the knowledge captured from the SDM projects using direct feedback. It contributes to knowledge capture and sharing between all SDM projects; promoting the integrated work through collaboration; guiding the client towards the sustainable improvement of SDMs project performance; assessing and monitoring the improvement achieved in the performance of SDM projects and helping to implement the improvement strategy. Significantly, this research has the potential to direct standardisation of design and process in construction projects in particular in the public sector and could help achieve a sustained project performance improvement in the Saudi construction industry.

Keywords: Standard Design Models, Saudi construction industry, Project performance improvement, Learning, Knowledge management, Critical success factors.

DEDICATION

This thesis is dedicated to

my father, my mother,

my wives, my children,

my brothers, and my sisters

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LIST OF ABBREVIATIONS

AEC	- Architecture, Engineering and Construction
BoQ	- Bill of Quantity
CLR	- Client Representative
CLR1	- Client Representative in Case Study 1
CLR2	- Client Representative in Case Study 2
CLR3	- Client Representative in Case Study 3
CLR4	- Client Representative in Case Study 4
CI	- Continuous Improvement
CONSR	- Consultant Representative
CONSR1	- Consultant Representative in Case Study 1
CONSR2	- Consultant Representative in Case Study 2
CONSR3	- Consultant Representative in Case Study 3
CONSR4	- Consultant Representative in Case Study 4
CONTR	- Contractor Representative
CONTR1	- Contractor Representative in Case Study 1
CONTR2	- Contractor Representative in Case Study 2
CONTR3	- Contractor Representative in Case Study 3
CONTR4	- Contractor Representative in Case Study 4
CS1	- Case Study 1
CS2	- Case Study 2
CS3	- Case Study 3
CS4	- Case Study 4
CSFs	- Critical Success Factors
DeuL	- Deutero-Learning
DLL	- Double Loop Learning
HO	- Client Head Office
ICT	- Information and Communication Technology
IT	- Information Technology
KM	- Knowledge Management
KPIs	- Key Performance Indicators
LC	- Learning Curve
LL	- Lessons Learnt
LO	- Learning Organisation
OL	- Organisational Learning
PD	- Police Department
PKF	- Project Knowledge File
SDMs	- Standard Design Models
SLL	- Single Loop Learning
SMoI	- Saudi Ministry of Interior
TQM	- Total Quality Management

CHAPTER 1

1 INTRODUCTION

1.1 BACKGROUND

The construction industry is being forced to improve its performance to be in line with other industries, namely the manufacturing industry. This is due to the global technological and financial changes and the development process of design and production. According to a study conducted by CIDB (2000), investment in global construction accounts for about 10% of the world economy, of which 70% is in the USA, Europe and Japan and 30% in the rest of the world. Martin (2004) indicated that the magnitude of investment in the construction industry encouraged different governments to undertake initiatives to improve the performance of the construction projects and the construction industry overall. A construction project is regarded as a hybrid result of several activities in which interactions, planned or unplanned, occur throughout the period of producing a building; these happen with unstable participants and processes in continually changing circumstances (Sanvido et al. 1992). As a result, the construction industry suffers broadly from fragmentation, which reduces the effectiveness of project management. Indeed, Egan (1998) argued that there were a deep concerns regarding the construction industry in terms of underachievement of performance, where it suffered from low profitability, minimal capital investment and under-funded research, development and training.

Improving project performance in the construction industry poses several challenges for stakeholders. However, it is not an easy task to sustain radical improvement in a diverse environment such as the construction industry (Egan 1998). It requires the identification and implementation of suitable improvement programmes subjected to the construction business cycle (Tang and Ogunlana 2003). This is important since the integration of improvement programmes in construction may incur high cost and yet the benefit can only be realised after some time delay (Takim 2005). However, there is a need for new improvement programmes and initiatives at various stages of a project life-cycle in order to enhance construction project performance and target changing trends of private and public sector construction project organisations (Tang and Ogunlana 2003; Atkinson 2003)). Such programmes entail the integration and implementation of process improvements across project phases.

Process improvement in the development of construction projects is necessary to enhance the performance of projects, in particular of large-scale projects and to mitigate the problems of adversarial relationships. For example, the UK construction industry has made advances since the publication of the Egan report. The establishment of the Construction Best Practice Programme, the Movement for Innovation, and the new establishment of Construction Excellence have helped to promote management techniques such as benchmarking partnering, lean construction, supply chain management, and risk management, all of which are more prevalent within UK construction companies (Barrie 1999; Cook 1999; DETR 1999a; Dainty et al. 2003). On the other hand, in developing countries, for example, Malaysia, the Malaysian government has sought to improve performance through seven major areas of the construction industry which are targeted for further improvements: productivity, quality, information and communication technology (ICT) in construction, knowledge-based technology in construction, environmental management and sustainability, health and safety, and globalisation issues (Takim 2005).

The "Golden Triangle" elements expressed in terms of cost, time and quality have been considered the most important traditional basic criteria for project success (Walker 1995; 1996; Belassi and Tukel 1996; Hatush and Skitmore 1997; Kloppenborg and Opfer 2002). Moreover, Belout and Gauvreau (2004) argued that cost and schedule control are considered as crucial measures of capital project success leading to client satisfaction. However, the successful completion of large-scale construction projects is considered a serious challenge. Therefore, identification of Critical Success Factors (CSFs) becomes crucial. However, there is no apparent consensus among researchers on CSFs on construction projects (Toor and Ogunlana 2009). The term "Critical Success Factors" was used to describe the potential factors that contribute to the success or failure of a project (Rockart 1982). For two decades, many studies have been conducted to identify the CSFs that significantly lead to successful project delivery (Chan et al. 2001; Cooke-Davies 2002). The studies involved different construction projects, for instance: general construction projects (Ashley et al. 1987; Pinto and Slevin 1988; Savindo et al. 1992; Chua et al.1999; Egbu 1999; Phua and Rowlinson 2004; Fortune and White 2006), design-build projects (Songer and Molenaar 1997; Ng and Mo 1997; Chan et al. 2001); public-private-partnerships or BOT (Tiong 1996; Jefferies et al.

2002; Zhang 2005; Li et al. 2005); international and multi-firm projects (Mohsini and Davidson 1992; Phua 2004; Gale and Luo 2004); large-scale construction projects (Nguyen et al. 2004) and various other project management topics (Hatush and Skitmore 1997; Cooke-Davies 2002; Nicolini 2002; Yu et al. 2005; Fortune and White 2006). However, Chua et al. (1999) noted that there is a general agreement among experts regarding the variety of CSFs for different projects objectives. Liu (1999) argued that there is a specific set of success factors related to one project that may not be transferable to another project. Similarly, Belout and Gauvreau (2004) indicated that there are variations between projects with respect to allocated budget and schedule, quality standards and a series of complex and interrelated activities, although some common characteristics do exist.

However, it might be that the concept of a learning organisation is a 'new' idea to construction organisations, although the concept is well established in the management field (Chinowsky et al. 2007). The learning process relates to how companies absorb knowledge and other stimulus from experience due to internal and external environments and thus how acquired knowledge is employed to achieve continuous improvement (Kululanga et al. 1999). Lessons learnt (LL) are emerging as one of the essential tools for driving the project improvement wheel and may soon become one of the key sources of competitive advantage (Goh and Richards 1997). However, Chinowsky et al. (2007) stated that an organisation is classified as a Learning Organisation (LO) when it is skilled at creating, acquiring, sharing and applying knowledge and then embracing change and innovation at all levels, resulting in optimum performance and maximum competitive advantage. Snider et al. (2000) stated that although the idea of learning from experience is timeless, the close attention given to formalising systems for capturing and disseminating LL within an organisation has recently been realised. Garon (2006) indicated that LL are the best key elements of Knowledge Management (KM) where they help to improve the planning/management of future projects in order to accomplish corporate missions by acting as a communication tool between projects. The importance of KM has led to its adoption by many organisations, and the common suggestion is that the majority of successful organisations in the world are experts at managing their knowledge (Nonaka and Takeuchi 1995; Davenport and Prusak 1998). In fact, a construction project is regarded as unique in that it undergoes a sharing process between a number of stakeholders who collaborate with each other at various stages during the construction phase (Dave and Koskela 2009); however, they may or may not continue to work together once the project is completed (Kamara et al. 2002). However, in general, literature revealed that not much has been published on CSFs for repetitive or standard design projects and in particular in the context of the Saudi construction industry. Specifically, literature revealed that no publications have addressed the CSFs for SDM projects in the SMoI. Accordingly, this research investigates the Standard Design Models (SDMs) which have been adopted by the Saudi Ministry of Interior (SMoI) to improve performance in their on-going and future repetitive SDM projects. The SDMs have the same design characteristics, material specifications and quality. This helps in generalising the identified CSFs for other repetitive SDM projects. The next section will address the justification of the current research.

1.2 JUSTIFICATION OF THE RESEARCH

The construction industry, globally, is under great pressure to deliver better value for money and a more sustainable built environment. Government reviews in the UK revealed the sector to be seriously underachieving, and plagued with claims and disputes (Latham 1994; Egan 1998). Low profitability, growing client dissatisfaction, low capital investment, mediocre research and development spending and under-funded training schemes were listed as problems typical of the sector.

Egan (1998) concluded that one of the major barriers to improvement in the construction industry was that clients were left unable to understand all the components of a project, such as equating price with cost, or selecting designers and contractors. Furthermore, both private and public sectors were equally dissatisfied with the sector's under-achievement. Projects were unpredictable, in terms of delivery on time, within budget, and to the standards of expected quality. British Property Federation (1983) conducted a survey on the UK clients in 1997 and identified the following critical points:

- Client dissatisfaction with contractor performance in following the basic criteria of cost, time and quality, as well as remedying defects;
- Client dissatisfaction with consultant performance in driving the design innovation wheel, coordinating teams, developing a more speedy and reliable process, and providing real value for money.

Moreover, Egan (1998) was optimistic about the wide range of possible developments that have appeared in the industry, for example, improvements in construction performance through the latest initiatives, and the ways in which all factors affecting project performance have been improved, including components and materials, as well as standardisation. A further factor was the existence of tools used to tackle fragmentation, such as partnering. A final factor was the LL from other industries, in using useful tools and techniques to improve efficiency and quality. These tools include benchmarking, value management, team working, Just-In-Time and Total Quality Management (TQM). Egan (1998) considers that there is great room for improvement through the client who plays a vital role in improving performance in construction.

In stressing the importance of performance measurement to the achievement of continuous improvement, Egan (1998) warned that *"if you don't measure, you will never know how much improvement is possible or desirable. High level targets are the start and are necessary to start improvement-but need to be broken down into a series of lower level targets that will enable everyone involved in a project to see how their daily work contributes to the overall improvement target. Measures are therefore required in all these areas of activity of the critical processes so that improvement targets can be set and progress to their achievement monitored".* However, because construction is project-oriented, it would be natural to concentrate on project work more than on the organisational level (Love and Holt 2000; Kagioglou et al. 2001). As can be seen, project performance in the construction industry is typically evaluated in terms of cost, time and quality (Ward et al. 1991; Kagioglou et al. 2001). However, Ward et al. (1991) argued that these three factors alone were insufficient, and other factors influenced customer satisfaction and impacted on the success/failure of projects. These factors included the quality of relationships amongst participants, and flexibility. They further explained that after completion of a project, the only concern remaining in the minds of participants was not so much early completion or financial success, but success like rhythm, goodwill and trust, or conversely, argument, distrust and conflict. In addition, Olomolaiye et al. (1998) argued that productivity was a powerful issue in project management, promising efficient use of resources and cost saving, which ultimately impact on the baseline of every attempt in the construction process. Egan (1998) emphasised the importance of learning from other industries that have improved their performance. He believed that such improvements can be implemented in the construction industry and made available to its clients. He cited Nissan UK in the motor industry, and its advanced approach to production. He wrote: *"we see that construction has two choices: ignore all this in the belief that construction is so unique that there are no lessons to be learned; or seek improvement through re-engineering construction, learning as much as possible from those who have done it elsewhere".* This suggests that the construction industry must rethink its processes, which will help it to achieve continuous improvement in its performance and products. Furthermore, Egan disagrees with the view that construction is different from manufacturing because every product is unique, since research suggests that up to 80% of inputs into buildings are repeated; crucially, the process of construction is unchanged from project to project. This view was shared by Wegelius- lehtonen (2001), who observed that while construction was project-oriented, and each project unique, process stages in every project were similar. Egan (1988) linked the standardised components and processes and learning from experience in order to achieve continuous improvement of construction products as well as sustained project performance.

Due to the current rapid growth of the Saudi economy, a significant number of construction projects are being implemented in both the public and the private sectors. Although a considerable construction programme is underway, there is a concern associated with the frequent and lengthy delays that have caused underachievement in project performance (Al-Kharashi and Skitmore 2009). Additionally, the same authors identified that the most influential current cause of delay is the lack of qualified and experienced staff concerned with the extensive portfolio of current construction projects and the associated current undersupply of skilled staff in the industry. Equally, several inconsistencies between design and construction in Saudi Arabia were pointed out by Arain et al. (2006). These included communication gaps between contractor and designer; insufficient details in the working drawings; lack of coordination between the parties; shortage of human resources in the design firms; designers' lack of knowledge of available materials and equipment; and incomplete drawings and specifications (Arain et al. 2006).

The SMoI adopted a new SDMs approach for implementing its projects. The Ministry seeks to implement these at different times and locations all over the country. During the preparation of the SDMs, usual circumstances should be taken into consideration. In addition, possible design modifications need to be prepared for the approved SDMs, allowing for predicted variations due to the nature and circumstances of sites, e.g. a site located in an earthquake zone. Pre-determined dimensions of model sites in each category need to be agreed. SDMs have the same design standards and material specifications, as well as criteria of high quality, however end user-specified, special requirements such as material specifications were allowed. SDMs seek to secure success in three dimensions: economic, social, and environmental. The adopted approach enables the SMoI to learn from past mistakes which occurred in completed projects in order to avoid these and improve the performance of on-going and future projects, however, no learning mechanism was put in place to capture, store and disseminate LL. Additionally and despite the adoption of SDMs as a strategic approach for improving the performance of SMoI projects, there is a major concern about the long delays, breakdowns, and, therefore, dissatisfaction of the client and the end-users. According to SAD (2006), regular progress reports revealed that the percentage of delay in SDM projects involved in one stage of the programme was estimated at just 15.28 per cent as an overall delay in time for all projects. Specifically, 19 projects out of a total of 61 projects accounted for a high percentage of these delays (73.03 per cent). While the acceptable percentage of achievement ranged from 90 to 100 per cent for the other projects, it was noted that there was a variation in the percentage of completion due to unforeseen circumstances, which are often due to external factors. Additionally, according to a progress report issued by the SMoI in 2008, it has been established that there was no improvement achieved on SDM projects performance over the last period. The report revealed that the percentage delay increased from 37 per cent to 52.4 per cent, and the gap between the planned and actual curve increased (SAD 2008). Specifically, delay in time for PD projects increased from 14 per cent to 28 per cent. Figure 5.6 shows that no improvement has been achieved over the last period through learning from previous projects (accumulative learning) and the projects suffering from delays reached about 45 per cent (see Chapter Five for further details).

Accordingly, a review of existing literature indicates that despite the adoption of SDM projects/repetitive projects which enable the learning from past mistakes and thus improving the performance of future projects, it has been realised that there is a lack of learning instruments to capture, store and disseminate LL. This recently resulted in poor performance and long delay in the SDM projects. The need for an improvement framework for SDM projects, however, has not been adequately addressed. This research, therefore, addresses the importance of developing a framework that improves the performance of SDMs in the SMoI projects.

1.3 RESEARCH AIM AND OBJECTIVES

The research aims to develop a framework for improving the performance of SDMs in the SMoI projects. To achieve the aim of the research six qualitative objectives are proposed:

1. review the relevant literature related to project performance, learning, knowledge management and continuous improvement;

2. examine the Saudi construction industry and SDM projects in Saudi Arabia in terms of production process, current status of performance and categorisation;

3. explore current SDM projects in relation to methods of planning, control, projects performance criteria and key issues affecting improvement project performance;

4. identify the key Critical Success Factors (CSFs) that affect the improvement of SDM projects' performance;

5. develop a framework for performance improvement of SDM projects for the SMoI; and

6. validate the proposed framework for improving the performance of SDM projects.

1.4 OVERVIEW OF RESEARCH METHODOLOGY

The research methodology, as detailed in Chapter Two, has been followed to achieve the outlined research objectives. This comprises five interrelated stages as shown in Figure 1.1.

1.4.1 Literature review

An extensive literature review was conducted to provide a solid foundation as well as a basis for the formulation of the proposed improvement framework. The review covered project performance, including CSFs; performance criteria; and tools used for improving construction project performance such as benchmarking, partnering and LL. Additionally, the review covered learning, the Learning Curve (LC), Knowledge Management KM and Continuous Improvement (CI). The review also covered the Saudi construction industry in terms of current project performance, the SDMs approach the production process and the current performance of SDM projects. The obtained information helped to identify the gap in knowledge with respect to this topic and the importance of adopting the SDMs approach in the Saudi construction industry and provide the essential background knowledge prior to conducting the preliminary study and case studies. This stage is dealt with in Chapters Two to Five. The location of the relevant literature was carried out through the Loughborough University Library Catalogue (i.e. Loughborough OPAC); Loughborough University Metalib (i.e. an integrated search engine that facilitates searching across different databases and electronic journals at one time); the SMoI' projects documents; and other Internet search engines (e.g. Google Scholar), comprehensive review of the relevant literature including books and the following academic sources:

- Construction Management and Economics (UK);
- ASCE Journal of Construction Engineering and Management (US);
- Engineering, Construction and Architectural Management (UK);
- ASCE Journal of Management in Engineering (US);
- International Journal of Project Management (UK);
- Project Management Journal (US);
- Journal of Construction Procurement (UK).

The literature search was used to establish problem statements, research questions, the aims and objectives of the study, development of the data collection strategy, and methods and methodology to be adopted in order to accomplish the stipulated objectives.

1.4.2 Preliminary Study

Due to the infancy of the SDMs approach which was recently adopted by the Saudi construction industry; and because there was a limited number of publications related to SDM projects within the context of Saudi construction, there was a need to conduct a preliminary study to prioritise the problems related to the performance of SDM projects and provide a useful starting point for this research. As stated by Sekaran (2003) when not much is known about the situation at hand, or no information is available on how similar problems or research issues have been covered, a preliminary study needs to be conducted to gain familiarity with the phenomena in the situation, and understand the current status before creating a rigorous design for a comprehensive investigation.

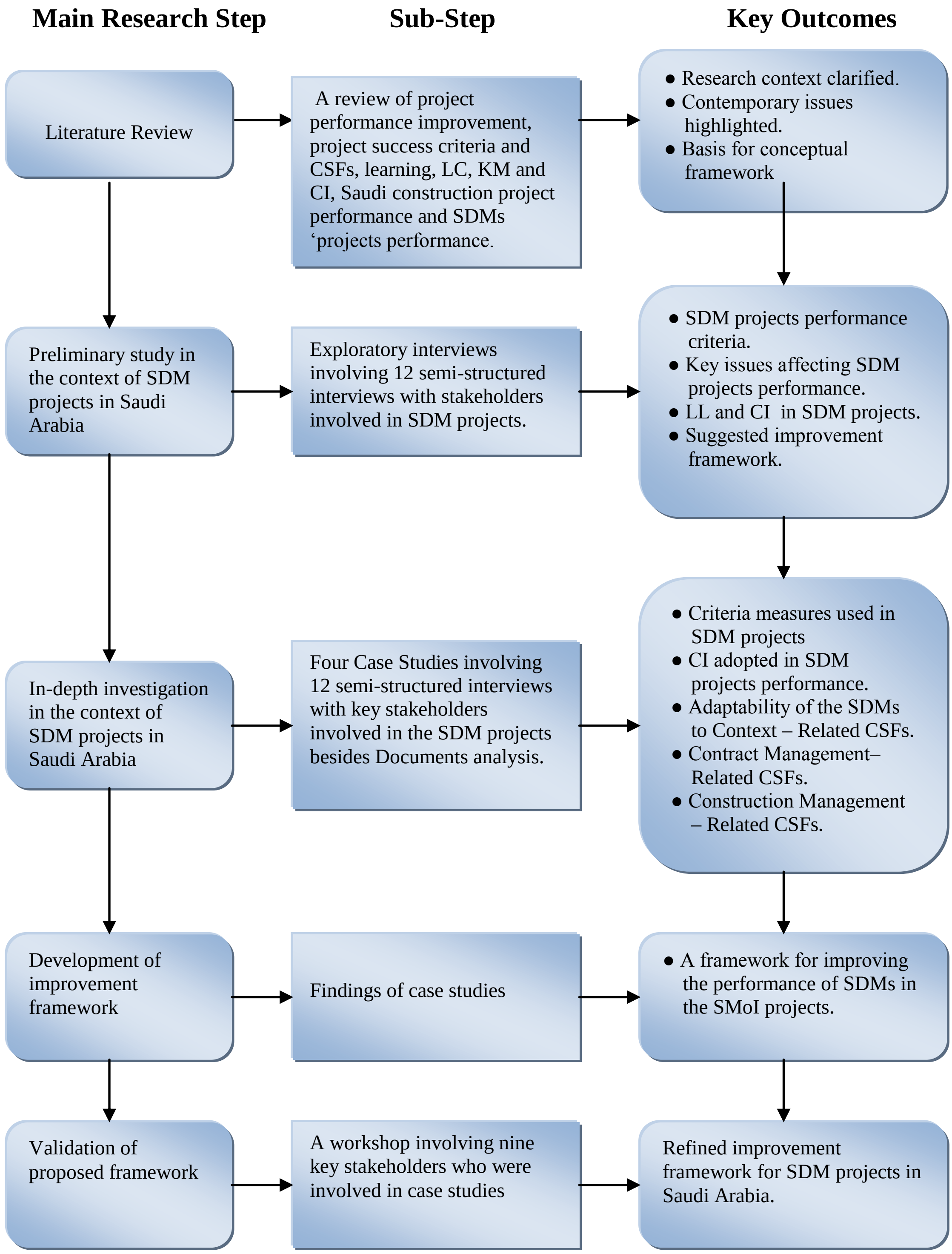

Figure 1.1: Overview of the Research Steps and Outcomes

Additionally, the preliminary study highlighted potential research issues and areas and, therefore, helped in obtaining general feedback on major research issues. The template of preliminary interviews comprises: personal background; project background; success criteria for project, and key ways of improving project performance (see Appendix C). This stage is presented in more detail in Chapter Six. Accordingly, the conclusions of the interview highlighted the need to conduct in-depth investigation in the context of SDM projects to better understand the situation. Additionally, because of the nature of repetitive SDM projects which enables the learning from project to project to improve the performance through LL, it must investigate in-depth and observe the situation of learning within a real-life context of on-going projects and compared with completed projects, and therefore, identify the CSFs affecting the improvement of SDM projects performance through LL, and this can be achieved through conducting case studies.

1.4.3 Case Studies

A case study approach was adopted because it could provide an in-depth insight into the current performance of SDM projects and identify the CSFs affecting the process of improvement of SDM projects performance through LL. Four case studies were selected and designed as discussed in Chapter Two involving two on-going projects and two completed projects. The case studies used two data collection sources: semi-structured interviews and SMoI SDM-related documents. The semi-structured interviews were held with twelve key stakeholders involved in SDM projects. In each case study, three representatives were selected including: client, consultant and contractor. Furthermore, SMoI SDM–related documents such as invitation documents, tendering documents, BoQ documents, the project contract documents, financial requests, minutes of meetings, change order documents, submittal request documents, prequalification request documents, disseminated documents and the project handover to end-user document were used and analysed as a reliable source to gather the needed information relevant to the four cases. This was done to ensure that a comprehensive view of CSFs of SDM projects was obtained. Each interview lasted between 90 to 120 minutes to cover the identified issues and to ensure the needed information was obtained. The template of interviews includes: case study and personal background; learning in SDM project; and SDM projects' performance (see Appendix D). A framework analysis technique was used to analyse the interviews (Ritchie and Spencer 1994), while documents were analysed by using qualitative content analysis (Bryman 2008). A cross-case synthesis technique was used to analyse the four cases, since it is likely to be easier and the findings likely to be more robust when a case study consists of at least two cases (Yin 2008). The data analysis was designed to involve cross-case synthesis. Findings from the four case studies in both interviews and documents analysis were synthesised through cross-case identified CSFs and CI used in SDM projects.

1.4.4 Framework Design and Development

A framework for improving the SDM projects performance was developed based on the findings of the four case studies. Some guidelines were derived from the literature review and preliminary study, which also suggested a number of factors that should be involved in the improvement framework. The developed framework as illustrated in Chapter Eight (see Figure 8.2) comprises the three main components that influence the process of improvement of SDM projects performance as well as the expected performance improvement curve that results from the cumulative learning and experience. Chapter Eight presents a detailed account of the development of the improvement framework including purpose, structure and contents.

1.4.5 Framework Validation

The aim of the validation was to test how much of the framework is workable and could be adopted for improving SDM projects performance. The design of validation is discussed in Chapter Two. The validation was conducted through a workshop held in Saudi Arabia, in which the feedback on possible improvements to the framework was obtained from the stakeholders who had been involved in the case studies. The template of the validation workshop is included in Appendix E. This workshop aimed to seek stakeholders' feedback on the clarity, structure, content and legibility of the framework. Through the workshop, discussions were conducted involving nine key stakeholders and facilitated by the researcher. The implementation guide was presented to be followed for a better outcome and long-term success as illustrated in Chapter Eight (see Table 8.3). The framework was further refined based on the feedback received from the validation as shown in Figure 8.2. Chapter Eight presents the framework validation results in more detail.

1.5 CONTRIBUTION TO KNOWLEDGE

In the entirety of the research, the major achievement was to meet the aim of the research study in providing stakeholders involved in the SDM projects with a framework to improve the performance of SDM projects based on LL. The research provided an extensive review in terms of project performance improvement; project success criteria; classification of CSFs; learning and KM; the Saudi construction industry; the SDM production process and its current performance. It therefore identified the gap existing in knowledge with regard to project performance improvement in terms of SDM projects in Saudi Arabia. It also developed and validated an improvement framework for SDM projects based on the findings of four case studies.

More specifically, the research achievement in terms of contribution to knowledge can be summarised in the following points:

- a detailed review of current literature issues and gaps in knowledge on the project performance improvement;
- a detailed review of the literature on the Saudi construction industry and SDMs in terms of their production process, importance, anticipated benefits and current performance;
- a detailed assessment of stakeholders' perceptions of the subject through an in-depth investigation in the form of case studies including interviews and documentation;
- identification of a gap existing in knowledge with regard to CSFs, LL and KM related to repetitive/SDM projects;
- a framework development for improving the performance of SDM projects based on learning; and
- the significant indicators provided by the SMoI' experience which are that the construction industry would adopt a policy of standardisation of design and process to improve project performance and encourage the sharing of learning.

Significantly, it is recommended that the SMoI' experience should be adopted in Saudi construction sectors in both public and private sectors to help achieve an improvement for project performance. Additionally, this experience provided evidence that a standardised product could succeed in the field of construction and not just in other industries. The research outcomes were disseminated to the construction industry and academic peers through a number of publications as shown in Appendix A.

1.6 GUIDE TO THE THESIS

This thesis is divided into ten chapters. The layout of the thesis is illustrated in Figure 1.2. The following discussion describes the content of each chapter.

Chapter 1 discusses the background to the study and the research justification and states the aims and objectives of the study; highlights the adopted methodology, the research achievements and the contribution to knowledge.

Chapter 2 provides a detailed discussion of the overall research methodology, including the background to research and the research methodology, the research philosophy, the research approach, the actual research process including a literature review, a preliminary study, case studies, framework development and validation and limitations.

Chapter 3 presents a comprehensive literature review and a critical debate on construction project performance, critical success factors, project success criteria, different aspects affecting project performance and the tools used for improving project performance.

Chapter 4 presents a comprehensive literature review and a critical debate on the concept of learning, the learning curve, knowledge management and continuous improvement.

Chapter 5 explores the Saudi construction industry performance, the production process of SDMs' approach and the current performance of SDM projects.

Chapter 6 presents the preliminary study conducted in the context of SDM projects in Saudi Arabia. It covers the analysis and findings of the study which highlight the key issues affecting the performance of SDM projects.

Chapter 7 presents the findings and analysis of the interviews and documentation of the case studies.

Chapter 8 presents the development of the proposed framework for improving the performance of SDM projects and overviews and discusses the need for a framework. It presents and discusses the framework validation including its aims and objectives, approach, process, scope, limitations and results and features a discussion of its implications.

Chapter 9 presents a discussion of the research findings in the light of the literature review. It also discusses the development of the improvement framework.

Chapter 10 brings together the findings of the research and draws conclusions with specific reference to the research objectives. It also highlights the limitations of the research and makes recommendations for further research.

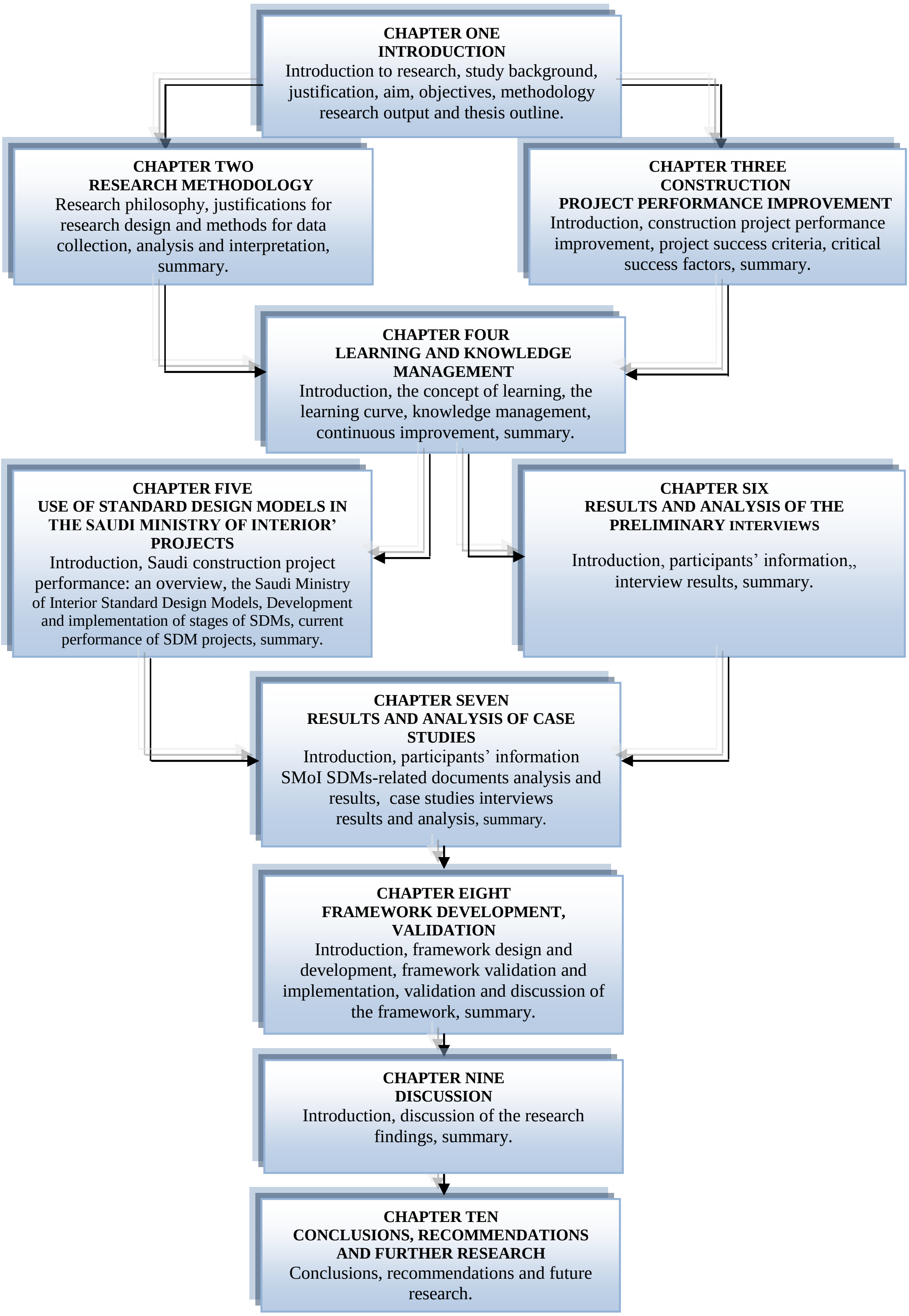

Figure 1.2: Thesis Layout

CHAPTER 2

2 RESEARCH METHODOLOGY

2.1 INTRODUCTION

Research has been described as an investigation into a problem that requires a solution based on a systematic and organised effort (Neuman 2006). Leedy and Ormrod (2005) described research as a way of increasing the understanding of a phenomenon through a systematic process of collecting, analysing, and interpreting information (data). On the other hand, they described research methodology as a way to extract meaning from data. Fellows and Liu (2008) defined research methodology as "*the principles and procedures of the logical thought process which are applied to a specific investigation*". Remenyi et al. (1998) suggested that the primary drivers for selecting a suitable research methodology are: the issue to be researched, the key research questions and the availability of resources. However, robust research must be rigorous, systematic, integrated and focused whatever the method selected (Peters and Howard 2001). This chapter presents the fundamental concepts and principles related to research methodology and outlines the strategy adopted for this research in order to achieve its aims and objectives. It also explains the justification for selecting the interviews and case study approach used for the research as well as the use of workshops as the framework for validation. In addition, the methods and techniques adopted for data collection, analysis and interpretation are also presented.

2.2 RESEARCH PHILOSOPHY

The meaning of philosophy is *the love of wisdom* derived from the Greek (Cavalier 1990). Ruona (2000) pointed out that philosophy involves thinking about questions, giving interpretations, trying out ideas and thinking of powerful arguments for and against and wondering how concepts indeed work. It also provides a framework for thinking, helps to develop areas of thinking and improves the alignment between what we think and what we do (Paul 1993; Honderich 1995). As Easterby-Smith et al. (2003) noted, there are three major crucial factors for understanding the philosophical issues of research: clarification of the research design; recognition of the suitable design and supporting the researcher in identifying the design or the value of other designs, particularly those that might have been excluded in his/her past experience. The two main philosophical positions of social research and, by extension, most construction management research, are ontological and epistemological considerations (Bryman 2008), which are discussed in more detail below.

2.2.1 Ontological Considerations

Ontology relates to the nature of reality and its characteristics (Creswell 2007). In this position, a researcher uses quotes and themes in the words of the participants and therefore, seeks to provide evidence of different perspectives and experiences. Grbich (2007) argued that ontology is related acquisition of knowledge about the nature of being and reality. Bryman (2008) indicated that ontological considerations are concerned with two positions: objectivism and constructionism. Objectivism asserts that social phenomena and their meanings depend on an existence independent of social actors. On the other hand, constructionism affirms that social phenomena and their meanings are continuously being achieved by social actors. Similarly, Fitzgerald and Howcroft (1998) indicated that there are two types of ontological position: the realist and the relativist. The realist position sees the external world as comprising hard and tangible structures that pre-exist independently of an individual's ability to acquire knowledge about them; it is considered practical and not concerned with an abstract or idealistic view of life. On the other hand the relativist position observes reality as being directed by socially-transmitted terms and varies according to language and culture. It holds to the multiple existences of realities as subjective constructions of the mind. In this view, concepts such as right or wrong, goodness and badness or truth and falsehood could differ from culture to culture and situation to situation.

2.2.2 Epistemological Considerations

In order to select the research design and analytical processes, it is important that the researcher is able to identify which of the epistemological traditions she/he has chosen to work within (Grbich 2007). Epistemological issues deal with questions of knowledge acceptability within a discipline. They are associated with "how we know" and the methods by which knowledge is acquired (Bryman 2008). However, epistemological positions fall into broad categories such as positivist or interpretivist (Love et al. 2002). With an epistemological assumption, researchers should try to get as close as possible to the participants being studied and stay longer in the field so as to understand the participants' issues (Creswell 2007).

Constructivism and interpretivism

According to Creswell (2007), the constructivism position is often combined with interpretivism. Therefore, meanings are formed through interaction with others through individuals' lives. Similarly, Grbich (2007) indicated that constructivism and interpretivism assume that there is no objective knowledge independent of thinking; therefore, knowledge is constructed jointly in interaction by the researcher and the participants, in contrast to objectivism and positivism. Fellows and Liu (2008) argued that reality is constructed and derived by observations and perceptions to identify truth and reality from the participants' collective perspective. According to constructivism and interpretivism, there is not only one reality, but multiple realities, so a collective mentality is constructed and that is likely to evolve over the course of time (Guba and Lincoln 1994). Creswell (2007) argued that in these positions, individuals seek understanding of the situation in which they live and work, in order to develop subjective meanings of their experiences that lead to certain objects or things. The variety and multiplicity of meanings leads the researcher to focus on the complexity of views instead of a few categories or ideas. In such a position, more open-ended questions are better, as the researcher listens carefully to the interviewee and also probes questions when necessary. Therefore, interpretation can be made through findings and also shaped by interviewees' experiences and background.

Grbich (2007) highlighted the major characteristics of constructivism and interpretivism, which are as follows:

- the research focus is on exploration of the way people interpret and make sense of their experiences in targeted situations to know the impact of these situations on constructed understandings;
- the researcher constructs and imposes understandings through interpretation which is limited by the frames derived from his/her experiences in these situations: and
- subjectivity and intersubjectivity depend on the researcher's constructed views and the reconstruction of views through interaction with others, which all are of interest.

Significantly, these positions are more likely to feature in qualitative studies (Royer and Zarlowski 2001; Creswell 2007; Grbich 2007; Fellows and Liu 2008; Bryman 2008).

2.2.3 Philosophical Position of this Research

This research was conducted within the context of SDM projects. This context consists of many stakeholders having different experiences, ways of thinking and backgrounds. Those stakeholders are classified as client, consultant and contractor and have a complexity of views. Therefore, multi-realities are derived through observations and perceptions to identify the truth and reality from the participants in the form of collective perspective and then fluid and changing and then knowledge is constructed jointly in interaction by the researcher and participants. Creswell (2007) argued that in such situations, more open-ended questions are better to enable the researcher to listen carefully and probe questions when necessary. Based on the aforementioned discussion, this research adopts constructivism as an ontological position and interpretivism as an epistemological position within an overall qualitative research philosophy.

Such a philosophy is justified by the existence of different perspectives among the stakeholders in the SDMs project approach. As mentioned above, a constructivist ontology and an interpretivist epistemology achieve the exploration of a situation and construct a full understanding about the situation which enables the researcher to provide an interpretation about the targeted phenomenon. They also provide a varied and multiple knowledge that leads the researcher to look for a complexity of views rather than narrow the search for knowledge to a few categories or ideas. Additionally, this research adopts a qualitative approach, and these positions are more likely to feature in the qualitative approach, which is dominant in the constructivism and interpretivism paradigms.

2.3 RESEARCH APPROACH

Bryman (2008) highlights the usefulness of distinguishing between quantitative and qualitative research. However, this distinction is seen to be ambiguous by some writers and is seen by others as no longer useful or even simply ‘false’ (Layder 1993). Similarly, Baumard and Ibert (2001) argued that the distinction between the two approaches is both equivocal and ambiguous as it is based on a multiplicity of criteria, none of which allow for absolute distinction. However, Bryman (2008) argued that quantitative and qualitative approaches represent different research strategies and each carries with it striking differences in terms of the role of theory, epistemological issues and ontological concerns. According to Bryman (2008), the connection between theory and research, epistemological considerations and ontological considerations - quantitative and qualitative research - can be taken to form two distinctive groups of research approaches, the differences between which are outlined in Table 2.1.

Table 2.1: Fundamental differences between quantitative and qualitative approach (Bryman 2008)

	Quantitative	**Qualitative**
Principle orientation to the role of theory in relation to research	Deductive; testing of theory	Inductive; generation of theory
Epistemological orientation	Natural science model, in particular positivism	Interpretivism
Ontological orientation	Objectivism	Constructivism

A research approach can be defined as a description of the way in which a researcher goes about doing the research, the particular style that is used and the different methods adopted. It has been referred to in the literature as the research method (Yin 2008). According to Yin (2008), the selection of an appropriate research approach should be identified on the basis of:

- The nature of the enquiry and the type of questions being posed;
- The extent of the investigator's control over the actual behavioural events; and
- The degree of focus on contemporary events.

Often, data and methodologies are inextricably interdependent. Therefore, the methodologies used for a particular research problem must always take into account the nature of the data that will be collected in the resolution of the problem (Leedy and Ormrod 2005). Furthermore, the decision taken to adopt any particular approach depends on the purpose of the study and the type and availability of information for the research (Naoum 2002).

The research approach is concerned with the types of evidence to be collected and the sources of such evidence, besides the process of interpretation used to obtain satisfactory answers to the questions being posed (Easterby-Smith et al. 2002). However, the commonest research approaches used in business and management research are categorised into qualitative and quantitative (Cooper and Emory 1995; Hussey and Hussey 1997; Baumard and Ibert 2001).

Although each of these methods differs in many respects, they can complement each other (Neuman 2006). A mixture of the qualitative and quantitative methods could be used and is referred to as triangulation.

2.3.1 Qualitative Research

Qualitative research can be defined as "*an inquiry process of understanding based on distinct methodological traditions of inquiry that explores a social or human experience*" (Creswell 2007). Qualitative research approaches follow an inductive approach in relation to theory and were originally evolved in the social sciences to enable researchers to study social and cultural phenomena. They further emphasise words instead of quantification in the collection and analysis of data (Bryman and Bell 2007). Qualitative research is subjective in nature and is exploratory and attitudinal (Frechtling and Sharp 1997) with researchers often depending on interpretive or critical social science and following a non-linear research path (Neuman 2006). They operate under the assumption that reality is not easily divisible into discrete, measurable variables (Creswell 2007). Qualitative researchers often begin their research by posing general questions rather than specific hypotheses, hence collecting vast amounts of verbal data from a small number of participants and organising it into a coherent form. Therefore they use verbal descriptions to depict the situation subjected to study (Leedy and Ormrod 2005). With its emphasis on people's 'lived experience', qualitative data are fundamentally suitable for locating the meanings people place on the events, processes and structure of their lives in terms of perceptions, assumptions, prejudgments and presuppositions (Amaratunga et al. 2002).

It has been realised that the language of the qualitative approach involves cases and contexts; and does not seek to represent data in quantitative form; but rather it seeks to analyse interaction; statements and transcripts with the intention of identifying patterns, links, beliefs and trends (Neuman 2006). According to Kaplan and Maxwell (1994), the purpose of understanding a phenomenon from the point of view of the participants and its particular social and institutional context is largely lost when textual data is placed in a quantified form. Similarly, Leedy and Ormrod (2005) pointed out that the qualitative approach "*is typically used to answer questions about the complex nature of a phenomenon, often with the purpose of describing and understanding it from the participant's point of view"*. Additionally, they indicated that *"The qualitative approach is also referred to as the interpretative,* *constructivist, or postpositivist approach.*" A small number of, usually non-representative, cases but with focussed samples are used and respondents are selected to fulfil a given requirement (Sherif 2002). Accordingly, Bryman (2008) argued that a qualitative research approach might be adopted when:

- there is no existing research data on the topic and the most appropriate unit of measurement is not certain; and
- the concepts to be researched are assessed on a nominal scale, with no clear demarcation and involve exploring behaviour or attitudes.

Perry (1994) indicated that qualitative research is exploratory in nature, and tends to attempt to deduce answers to 'how? and why?' questions. Therefore, he argued that a major issue was the identification of what variables are involved in the question, and advised that a case study methodology tends to be adopted. Furthermore, Creswell (2007) focused on the situations in which the researcher selects the qualitative approach as an appropriate approach, these include:

- When the problem or issue needs to be explored;
- the need for a complex, detailed, understanding of the issue;
- the need to empower individuals to share their stories, hear their voices, and minimise the power relationships that often exist between a researcher and participants in a study;
- to write in a literary, flexible style that conveys stories without the restrictions of the formal, academic, structures of writing;
- to understand the context or settings in which the participants in a study address a problem or issue;
- to follow up quantitative research and help explain the mechanisms or linkages in causal theories or models;
- to develop theories when partial or inadequate theories exist for certain populations and samples or existing theories do not adequately capture the complexity of the problem that is being examined;
- it is used because the quantitative measures and statistical analyses simply do not fit the problem; and

- it is simply a better fit for the research problem.

Bryman (2008) argued that the main steps involved in qualitative research, which are represented in Figure 2.1, are non-linear and the research questions are often driven by theoretical issues, which in turn drive data collection and analysis.

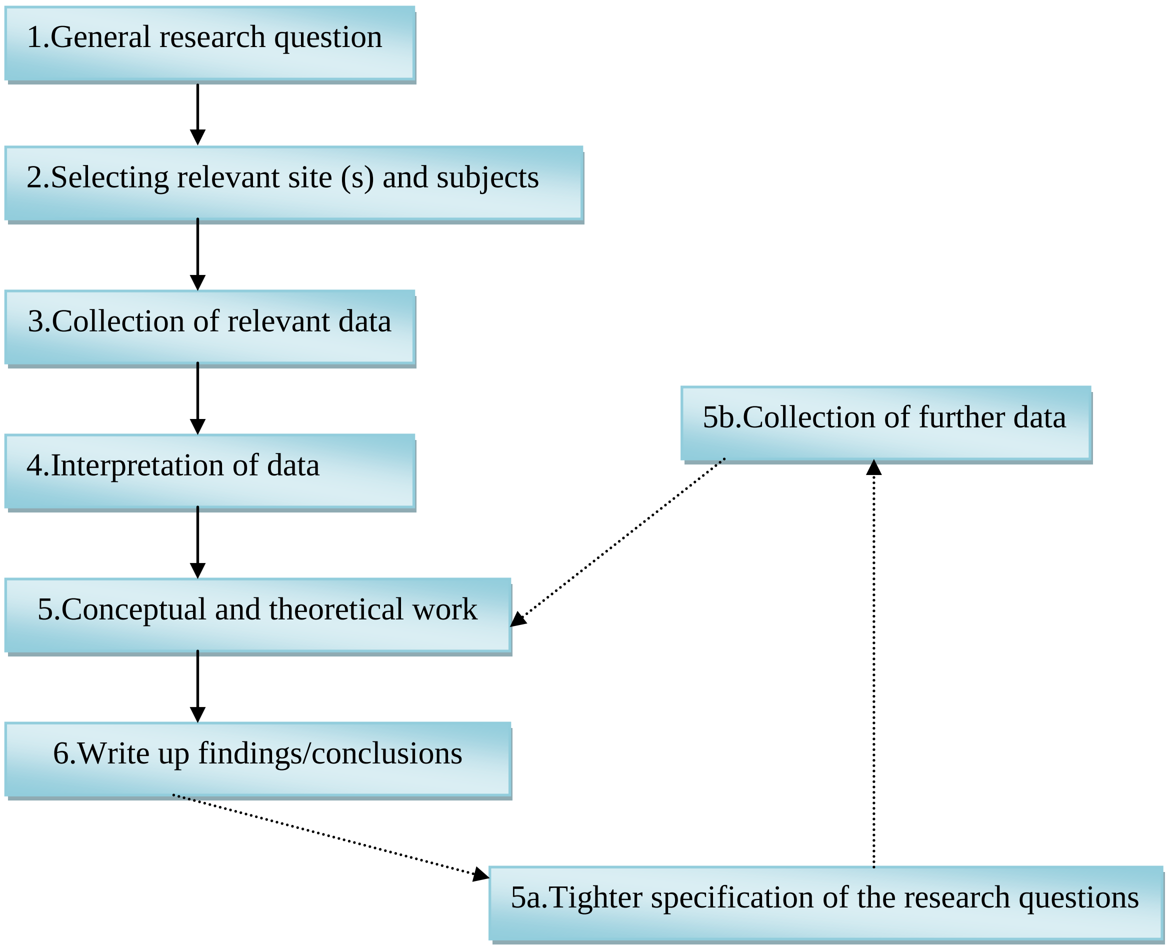

Figure 2.1: Outline of the qualitative process (Bryman 2008)

However, qualitative research has been criticised by some researchers; including Bryman and Bell (2007) who identified the following limitations:

- *Limited generalisation capability*: limited capability to generalise the research findings due to the sample sizes and sampling methods used in qualitative research.
- *Too subjective*: there is a weakness in the strength of the deeper understanding provided by the qualitative approach, which limits confidence in the results.

- *Difficult to replicate:* limitation in terms of replication by other researchers. For example, what one researcher might focus on might not be the focus of another researcher.
- *Lack of transparency*: the process of collecting and analysing qualitative data is sometimes difficult to establish and can lack clarity.

The qualitative approach depends on three types of collected data: interviews; direct observations; and written documents. These yield quotations, descriptions and excerpts which are either unstructured or semi-structured (Patton 2002).

2.3.2 Quantitative Research

Quantitative research can be defined as "*an investigation that is related to positivism and seeks to gather factual data and to study relationships between facts and how such facts and relationships accord with the theories and findings of previously executed research*" (Fellows and Liu 2008). Quantitative research methods originally evolved in the natural sciences to study natural phenomena. Leedy and Ormrod (2005) pointed out that quantitative research is used to answer questions about relationships among measured variables with the purpose of explaining, predicting and controlling phenomena. This approach is sometimes called the traditional, experimental or positivist approach. Quantitative research follows a deductive approach in relation to theory and is concerned with design, measurement and sampling. The approach follows the practices and norms of the natural scientific model. Positivism particularly views social reality as an external, objective reality. It employs the use of mathematical and statistical techniques to identify facts and causal relationships (Naoum 2002). Moreover, the quantitative approach is objective in nature and based on testing a hypothesis or theory that is composed of variables (Fitzgerald and Howcroft 1998; Naoum 2002). According to Naoum (2002), the quantitative research approach is selected for:

- finding facts about a concept, a question or an attribute; and
- collecting factual evidence and studying the relationships between the facts in order to test a particular theory or hypothesis.

Nevertheless, in addition to finding facts, it provides considerable evidence when it is used to evaluate perceptions about a concept or an attribute. As shown in Figure 2.2, Bryman (2008) highlighted the major steps followed in quantitative research and emphasised that these represent an ideal account of how research should progress. He, however, argued that despite research being rarely linear, as depicted in Figure 2.2, it provides a rough indication of the interconnections between the main steps in quantitative research.

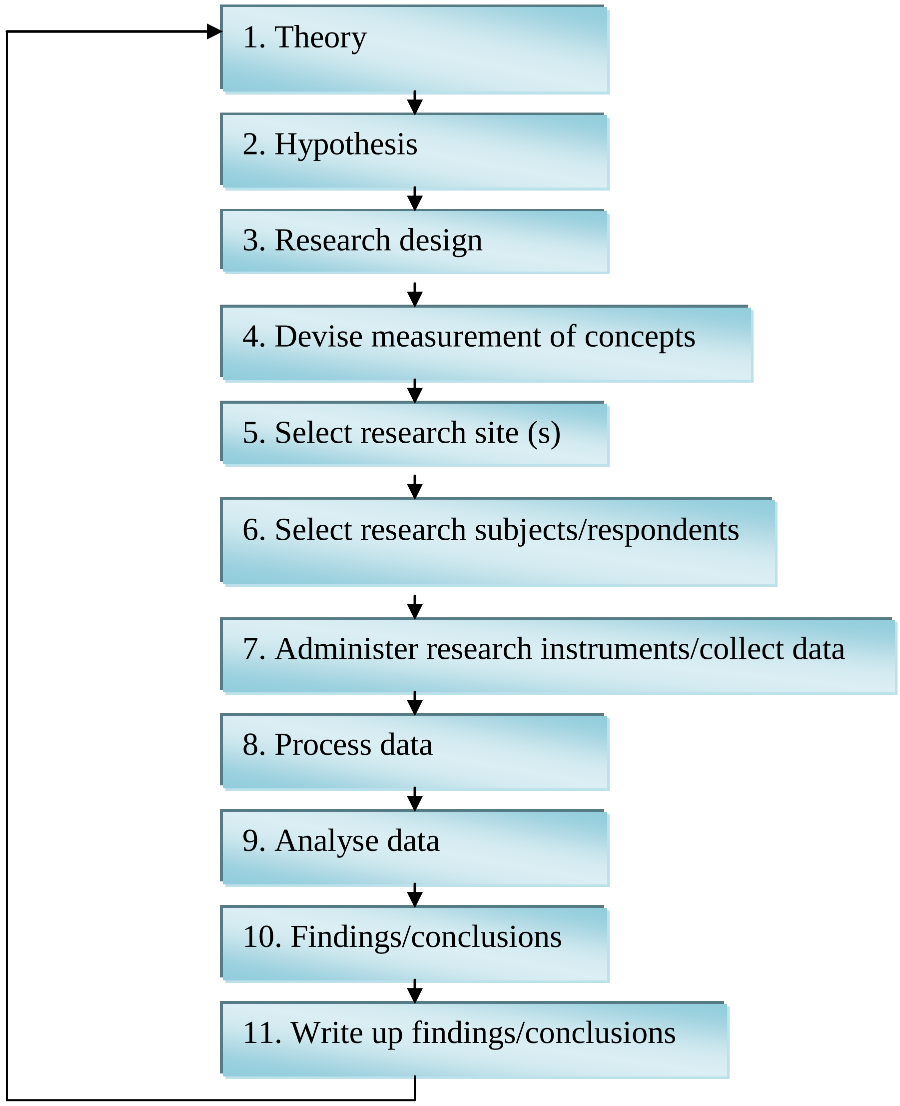

Figure 2.2: Quantitative research process (Bryman 2008)

Although used extensively, quantitative research has been criticised by the research community. These criticisms were outlined by Bryman (2008) as follows:

- failure to distinguish between people and social institutions from the natural world;
- involvement of an artificial measurement process and a sense of precision and accuracy not proceeding from a true or claimed source;

- reliance on instruments and procedures that hinders the connection between research and everyday life; and
- creation of a static view of social life that is independent of people's lives when analysing the relationships between variables.

Additional criticisms in relation to the limitations of quantitative research have been outlined by Bryman and Bell (2007) as follows:

- *Sampling limitation*. A sample by its nature cannot be identical to its population, and thus poses a limitation in terms of generalising results and research outcomes.
- *Non-response limitation*. The rate of non-response can affect how well the sample represents its population, and thus affect the possible generalisation of results.
- *Data collection errors*. Some limitations and errors are associated with how data is collected, for example, ambiguous questions or differences in responses arising from different data collection methods.
- *Data processing errors*. The large amount of data in quantitative analysis can lead to data processing errors.

2.3.3 Triangulation

The idea of triangulation refers to the combination of approaches in the study of the same phenomenon (Amaratunga et al. 2002). Triangulation entails using more than one method or source of data in the study of social phenomena (Bryman 2008). Baumard and Ibert (2007) argued that the combination of qualitative and quantitative approaches is a practical way for researchers to proceed. This involves combining the two approaches simultaneously in order to gain advantage from their respective qualities. According to Love et al. (2002), triangulation means that representation based on logic helps to gain a vivid picture by making multiple measurements, adopting multiple methods, or investigating at multiple levels of analysis. Typically, the triangulation process is built on corroborating evidence from different sources to shed light on a theme or perspective (Creswell 2007). Jick (1979) argued that triangulation provides an opportunity for the researcher to benefit from the multi–advantages of the two approaches, avoiding any possible defects of one approach by using the qualities of the other. Similarly, Fellows and Liu (2008) pointed out that triangulated studies employ two or more research techniques; qualitative and quantitative approaches may be employed to reduce and eliminate the disadvantages of each individual approach whilst gaining the advantages of each, and of the combination. The adoption of qualitative and quantitative techniques jointly to study the topic can be very useful to obtain clear insight and results, to assist in making inferences and as a means of drawing conclusions, as illustrated in Figure 2.3.

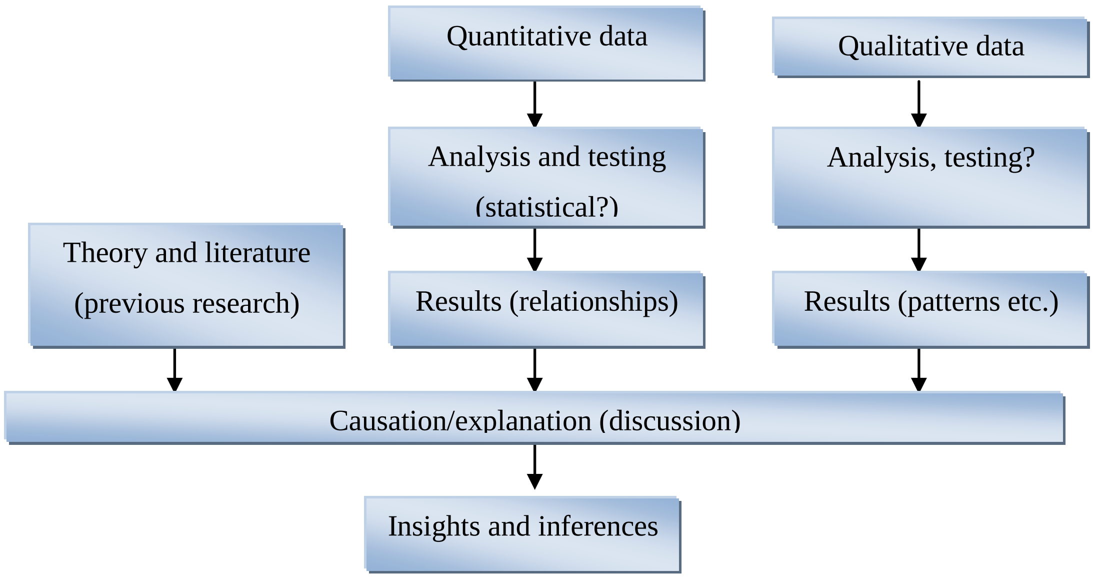

Figure 2.3 Triangulation of quantitative and qualitative data (Fellows and Liu 2008)

According to Easterby-Smith et al. (2002), there are four distinct categories of triangulation, namely:

- *Theoretical triangulation,* involving borrowing of models from one discipline and using them to explain situations in another discipline;
- *Data triangulation,* where data is collected over different time frames or from different sources;
- *Investigator triangulation*, where different people collect data on the same situation, and the results are then compared; and
- *Methodological triangulation* using both quantitative as well as qualitative methods of data collection such as questionnaires, interviews, telephone surveys and field study.

Moreover, Love et al. (2000) argued that the combination of qualitative and quantitative approaches involves two main advantages: the capability of providing the knowledge in a tangible form is increased and congregation of findings can provide greater researcher confidence in the reliability and/or validity of the results. Divergence, on the other hand can lead to greater definition and theoretical elaboration as the researcher attempts to put the many pieces of a complex puzzle together into a coherent picture. Formalising the problem along two complementary axes provides triangulation strategies that aim to improve the precision of both measurement and description (Baumard and Ibert 2007). Furthermore, Abdullah (2003) indicated that triangulation might lead to a better understanding of the phenomena under investigation by revealing additional information that would otherwise remain undiscovered via a single methodological approach.

However, Yin (2008) noticed that the researcher could face two main problems when implementing triangulation in any research. Firstly, collecting data from a single source would be less expensive compared to collecting data from multiple sources. Secondly, the investigator needs to know how to carry out the full variety of data collection techniques. This is particularly significant, since if the research techniques are used improperly, the possibility of addressing a broader array of issues or launching converging lines of inquiry may be lost. In order to clarify the distinctions between qualitative and quantitative approaches, Table 2.2 summarises these distinctions based on a number of characteristics.

Table 2.2: Differences between quantitative and qualitative research approaches (Leedy and Ormrod 2001; Amaratunga et al. 2002; Abdullah 2003; Neuman 2006)

Characteristics	Qualitative research	Quantitative research
Purpose	• To describe and explain • To explore and interpret • To build theory.	• To explain and predict • To confirm and validate • To test theory.
Objective	• Study issues in-depth and detail and seeks to gain insight and understand people's perceptions.	• Gather factual data and study relationships between facts and relationships in accordance with theory.
Theory	• Theory can be causal or non-causal and is often inductive – concerned with development of theory from specific instances.	• Theory is largely causal and is deductive - associated with verification of theory and hypothesis testing.
Process	• Holistic • Unknown variables • Flexible guidelines • Emergent design • Context-bound • Personal view.	• Focused • Known variables • Established guidelines • Statistic design • Context free • Detached view.
Research Procedures	• Research procedures are particular, and replication is very rare.	• Procedures are standard, and replication is frequent.
Data Collection	• Informative, small sample • Observations, interviews, documents.	• Representative, large sample • Standardized instruments –questionnaires, laboratory experiments, etc.
Data characteristics	• Soft data, descriptive, less structured, analysed using non-statistical methods.	• Hard data, structured, large sample size, analysed using statistical methods.
Data Analysis	• Analysis proceeds by extracting themes or generalisations from evidence and organising data to present a coherent, consistent picture.	• Analysis proceeds by using statistics, tables, or charts and discussing how what they show relates to the hypothesis.
Reporting Findings	• Words • Narratives, individual quotes • Personal voices, literary style.	• Numbers • Statistics, aggregated data • Formal voice, scientific style.
Outcome	• Exploratory and/or investigative and findings are contextual.	• Conclusive findings used to recommend a course of action.
Strengths	• Data gathering methods seen as natural rather than artificial • Ability to look at a change process over time • Ability to understand people's meaning • Contribute to theory generation.	• Provide wide coverage of the range of situations • Fast and economical • Where statistics are aggregated from large samples, they may be of considerable relevance to policy decisions.
Weaknesses	• Data collection can be tedious and require more resources • Analysis and interpretation of data may be more difficult • Harder to control the pace, progress and end-points of the research process.	• Tend to be rather inflexible and artificial • Not very effective in understanding a process • Not very helpful in generating theories.

2.3.4 The Adopted Research Approach

The above review of qualitative and quantitative research approaches identifies the characteristic of each approach and their limitations. As mentioned before, this research adopted the constructivism ontological and interpretivism epistemological positions as an appropriate philosophy. There were four major reasons for this decision.

Firstly, this study focused on exploration into the background and experiences of the stakeholders involved in SDM projects. Only a qualitative approach permits the investigation of multiple realities that lead to subjective knowledge. Secondly, the nature of SDM projects is complex since it is a new phenomenon, there is no existing data about this phenomenon, and a number of stakeholders are involved. Therefore, the study aimed to cover issues in depth and involved detailed rather than superficial descriptions. The qualitative approach was necessary in order to gain real insights and so fully appreciate and understand the attitudes and behaviours of the stakeholders involved in the SDMs project environment. Thirdly, the research focused on understanding the issues affecting the performance of SDM projects from the point of view of those stakeholders in the form of words rather than in quantified form. Finally, the research did not involve the creation or consequent testing of a hypothesis or theory, which are associated with the quantitative approach as identified by Bryman (2008).

Accordingly, this research is subjective in nature and is exploratory and attitudinal, resulting in understanding and interpretation coming from the researcher's own frame of reference. As a result and in the light of the aforementioned literature and within the domain of SDM projects, the qualitative approach is the appropriate choice for this research.

2.3.5 Research Design

Once the appropriate approach to be adopted was identified, which was in this case the qualitative approach, the next stage was the research design. There are a number of research designs that could be used by researchers in addressing questions posed in both social science and construction management research (Blismas 2001). These include: experiment; survey; action research and case study. Similarly, Fellows and Liu (2008) and Naoum (2002) discussed five styles: action research; ethnographic research; surveys; case study and experiment. However, there are five most common research strategies: experiment, survey, archival analysis, history and case study as shown in Table 2.3.

Table 2.3: Research Strategies versus Characteristics (Yin 2008)

Strategy	Form of Research	Requires Control of Behavioural Events	Focuses on Contemporary Question?
Experiment	How, Why?	Yes	Yes
Survey	Who, What, Where How Many, How Much?	No	Yes/No
Archival Analysis	Who, What, Where How Many, How Much?	No	Yes/No
History	How, Why?	No	No
Case Study	How, Why?	No	Yes

According to Bryman (2008), research design is used to provide a framework for collecting and analysing data. Fellow and Liu (2008) indicated that, to ensure that the research maximises the chance of realising its objectives, it must take into consideration the research questions, determine the required data, and identify an appropriate analysis method. Similarly, Royer and Zarlowski (2001) argued that the design stage represents the approach the researcher will follow and the essential methodological choices made by the researcher including the data collection and analysis methods and the observational field. They argued that the design stage guides the course of research and helps avoid at least some of the barriers that emerge in the latter stages of research. Sekaran (2003) detailed that research design should involve a series of rational decision-making choices, relating to decisions regarding the purpose for the study (exploratory, descriptive, hypothesis testing), its location (i.e., the study setting), the type of investigation, extent of researcher interference, unit of analysis, and the time horizon.

As identified above, the adopted approach in this research is the qualitative approach. In this regard, many studies have covered qualitative research design. Grbich (2007) indicated that there are many research designs/approaches in qualitative research, such as, ethnography, grounded theory, and phenomenology. Similarly, Leedy and Ormrod (2005) and Creswell (2007) identified five common qualitative research designs including: case study; ethnography; phenomenological; grounded theory; and content analysis. To produce robust data there is a need for a structure that guides the execution of the technique for gathering and subsequently analysing data. It is, therefore, the overall framework within which the research method is employed. The purpose of doing this is to enable the researcher to connect empirical data to conclusions in a logical sequence beginning with the initial research question of the study (Bryman 2008; Yin 2008). Noticeably, the essence of the options available to organisational research and construction management is largely unstructured, variable and formulated (Fellows and Liu 2008; Yin 2008). Nevertheless, the choice of research design should reflect decisions about the dimensions of the research process, as importantly identified by Bryman (2008) who emphasised the importance of addressing the following points:

- Expressing causal conclusions between variables;
- generalising to larger groups of individuals than those actually forming part of the investigation;
- understanding behaviours and their meanings in a specific social context; and
- having a temporal (i.e. over time) appreciation of social phenomena and their interconnections.

According to Yin (2008), the research strategy should be chosen as a function of the research situation. As clarified in Table 2.3, there are different types of research strategy, each having its own specific approach to collect and analyse empirical data, and therefore, each strategy has its own advantages and disadvantages. Yin (2008) stated three conditions for adopting each strategy, these are: the type of research question posed; the level of control an investigator has over actual behavioural events; and the degree of focus on contemporary as opposed to historical phenomena. Fellows and Liu (2008) argued that the choice of research strategy is affected by the scope and depth required for study, with the researcher choosing to adopt either a broad but shallow study using questionnaires or a deep but narrow study using a case study and interviews.

According to Hamel (1993) the case study is considered as a part of the inductive approach, where the empirical details that represent the object of study are regarded in the light of the particular context. However, Yin (2008) stated that a researcher can adopt a case study as a preferred strategy when he/she meets three situations: "how" or "why" questions are being posed, the investigator has little control over events, and the focus is on a contemporary phenomenon within some real-life context. This is in line with the situation of this research.

In addition, Yin (2008) identified four different applications for case studies. First, to explain the causal links in real-life interventions that are too complex for a survey or experimental strategies. Specifically, case studies strive to explain the particular case at hand with the possibility of coming to broader conclusions. The second application of case studies is to describe the real-life context in which intervention has occurred. Third, a descriptive case study of an intervention can serve as an assessment tool. Finally, the case study strategy may be used to explore those situations in which the intervention being evaluated has no clear, single set of outcomes. This means that case studies can be useful for theory generation while the natural science approach is usually used for theory testing. This is in line with this research which aims to develop an improvement framework.

This research adopted the case study as a research strategy, due to a number of reasons that agree with the rationale discussed within the literature of using case studies. These reasons are acceptable to justify the adoption of case study strategy. They include: the situation in SDM projects requires us to pose the questions “why” and “how” in order to identify the issues affecting the performance of SDM projects and therefore, provide the ways of improving performance. Another major reason is that not only was there little information about this phenomenon, but there was no information due to this being a contemporary phenomenon within a real-life context. As mentioned in the literature, the explanation of causal links in real-life interventions is considered too complex for conducting surveys or experiments. In contrast, the adoption of case studies strives to explain the particular case at hand with the possibility of bordering conclusions, and this could be achieved in such SDM projects due to the typicality of projects. Additionally, the aim of this research is to develop a framework for improving the performance of SDM projects. In this regard, a case study is an inductive approach which is considered useful for generating a theory or a theoretical framework, where all theories and theoretical frameworks are based initially on a particular case or object.

2.4 ACTUAL RESEARCH PROCESS

Research is considered a dynamic process, therefore, it has to be flexible – implying, though not requiring, that a contingency approach will be helpful. *“A process approach to research is oriented towards change and development”* (Bhagat and Kedia 1996). The questions in this research were derived from exploratory interviews and an in-depth literature review.

Accordingly, a relevant theoretical background was formed to undertake the research. The research was conducted in three stages, shown in Figure 2.4 and explained in the following sections.

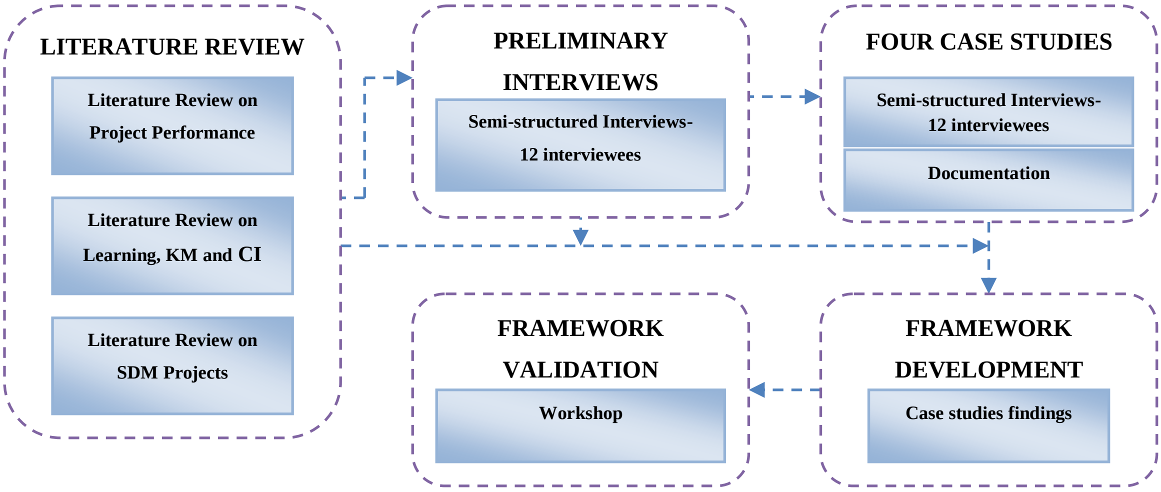

Figure 2.4: The Actual Research Process

2.4.1 Literature Review

Literature review is a task that should review established theories, findings from other research and particular applications of theory (Fellows and Liu 2008). The literature review is a clear and logical presentation of the relevant research work done thus far in the area or topic of research. The literature review aims to identify and highlight crucial variables and to document the significant findings from previous research in order to build a theoretical formulation in which contemporary issues and gaps in knowledge could be identified in project performance improvement (Sekaran 2003). Leedy and Ormrod (2005) identified that literature describes theoretical perspectives and previous research findings regarding the problem at hand; it also looks at what others have done in relevant areas. The literature review in this research (as discussed through Chapters, Three, Four and Five) covered these topics: tools used for improving for project performance; construction project performance; Critical Success Factors (CSFs); learning and knowledge management and an overview of the Saudi construction industry, as well as SDM projects in terms of the process of producing these models and the current performance of SDM projects. The review essentially served three main roles:

- it provided a solid foundation for this research by throwing light on all relevant issues;
- it made the contemporary issues clearer while highlighting the gaps in knowledge and practice; and
- it acted as a basis for the formulation of the proposed improvement framework.

2.4.2 Preliminary Interviews

Preliminary data collection aims to highlight potential research issues and areas and, therefore, obtain general feedback on major research issues (Sekaran 2003). Additionally, when not much is known about the situation at hand, or no information is available on how similar problems or research issues have been covered in the literature, a preliminary study needs to be conducted to obtain familiarity with the phenomena in the situation, and understand the current status before setting up a rigorous design for comprehensive investigation. Gray (1981) argued that work undertaken relating to preliminary data yields a useful starting point for research. Little has been published in the area of SDM projects performance in the Saudi Construction Industry. Consequently, a preliminary investigation was conducted to address the literature gap on the one hand, and to act as a precursor for the in-depth case studies of this research. Preliminary interviews were conducted in the context of SDM projects to identify the current issues and problems related to its performance. Furthermore, the interviews aimed to explore the understanding and perceptions of stakeholders involved in SDM projects concerning SDM projects' performance, and to explore how LL from the SMoI completed projects were being used to improve performance.

Four SDM projects were selected, comprising two completed and two ongoing projects. For each project, qualitative semi-structured interviews were held with the client representative, consultant and contractor; resulting in a total of twelve interviews. The semi-structured nature of the interview technique enabled researchers to allow the interviewees to elaborate on any topic, but required all predetermined topics to be covered (Love et al. 2002). As such, interviewees became "informers" (Yin, 2008). Additionally, it enabled the researcher to have some sense of the themes that they wished to explore, and set out the key topics and issues to be covered during the interview (Ritchie and Lewis 2009). It has sufficient flexibility in that the topics are able to be covered in the order most suited to the interviewee; responses can be fully probed and explored; and the researcher can be responsive to relevant issues raised spontaneously by the interviewee. Therefore, it enables the researcher to probe for further insights and clarification while maintaining some structure in the views collected. The interview questions were formulated to provide comprehensive information about the SDMs in terms of personal background, project background, project success criteria, and key ways of improving project performance (see Appendix C).

The sampling method used for this preliminary study was purposive and selected from participants representing the client, consultant and contractor involved in the Standard Design Models (SDMs) adopted by the Saudi Ministry of Interior (SMoI). Ritchie and Lewis (2009) argued that qualitative research uses non-probability samples for selecting the population for study, which are deliberately selected to reflect particular features of, or groups within, the sampled population. Therefore, the characteristics of the population are used as the basis of selection, which makes them well suited to small-scale, in-depth studies. Similarly, Mason (2002) and Patton (2002) indicated that in qualitative research, the selection of sampling units of the participants is criterion-based or purposive, in line with Bryman (2008). This is because they have particular features or characteristics which enable detailed exploration and understanding of the central themes and puzzles which the researcher wishes to study. These characteristics may relate to specific experiences, behaviours, or roles.

Accordingly, the participants were selected based on three scales: their experience in the field of SDM projects, their qualifications and their position. With regard to projects, four projects were selected; two of them were completed projects and two ongoing projects. The choice was based on: repetitive models and same category, making comparisons between completed and ongoing projects to measure the knowledge gained, procedures adopted for project management and how much project improvement had been achieved over time. Given the need for in-depth information and the time constraints, the study focused mainly on experienced participants who had a minimum of seven years within the construction sector. The next stage involved the identification of the target participants, initial communication, and final scheduling of interviews. Each interview lasted an average of 50 minutes, and the key questions were repeatedly asked to all interviewees. The conclusions from the interviews formed the basis for the selection of case study projects. Preliminary study results are presented and discussed in Chapter 6.

2.4.3 Case Studies

A case study is an empirical inquiry used to investigate a contemporary phenomenon within a real-life context where the boundaries between this phenomenon and the context are not clearly evident and in which multiple sources of evidence are used (Yin 2008). Similarly, Fellows and Liu (2008) indicated that a case study is an in-depth, empirical investigation of particular instances within the research subject. Case study research is comparatively flexible and contextual and emphasises exploration instead of prediction; thus, the researcher can find out and address the issues as they arise in the course of the research (Becker et al. 2005). The basic form of a case study entails the detailed and intensive analysis of a single case (Bryman 2008). A case study is concerned with all the complexity and particular essence of the case in question, and can also comprise a number of cases (Stake 1995). Creswell (2007) indicated that case study research involves the study of an issue explored through one or multi-cases within a bounded system (i.e. a setting; a context). Additionally, case study research is considered as a qualitative approach in which the researcher explores a case or cases over time, through detailed, in-depth data collection. Leedy and Ormrod (2005) argued that through a case study, a particular individual, programme, or event is studied in depth for a defined period of time. Moreover, in particular, a case study is a suitable methodology for learning more about a little known or poorly understood situation. It may also be considered a useful methodology for investigating the magnitude of changes achieved in a programme over time. Sekaran (2003) stated that case studies involve in-depth, contextual analysis of similar situations in other organisations, where the nature and definition of the problem occurring is to be the same as that experienced in the current situation.

Eisenhardt (1989) argued that case studies are considered as a combination of data collection methods such as archival searches, interviews, questionnaires and observation. Creswell (2007) indicated that a case study enables the researcher to explore through detailed, in-depth data collection based on multiple sources of information such as, observations, interviews and documents. Additionally, Johnston et al. (1999) asserted that the adoption of case study research enables the researcher to use extensive sources of data within the organisation. In this regard, Hamel (1993) emphasised that a theory or theoretical framework first emerges through the inductive approach of studying an empirical case or object, not through a deductive process. He further confirmed that all theories are initially based on a particular case or object. Eisenhardt (1989) indicated that the case study method’s in-depth style and the use of different methods frees the researcher from the shackles of strict procedure, unfreezes thinking and increases the likelihood of generating novel theory.

Although a case study approach was considered to be most appropriate, it has been criticised (Yin 2008; Bennett 1997) mainly for:

- *Lack of rigour* - This is due to the lack of systematic procedures and approach in carrying out the case study (Yin 2008). As a result, sometimes a case study approach is regarded as a time consuming approach which produces unreadable reports (Yin 2008). This shortcoming can be addressed or reduced through better research design, and the execution of the case study in accordance with the design;
- *lack of basis for generalisation* - The conclusion drawn by the case study approach is often criticised for the lack of representativeness as normally only a few cases are conducted for the study of a wide range of variables (Bennett 1997). Hence, it is unable to generalise in order to represent a wider and more diverse population. However, Bennett (1997) argues that the intention of conducting a case study is to seek only 'contingent' generalisations that apply to cases that are similar to those studied, rather than apply universally. Leedy and Ormrod (2005) argued that the use of two or more cases is to make comparisons, build theory or propose generalisations, and this approach is called a multiple or collective case study, in line with Yin (2008). Nevertheless, problems of validity also exist in strictly quantitative methods as the issue of validity in case studies deserves attention (Stake 1995). Therefore, the validity of the findings of this approach is not affected; and
- *selection bias* – Selection bias happens when researchers select cases that represent a truncated sample along the dependent variable of the relevant study of universe (Bennett 1997). As a result, the conclusion drawn from the study may be biased and the views obtained may be truncated as well. To avoid this problem, the case study stakeholders selected should comprise an appropriate mix of stakeholders with different backgrounds or roles.

2.4.3.1 Case study design

The case study approach comprises a detailed investigation that attempts to provide an analysis of the context and processes involved in the phenomenon under study (Johnston et al. 1999). Blumberg et al. (2005) identified two main types of case study research: single and multiple case studies. A number of categorisations are suggested by researchers to distinguish between various types of case study (see Stake 1995; Yin 2008; Hakim 2000). The case studies in the context of this research fall under the categories of:

- Descriptive case study (Yin 2008), as it attempts to present a complete description of a phenomenon (i.e. the study of various types of reusable project knowledge, the current practice and requirements for knowledge capture and reuse) within the context of construction organisations; and
- Collective case study (Stake 1995), since each case study conducted covers several cases. This means that a 'multiple-case' design was adopted for the case study (Yin 2008).

Significantly, the looseness of case research is considered as one of the problems related to this strategy. Yin (2008) suggested that to combat this looseness, a protocol should be established that outlines the procedures and general rules that will be employed during data gathering. The procedures should provide an overview of the project, definitive data collection procedures and the instruments that will be used for data collection. Therefore, this protocol establishes a framework for collecting and analysing data. The protocol is a major tactic in increasing the reliability of case study research and it is intended to guide the researcher in conducting the case study. In turn, well-designed steps of protocols ensure that the operations of the study can be repeated with the same results. In this regard, Johnston et al. (1999) argued that there are four important considerations when developing a case study protocol:

- *Defining the unit of analysis*: The unit of analysis is a crucial feature for the adoption of the case study method. Choosing the unit of analysis helps the researcher to articulate the conceptual frame of reference and encourages proposition development. Fellows and Liu (2008) noted that the unit analysis of the case study has to be clear. Yin (2008) stressed that the unit of analysis comes as one of the components related to the fundamental problem of defining what the "case" is - a problem that has plagued many researchers at the outset of case studies. McClintock et al. (1979) stated that the units of analysis can be defined as individuals, groups, or organisations and they also could be almost any activity, process, feature, or dimension of organisational behaviour.

- *Case selection*: There are some cases in which a single-case study should be conducted (e.g. a critical case, a rare case, or a unique case) (Yin 2008). When the researcher uses a single-case study design, he/she makes an extremely strong argument in justifying this choice. Crucially, multiple-case studies should be selected so that they replicate each other through either direct replications or predictably systematic replications, and thus are more compelling and make the overall study more robust. Therefore, analytic conclusions independently arising from multiple-case studies will be more powerful than those drawn from a single-case study.
- *Data collection*: Significantly, prior to starting the data collection, a systematic plan must be developed that stipulates what information is to be sought to fully investigate the research hypotheses and how it is to be gained. In this regard, Yin (2008) asserted the use of a "study protocol" which systematically documents all decisions pertaining to the research design, and includes the set of substantive questions reflecting the actual inquiry. Further details related to data collection techniques that were employed in this research are explained in the next section.
- *Data analysis*: The analysis of case study research is an important stage, where it represents assessing whether or not the evidence within each case study is internally valid, supportive of the pre-specified hypotheses across the multiple-cases, and conclusive. Nevertheless, the preferred strategy for data analysis is to use the propositions that encapsulate the objectives of the research, and which have shaped the data collection.

The robustness of the choice of research design plays a vital role in its quality. This is because the research design is assumed to represent a logical set of statements and the quality of any given design can be judged in accordance with certain logical tests (Yin 2008). Four tests are common to all social science methods:

1. Constructive validity: establishment of the correct operational measures used for the concepts being studied;
2. Internal validity: establishment of a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from incorrect relationships;
3. External validity: establishment of a domain to which a study's results can be generalised; and
4. Reliability: demonstration that the operations of a study can be repeated to give the same results.

This research was based on selecting four case studies using four repetitive projects. The case studies investigated practices leading to SDMs performance improvement within the four case studies by questioning the project managers who participated in the interviews. The choice of the case study approach is explained below.

2.4.3.2 Multiple-case studies

To fulfil the objectives (see Chapter One) proposed by this study, multiple-case studies were undertaken. A case study adopts a variety of data collection techniques during a specific period in order to study a single research case. In general, case studies are adopted widely in social science as well as the practice-oriented fields of construction engineering, management science and education. As discussed through research design, case studies are the preferred and appropriate strategy to be adopted in this research. Love et al. (2002) stated that by adopting case studies the researcher can better understand phenomena that influence organisational and project performance in construction. However, multiple-case design involves replication logic not sampling logic. In this regard, Yin (2008) strongly emphasised the importance of the distinction between multiple cases and multiple respondents in a survey. Structured and standardised processes, collection and methods of analysis were used for cross-case comparisons due to the need to standardise the cases by replication logic (Tellis 1997; Bryman 2008; Yin 2008). According to Yin (2008), the replication approach to multiple-case studies involves a three-stage process to help guide case research. This process includes the define and design stage; the collect and analyse stage; and the analyse and conclude stage. The process starts by designing the study, which must consist of theory development, and shows that case selection and the definition of specific measures are important steps in the design and data collection process. This multiple-case studies approach will help support the construct validity of the research design. Perry (1998) suggested that the ideal number of multiple-case studies is between four and ten cases.

Additionally, the number of cases included in a multiple-case study often gives strong evidence and the overall study is therefore considered as being more robust (Herriott and Firestone 1983). Furthermore, results are tangible and so suitable for generalisation. A multiple-case design is preferred to a single-case design as the views obtained from the latter are restricted to a single organisation or case (Galliers 1985). With fewer than four cases, it is often difficult to generate theory with much complexity, and the empirical grounding is likely to be unconvincing. Furthermore, analytical conclusions from more than one case study will be more substantial and powerful than those coming from a single case alone (Yin, 2008). In turn, this research used a multiple-case studies approach that incorporates qualitative comparators within four Police Department (PD), PD-SDM projects, as shown in Figure 2.5.

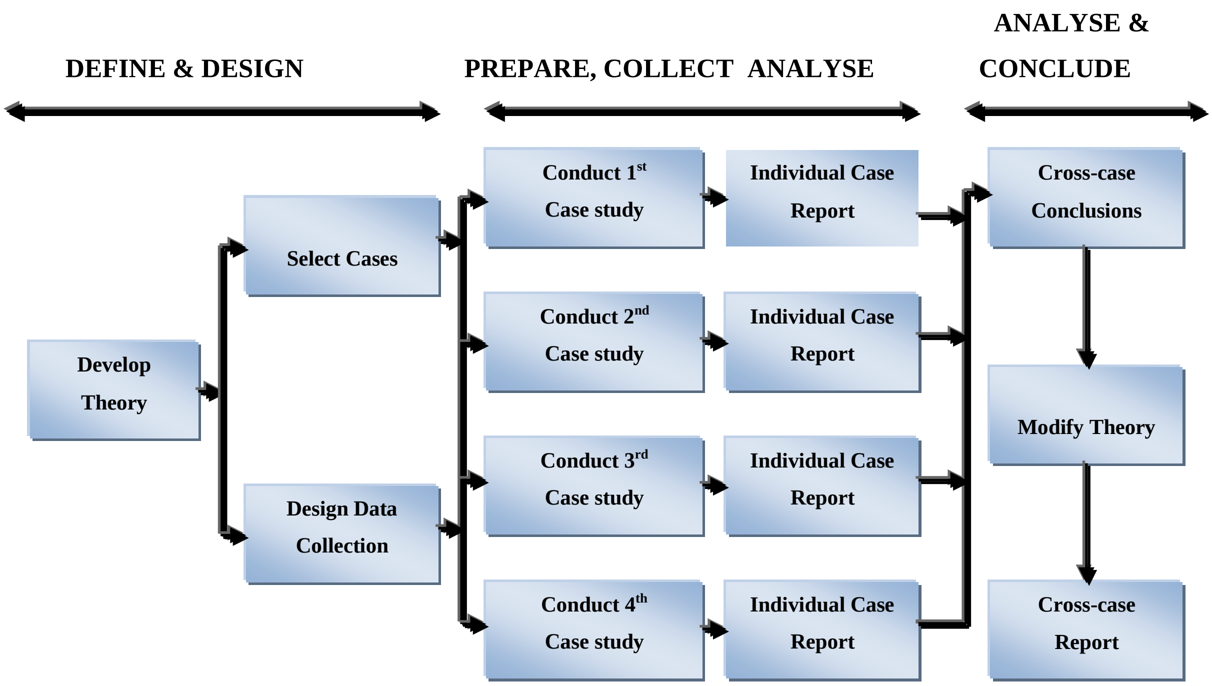

Figure 2.5: Multiple-Case Studies Approach (Yin 2008)

The multiple-case studies are the most appropriate choice to be adopted in this research. To help add depth to the study, qualitative data will be collected during each of the case study interviews. This is because the research involved the identification of the extent to which LL were used from completed SDM projects; the impact of these lessons on on-going SDM projects; the amount of improvement to be achieved in project performance based on the feedback from completed SDM projects, and determination of the criteria used to measure SDM project performance.

Four case studies were selected including two on-going PD-SDM projects and two completed PD-SDM projects. The four case studies were selected based on multiple criteria. Firstly, it was crucial to ensure the availability of the same category PD-SDM projects in both completed and on-going projects during the data collection stage in order to ensure that the improvement was being achieved in practice from project to project through LL. Additionally, the number of conducted cases was limited to four due to the available number of this category (PD) and also the availability of stakeholders who were involved in the two-completed projects as well as relevant documents. Secondly, the availability of access to relevant data of completed PD-SDM projects with respect to staff involved during the implementation stage as well as the documents was important. The category of PD-SDM projects represents about 30-40 per cent of the SMoI projects needing to be implemented over a long-term plan over the next twenty years, divided into five stages with each stage spanning four years. Thirdly, the case of PD-SDMs was suggested through the preliminary interviews because of the aforementioned rationales. Chapter Seven presents the four case studies analysis and findings.

2.4.3.3 Data collection

Significantly, the multiple-case studies approach has a main advantage compared to other approaches, which is that it permits the combination of different sources. The distinctive nature of case studies, as mentioned by Yin (2008), means that they have to be precisely shaped to yield the desired results. Due to the massive and different contextual variables involved in research activities, the use of case studies is an appropriate approach because they allow the use of multiple data collection techniques (Fellows and Liu 2008). Yin (2008) recommends the use of multiple sources of data collection as the various sources complement each other. The six recommended data sources are: documentation, archival records, interviews, direct observation, participant-observation and physical artefacts. According to Patton (2002), qualitative researchers collect three kinds of data; interviews, direct observations, and written documents. These yield quotations, descriptions and excerpts which are either unstructured or semi-structured. In this research, two main sources of evidence were used for data collection: documentation and semi-structured interviews.

Documentation

The use of documentary materials is regarded a valuable source of information. This was confirmed by Hutt et al. (1988) who used document analysis to verify information obtained in personal interviews in their investigation of marketing strategy formation. Nevertheless, documentary evidence is also considered objective because it is generated outside the influence of the research study. It provides a description and critical analysis of the current state of knowledge in a given subject area or organisation (Jankowicz 2000). It also justifies any new research through a coherent critique of what has occurred previously and demonstrates why the current research is both timely and important (Gill and Johnson 2002). Written documents may include reviews of unpublished or published documents and may be from primary (gathered directly from people or an organisation) or secondary (previously published) sources (Hussey and Hussey 1997). These may come in the form of reports, standards, guidelines, memos, letters, email messages, faxes and articles from journals, conferences, textbooks or newspaper sources. The availability of access to the data significantly contributed to obtaining valuable and confidential information. As a result, the investigation was able to cover all sources-either hard copies e.g. files, meeting agendas and payment records, or electronic copies even including access to software projects (Yin 2008).

This research depended on the robustness of the choice of data sources by using two methods. Methodologically, more than one data source was used, such as interviews and documentation. Interviews, as data sources, were used to obtain further understanding of the phenomenon being studied by eliciting interviewees' views. These were added through documentation, where they were relevant and available. The collected SMoI SDM–related documents included the following: invitation documents; tendering documents; BoQ documents; the project contract documents; financial requests; minutes of meetings; change order documents; submittal request documents; prequalification request documents; disseminated documents; and the project handover to end-user document; Vendor lists; budgets; geographical maps; plans/drawings; and a list of end-users (CAD 2000, 2003, 2004 and SAD 2006, 2007).

Interviews

Interviews have been defined as "*methods of collecting data through face-to-face or voice-to-voice interactive dialogue in order to discover the opinions or feelings of people on a certain subject"* (Hussey and Hussey 1997). In general, there are three forms of interview commonly used in business research: structured, semi-structured, and unstructured (Fellows and Liu 2008; Hussey and Hussey 1997). Structured interviews are by definition very specific and include defined questions and limited probing. In unstructured interviews, questions can differ between interviewees and the interviewer might not have questions prepared and can probe freely. In the middle of the above two extremes are semi-structured interviews, in which the interviewer has prepared some questions or a framework for the dialogue but is also free to probe when necessary.

Semi-structured interviews were selected as the main data collection technique in this research. Yin (2008) reported that interviews are regarded as one of the most important and essential sources of case study information, where they will appear to be guided conversations rather than structured queries. He emphasised that, although the researcher will be pursuing a consistent line of inquiry, the actual stream of questions in the case study should be flexible. The researcher is mandated to do two tasks through the interview process: (a) to follow his/her own line of inquiry, as reflected by his/her case study protocol and (b) to ask his actual (conversational) questions in an unbiased manner that serves the needs of the line of inquiry.

The use of a semi-structured interview helps the research due to the level of probing that is allowed without losing control of the issues that have to be discussed. Justification for using the semi-structured interview format was discussed in detail through section 2.4.2. The interview was the main source for data collection, since it aims to clarify and provide more details on the phenomenon being studied. Slack and Rowley (2000) concluded that cognitive information, such as beliefs, motivation and perception can be gained by interviewing those observed. Twelve interviewees (three in each case study) were selected and each interview lasted between 90 and 120 minutes. According to the project management system used by the SMoI, each party should appoint a representative as a project manager to work under the umbrella of client representative. To avoid the truncation of information and bias, the case studies involved people from different organisations and with different job functions. The stakeholders selected for the interviews are detailed in Chapter Seven. To refine the items in the interview questions, a pilot survey was carried out with three academic experts and three SDM projects' stakeholders. This resulted in a few modifications to the interview questions: some items were deleted due to repetition, a few items were combined and some terminologies were clarified for participants.

Significantly, prior to conducting each interview, an appointment was made with the selected person involved in the PD-SDMs' project. A telephone call was made to ascertain who would be best able to provide key information on the organisations and the specific project. Once access was agreed, an interview was arranged and a tape recorder used to record the conversation. A special permission letter from the client authority, in this case the SMoI, was presented during the interview as well as collecting the relevant documents to show the formality, importance and seriousness of the study. Through this approach, the interviewee was allowed to talk freely without interruption or intervention within the time frame allocated. The template of the interviews comprises three sections: case study and personal background; learning in SDM project; and SDM project performance (see Appendix D).

2.4.3.4 Data analysis

In fact, qualitative data analysis is considered a difficult task due to having large data that come in the form of "row" data. Ritchie and Lewis (2009) argued that the form of qualitative "row" data is various and most commonly comprise verbatim transcripts of interviews or discussions (or audio tapes if they have not been transcribed), observational notes or written documents of other kinds. Creswell (2007) and Yin (2008) indicated that data analysis consists of a number of stages, i.e. examining, categorising and tabulating or otherwise recombining the evidence, in order to address the initial goal of a study. In this regard, Krueger and Casey (2000) suggested that the purpose should drive the analysis; they believe that data analysis should start by going back to the intention of the study and survival requires a clear fix on the purpose of the study. In the qualitative analysis the focus is to bring meaning to a situation rather than the search for truth focused on by quantitative research (Rabiee 2004). Strauss and Corbin (1998) described the analysis process as an interplay between researchers and data although acknowledging that there is an extent of subjectivity in the selection and interpretation of the generated data. Data analysis and findings of case studies, including interviews, documentation are presented and detailed through Chapter Seven.

Documentation analysis

Documentation is another source adopted within the case studies in this research. Qualitative content analysis was used to analyse these documents. Simister (1994) described content analysis as a technique for extracting and categorising information from the text, while Neuman (1997) described it as a technique for gathering and analysing the content of text. Bryman (2008) posed the question of how, if the researcher is not using content analysis, he/she interprets documents. Accordingly, Bryman (2008) argued that qualitative content analysis is probably the most prevalent approach to the qualitative analysis of documents. It comprises a searching-out of underlying themes in the materials being analysed. According to Lynch and Bogen (1997), this approach can examine the text to show the key recurring themes that present an upbeat and scientific view of the discipline that is ironic in the researcher's view. Altheide (1996) proposed an approach named Ethnographic Content Analysis (ECA), which is much more of a movement back and forth between conceptualisation, data collection, and interpretation. Despite these differences, qualitative content analysis as a strategy of searching for themes which are regarded to be in one's data lies at the core of the coding approaches often employed in the analysis of qualitative data (Bryman 2008). Similarly, Grbich (2007) argued that qualitative content analysis provides a thematic slant which adds depth to the explanation as to why and how words have been used in particular ways and what the major discourses are. Accordingly, since qualitative content analysis achieves a robust research outcome by searching out themes which strengthen interview findings. This research adopted this method as a strategy for analysing documentation.

Interview analysis

There are a number of approaches to the analysis of qualitative data. In practice, as Green and Thorogood (2004) identified, most researchers use a combination of approaches. One of these approaches is the framework analysis method which was proposed during the 1980s at the National Centre for Social Research (Ritchie and Spencer 1994). 'Framework analysis', as described by Ritchie and Spencer (1994), is '*an analytical process which involves a number of distinct though highly interconnected stages*'. The five key stages involved in the framework are outlined as follow: familiarization; identifying a thematic framework; indexing; charting; mapping and interpretation. The 'Framework' refers originally to the 'thematic framework', which is the central component of the method. The use of a thematic framework is to classify and organise data according to key themes, concepts and emergent categories. The advantage of this method is to provide a clear series of steps, which could help first-time researchers to manage the large amount and complex nature of qualitative data much more easily. Significantly, this method enables the researcher to synthesise the identified themes across all cases. Rabiee (2004) argued that framework analysis provides some practical steps for the analysis of individual data. He indicated that 'Framework analysis' is used for individual interviews and it is now widely used by qualitative researchers. Krueger (1994) suggested that a helpful way of thinking about this role is to consider a continuum of analysis ranging from the mere accumulation of raw data to the interpretation of data: the analysis continuum: raw data; descriptive statements; interpretation. The other distinctive aspect of framework analysis is that although it uses a thematic approach, it allows themes to develop both from the research questions and from the narratives of research participants. Accordingly, the aforementioned discussion revealed that this method has a significant role in analysing the interviews due to having systematic process. This is extremely helpful for managing the data, making sense of what is going on, eliminating extra and irrelevant information and navigating safely through the maze of large and complicated paths of information, and thus addressing the aim of the study. Consequently, this research adopted the framework analysis as its analysis technique through conducting the familiarization; identifying a thematic framework; indexing; charting; mapping and interpretation.

Cross-case synthesis

Cross-case synthesis technique, which is likely to be easier and the findings likely to be more robust when a case study consists of at least two cases (Yin 2008) was used to analyse the four cases. The data analysis was designed to involve cross-case synthesis. The key to good cross-case synthesis is the avoidance of information-processing biases (Yin 2008). Additionally, Yin (2008) stated that the findings are likely to be more robust and this will strengthen the findings even further. An important challenge in conducting cross-case synthesis is that the examination of the key findings will rely on strongly argumentative interpretation, not numeric tallies (Yin 2008). Creswell (2007) argued that when multiple cases are chosen, a typical format is to first provide a detailed description of each case and themes within the case, called a within-case analysis, followed by a thematic analysis across the cases, called a cross-case analysis, as well as assertions or an interpretation of the meaning of the case. Ritchie and Lewis (2009) argued that the final stage of data management involves synthesising all the data on specific themes across all cases.

2.4.4 Framework Design and Development

Development of a framework for improving the performance of SDM projects was achieved through case study findings and supported by an extensive literature review on construction project performance improvement, learning, and Knowledge Management (KM), preliminary study findings. The case studies have helped to identify CSFs affecting the process of SDM project performance improvement. Findings identified fourteen CSFs that were classified into three main themes: adaptability of SDMs to context, contract management and construction management. The framework presents a holistic picture of the components that influence the process of SDM project performance improvement as well as the expected performance improvement curve that results from the cumulative learning and experience. Due to the repetitive nature of SDM projects, the framework was designed based on the learning concept which can achieve a continuous performance improvement from project to project. The framework consists of four phases that are in the form of chronological sequences. Each phase comprises one component, these phases are: the design modification phase (adaptability of SDMs to context), the pre-construction phase (contract management), the construction phase (construction management) and the post-project audit (LL, Database and LC). Chapter Eight provides a detailed discussion on the framework development process for this research project.

2.4.5 Framework Validation

The concept of validation is dependent on the view that the model is a representation of the real world, or part of it (Pidd 2009). Furthermore, validation is used to check if the model behaves as the real world would under the same conditions (Miser 1993; Pidd 2009). The validation process was conducted through a workshop held in Saudi Arabia, which the stakeholders who had been involved in the case studies were invited to attend. This workshop aimed to seek stakeholders' feedback/judgement about the research results. The target people were those stakeholders who were involved in the four case studies. This was a focused effort to sustain consistency between the results of the research and the source of data and might help tackle the existence of any gap between results and their source. A further reason was to ensure that the proposed framework truly represented the key findings identified from the four case studies. To this end, they were invited to offer their perspective regarding the proposed framework and whether it indeed reflected reality.

Discussions involving Nine stakeholders were facilitated by the researcher, the rationale behind selecting Nine participants is explained in the research limitations as clarified in Chapter 10. Miser (1993) and Pidd (2009) argued that useful and realistic views of validation emphasise the possible utilisation of models as the means of validation. This allows the framework to appear to be of more practical use. The format of each workshop involved a short presentation on the background to the research, the proposed improvement framework and highlights of the recent legislative developments related to the research, followed by discussions on the applicability and practicality of the proposed framework for improving the performance of SDMs in SMoI' projects.

The workshop focused on validating three major issues: the framework concept, SDM life cycle project performance and LL (details and feedback), and the framework implementation strategy (see Appendix E). The validation workshop was carried out in four phases described below, and the stakeholders were given sticky notes to write their comments/views on, which were then posted on a board for discussion in groups. The results show that a high percentage of the stakeholders believe that the improvement framework components are adoptable and workable. Further details are presented and discussed in Chapter Eight.

2.5 RESEARCH METHODOLOGY LIMITATIONS

The research method used in this research qualitative case studies, carries within it some inherent limitations, summarised in the following points.

- Limited generalisation capability. The sample sizes and sampling methods used in qualitative research are limited within the context of PD-SDM projects. However, the characteristic of standardised models across all the categories helps in generalising the research outcomes/results to other categories. All categories are standardised in terms of design, material specifications, contract documents, procurement method, only the size of the model was not standard. The selected sample of interviewees covered all stakeholders (client, consultant and contractor) involved in the implementation of SDM projects. Furthermore, a varied sample was sought to provide various points of view.

- Subjectivity. The strength of deeper understanding provided by the qualitative approach is in itself a weakness as it limits confidence in the findings. In order to minimise the subjectivity in the data collection and analysis of the research, a "study protocol" was used. In addition, a structured form for the interviews was utilised, although probing was used to explore issues further. Furthermore, the interviews were recorded and documented. The large amount of qualitative data was processed in accordance with a "framework analysis" which involves a number of distinct though highly interconnected stages, as well as qualitative content analysis.
- Difficulty of replication. Another weakness of the qualitative approach is its limitation in terms of possibilities of replication by other researchers. This could be overcome through structuring the interview process by using the interview forms.
- Lack of transparency. The process of collecting and analysing qualitative data is occasionally difficult to establish and can lack clarity. However, throughout this research the qualitative approach utilised was discussed in as much detail as possible.

2.6 SUMMARY

The research methodology adopted in this research has been discussed in this chapter. This research adopted constructivism as an ontological position and interpretivism as an epistemological position as a research philosophy. This is because these positions achieve the exploration of situations and construct a full understanding about situations, which enables the researcher to interpret the targeted phenomenon. With regard to the research approach, this research adopted the qualitative approach. Additionally, the research employed the case study as a research strategy for several reasons. The situation in SDM projects requires to pose the questions "why" and "how" to identify the CSFs affecting the performance of SDM projects in order to develop an improvement framework. Additionally, not only was there little information about this phenomenon, but there was no information as this is a contemporary phenomenon within a real-life context. The actual research process was covered, including literature review, preliminary study, case studies, development of a framework and validation. Two sources (semi-structured interviews and SMoI SDM-documents) were used as data collection techniques. The collected data was analysed by using "framework analysis" as well as qualitative content analysis and then cross-case synthesis. Framework design and development were discussed. Additionally, framework validation was discussed. The validation was conducted through a workshop including a focus group of the stakeholders involved in the case studies. Finally, research methodology limitations and some actions taken to minimise them were discussed. The following chapter presents project performance improvement in the construction industry.

CHAPTER 3

3 CONSTRUCTION PROJECT PERFORMANCE IMPROVEMENT

3.1 INTRODUCTION

It is widely accepted that the objectives of any construction project are expressed in terms of cost, quality and time. However, there are other explicit objectives which have an impact on project success, such as safety considerations and market entry, which depend on the nature of the company and the project. There appears to be a variety of means used to identify the success or failure of projects with regard to these objectives. This chapter reviews project performance improvement including: key tools used in improving construction project performance, such as benchmarking, partnering and LL; project success criteria; and categorisation of project success. The chapter also examines Critical Success Factors (CSFs), which have been categorised into three groups: design development-related factors; contract management-related factors; and construction management-related factors.

3.2 CONSTRUCTION PROJECT PERFORMANCE IMPROVEMENT

3.2.1 Project Performance Improvement

Improving project performance in the construction industry poses several challenges for practitioners. However, it is not an easy task to sustain radical improvement in a diverse environment such as the construction industry (Egan 1998). It requires the identification and implementation of suitable improvement programmes subjected to the construction business cycle (Tang and Ogunlana 2003). This is important since the integration of improvement programmes in construction may incur high costs and yet the benefit can only be realised after some time delay (Takim 2005). However, there is a need for new improvement programmes and initiatives at various stages of a project life-cycle in order to enhance construction project performance and target changing trends of private and public sector construction project organisations (Tang and Ogunlana 2003; Atkinson 2003). Such programmes entail the integration and implementation of process improvements across project phases.

Process improvement in the development of construction projects is necessary to enhance the performance of projects, in particular large-scale projects, and to mitigate the problems of adversarial relationships. Clearly, the UK construction industry has made advances since the publication of the Egan report. The establishment of the Construction Best Practice Programme, the Movement for Innovation, and the new establishment of Construction Excellence have helped to promote management techniques such as benchmarking partnering, lean construction, supply chain management, and risk management, all of which are more prevalent within UK construction companies (Barrie 1999; Cook 1999; DETR 1999a; Dainty et al. 2003). However, a review of project success and success criteria is necessary to show a clear understanding of construction project success criteria to be considered as a starting point towards project performance improvement.

3.2.2 Project Performance Improvement Tools

There are several tools used for improving project performance, including: benchmarking, partnering and Lessons Learnt (LL). These tools are discussed in the next sections.

3.2.2.1 Benchmarking

Although the philosophy of benchmarking has been increasingly adopted by many industrial sectors, particularly manufacturing, the construction industry is still reluctant to fully adopt this philosophy. Benchmarking is an attempt to find the best practices that lead to superior organisational performance (Camp 1989). Maire et al. (2005) described benchmarking as one of the most effective approaches that help a company to improve its performance. Furthermore, they stated that benchmarking has passed from a “continuous and systematic process of evaluation of products or services” (Camp 1989) to a continuous process of identification, learning and implementation of best practices in order to obtain competitive advantage, whether internal, external or generic. The importance of developing best practice benchmark measures has been realised by many researchers in construction management and practitioners in the construction industry (Chan and Chan 2004). A study conducted by Fisher et al. (1995) revealed that the use of benchmarking leads to performance improvement regarding cost, schedule, and reducing change orders. Additionally, they stated that benchmarking helped to overestimate total quality costs by 8 per cent (on average), and underestimate schedule by 8 per cent (on average), while change orders average was +11 per cent and therefore project performance was improved. Moreover, Lee et al. (2005) believes that there is still room for improvement in overall performance in terms of quality, efficiency, productivity, site safety, environmental sustainability and customer satisfaction through benchmarking. In addition, Lema and Price (1995) stated that the improvement of performance can be achieved quickly by using Total Quality Management (TQM) through benchmarking. Furthermore, they argued that benchmarking is described as a technique that is used to identify methods to improve project and organisational performance.

Several models of benchmarking have been developed and applied in various settings (Zairi and Youssef 1995a, 1995b; Delbridge et al. 1995; Buyukozkan and Maire 1998; Brah et al. 2000; Maire 2002; Kyro 2004). Marwa and Zairi (2008) provided a conceptual framework for benchmarking based on the visits approach in order to capture meaningful learning of best practices. The aforementioned framework is based on seven steps: pre-visit debrief; visit; inquire and record; debrief; multiple visits; review; and feedback. However, training and effective communication are essential in the success of a benchmarking visit (Love et al. 1998 and Hinton et al. 2000).

3.2.2.2 Partnering

Over the last decade, partnering emerged as one of the important tools used to improve project performance, and so has gained major popularity. Different partnering studies have been conducted by several researchers (Black et al. 2000; Gransberg et al. 1999; Chan et al. 2004; Beach et al. 2005; Tang et al. 2006) to monitor the performance of building industry projects. Egan (1998) indicated that the industry must replace competitive tendering with long-term relationships based on clear measurement of performance and sustained improvement in quality and efficiency. Implementation of these recommendations should take immediate effect, so that an enhanced project performance can be accomplished leading to the completion of a successful project. To accompany this, it is important to identify certain building construction projects to help demonstrate the improvements that can be achieved through the application of this best practice.

As indicated by Chan et al. (2004), there must be a sufficient and effective partnering system that ensures strategic communications between all contracting parties, as well as a mutual willingness to share resources amongst all project participants. In addition, partnering as a positive concept cannot be achieved without a clear definition of responsibilities and a long-term commitment towards the “win-win” attitude. This must also be under the continuous and regular monitoring of the partnering process itself.

Many studies have focused on CSFs for partnering in construction projects (Chua et al. 1999; Cheng and Li 2002; Chan et al. 2004;). A series of journal articles have emphasized the success factors for PPP’s (Bing Li et al. 2005; Zhang 2005; Trafford and Proctor 2006; Sagalyn 2007). Furthermore, Chan et al. (2004) explored the CSFs for partnering in construction projects in Hong Kong, focussing on building a common ground for innovative developments in delivering a project efficiently and reducing construction disputes among the contracting parties. As a result, a number of potential factors have emerged, in particular the concept of applying partnering in construction projects. This was important in eliminating problems such as lack of cooperation, lack of trust and ineffective communication between the different people working on large-scale construction projects. Chan et al. (2004) reported that certain requirements must be met for partnering to succeed, so that enhanced project performance can be satisfactorily achieved. Zhang (2005) conducted a study on CSFs for public-private partnerships in infrastructure development. The study highlighted the urgent need to develop an appropriate procurement protocol for constructive partnerships in which private sector funds, managerial skills and operational efficiencies would be brought into full play to enhance values that would benefit both public and private interests. Indeed, various success factors were identified through case studies, literature reviews and interviews from worldwide applications of public-private partnerships. Chen and Chen (2007) identified a number of partnering CSFs that contribute towards improving project performance in Taiwan which include a collaborative team culture, a long-term quality focus, consistent objectives and resource-sharing. In a study to identify partnering success factors, Jacobson and Choi (2008) found ten success factors namely: specific plan/vision, commitment, open communication and trust, willingness to compromise/collaborate, respect, community outreach, political support, expert advice and review, risk awareness and clear roles and responsibilities. They stressed the importance of achieving a high degree of commitment and shared vision between the client, architect and contractor as well as pairing factors of open communication and trust with high levels of compromise or collaboration. As a result, partnering CSFs were categorised into five main groups: economic viability; appropriate risk allocation via reliable contractual arrangements; sound financial package; a reliable concessionaire consortium with strong technical strength; and a favourable investment environment. It is important to highlight that the above factors were believed to be the most significant factors for partnering success. This will no doubt facilitate the formulation of effective strategies for minimising construction conflicts in order to substantially improve project performance.

There are also other potential advantages behind the application of the partnering concept in the construction industry. Partnering can lower the risk of cost overruns and delays as a result of better time and cost control over the project. Moreover, it has the potential to increase the opportunity for innovation, such as the development of value engineering changes and constructability improvement as a result of open communications, and strong trust among project parties. Partnering is always beneficial for lowering the gap between all different groups within the project. This has been the common conclusion from various partnering studies (Bresnen and Marshall 2000; Anvuur et al. 2007).

Sarshar et al. (2004) studied the strengths and weaknesses of the partnering operation by focusing on best practice to provide specific guidelines for project improvement. The main strengths of partnering include: close physical proximity of the client, design and project management teams; top level commitment to improve productivity; the adoption of manufacturing philosophies; and methods which can help to deliver improvement. On the other hand, the weakness factors that prevent achieving improvements include: lack of integration between the systems and processes of the partnering organisations; fragmentation of the project teams due to the presence of cultural and incentive differences between the partnering organisations and a lack of process evaluation and improvement by the teams.

3.2.2.3 Lessons Learnt

Nowadays, Lessons Learnt (LL) have become the language of improvement. Most industries have become acutely aware of their significant role in achieving continuous improvement for their performance sectors in order to survive in a competitive environment. At this time, the construction industry, known for its fragmentation and traditional culture, lags behind other industries in its project performance. For example, the reviews by Egan (1998) and Latham (1994) stated that the sector was underachieving, bogged down with claims and disputes, had low profitability, many of its clients were dissatisfied with its overall performance and too little was invested in capital. Egan (1998) emphasised the importance of learning from other industries that have improved their performance. He believed that such improvements could be achieved in the construction industry and made available to its clients. In the motor industry, he cited Nissan UK with its advanced approach to production, and argued that the construction industry *"has two choices: ignore all this in the belief that construction is so unique that there are no lessons to be learned; or seek improvement through re-engineering construction, learning as much as possible from those who have done it elsewhere".*

The US Army (1979) defined LL as "validated knowledge and experience derived from observations and historical study of military training, exercises and combat operations". Carrillo (2005) argued that LL are created as a result of both organisational learning and knowledge management. Consequently, it has been realised that LL are regarded as part of a periodic event and learnt by individuals or groups as part of a sequence of tasks, while knowledge comes as a result of gaining experience and understanding, but in a sophisticated approach. In turn, significantly, the use of LL is based on essential elements that include not moving out the key staff of the company; difficulties in reusing LL sometimes in the same project and the non-similarity between projects.

Gilbreath (1986) enumerates a number of LL-CSFs that should be included in the agenda of lessons. These factors include the following:

- learn failure, but do not practise it: understand it and then avoid it;
- know your project, assessing its weaknesses, both generic and specific;
- create achievable zones of expectation;
- review alternatives: there is no one right way but many workable ways;
- continually reassess your objectives, adjusting the management focus whenever necessary;
- accept some failures, realizing that this is the price of success;
- use models and similar devices that reflect the project reality;
- foster project intimacy and stimulate the closeness of the project manager and his team; and
- learn from your mistakes: compile lists and analyse them.

LL are considered to be a crucial tool used in achieving continuous improvement. Graham (1988) stated that a project manager should have the ability to use any advantage or even mistake as a beneficial lesson that could be used in a future project. Garon (2006) stressed existing good project management which is able to create a suitable environment within which LL of a project will be systematically identified, captured immediately, documented, authorised, disseminated and used in future projects to support planning and decision-making at both project and corporate levels. Moreover, he proposed a number of key elements of LL about infrastructure management such as the creation of LL culture affecting policies, standards and corporate success with the support of a web-based data-management system. He concluded that, in reality, LL contribute a considerable experience for a project team but, unfortunately, sometimes they had not been written down so that they could be shared with future projects. In proposing modern project management associated with LL, Bailey (2005) proposed the use of modern project-management language to identify the LL from the past in groups of "bullet points". The following are some of these relevant thematic lessons: personnel features; command features; control features; product portfolio features; product development features and communications features.

Kharbanda and Stallworthy (1992) reported that experience plays a crucial role in better management. They stressed that whilst learning from success is important, learning from failure should be much more so. Furthermore, they considered project management to be the key factor in the success of learning. They identified that learning could be achieved through the experience of the practitioner's own mistakes as well as the mistakes of others. In their study, they focused on how learning can come from project failures and disasters. This is because there is no guarantee of success and mistakes could happen in the best and most successful organisation; in fact this same success might lead to serious mistakes. Significantly, the organisation becomes at serious risk when it believes that it will be continuing its success and the future will be a mirror of the past, but this is not true. Accordingly, in order to maintain success, companies must adapt to changing circumstances and stimulate more innovation. Undoubtedly, improving project processes through best practice reflects positively on a construction project.

Practically, LL are still suffering from a lack of attention and commitment by all stakeholders. Weiser and Morrison (1998) noted that systematic methods of identifying, capturing and transferring LL for future projects are still to be found in very few firms. They emphasized the important role of project management, where explicit knowledge in the form of drawings, standards, specifications, and such is documented. Garon (2006) indicated that LL are the best key element of knowledge management as they help to improve the planning/management of future projects in order to accomplish corporate missions by acting as a communication tool between projects. In this regard, Collison and Parcell (2001) delivered a number of stages related to capturing LL through holding regular meetings, these include:

- call the meeting;
- invite the right people;
- appoint a facilitator;
- revisit the objectives and deliverables of the project;
- revisit the project plan or process;
- ask “what went well?”;
- find out why these aspects went well, and express the learning as advice for the future;
- ask “what could have gone better?”;
- find out what the difficulties were;
- ensure that the participants leave the meeting with their feelings acknowledged;
- determine “what next”?; and
- record the meeting.

Snider et al. (2000) stated that although the idea of learning from experience is timelessness, the high attention given to formalising systems for capturing and disseminating LL within an organisation has recently been realised. Ayas (1996) stressed the crucial role of disseminating LL across the organisation. Balthazor (1994) and Holtshouse (1999) suggested the possibility of achieving effective dissemination by using databases of LL, rotating personnel and circulating written reports. In this regard, Carrillo (2005) claimed that LL must be documented in a systematic way and a structured format with a number of key attributes and levels of detail in terms of project participants, contact details, recommendations, responsibilities, etc. Importantly, therefore, these documents must be accessible and searchable either as hard copies or electronically through the Internet to be used as relevant knowledge for future projects. Furthermore, Carrillo (2005) stated that where there is no systematic approach for disseminating LL this important information becomes useless. She mentioned many problems related to the documentation of LL, such as considering the LL as a part of the overall project documentation such that they become insignificant, the difficulties in finding and reviewing these lessons, the lack of both electronic storage and a clear storage mechanism.

On the other hand, Williams (2006) emphasised that the competency of individual project managers must be increased in order to identify and capture valuable LL. Accordingly, Dvir et al. (2006) demonstrated that learning mechanisms are extremely important if successful (defence) projects are to be achieved. However, Newell et al. (2006) criticised the rare use of databases built from transferring LL from one project to another.

3.3 PROJECT SUCCESS CRITERIA

Over the past decades, there has been no full agreement on the term "project success measures" (Baccarini 1999). This indicates that this term comprises a wide spectrum of multi-factors. However, the perceptions of project success criteria are controversial especially when they are to be measured against the widespread and traditional measures of project performance in terms of cost, time and quality (Cooke-Davies 2002). The "Golden Triangle" elements expressed in terms of cost, time and quality have been considered the most important traditional basic criteria for project success (Walker 1995; 1996; Belassi and Tukel 1996; Hatush and Skitmore 1997; Kloppenborg and Opfer 2002).

Ahadzie et al. (2008) identified a number of project success criteria used for measuring the success of mass house-building projects. These included: environmental-impact; customer satisfaction; and the traditional measures (cost, time and quality). Similarly, Lam et al. (2007) identified time, cost, quality and functionality as the success criteria for design-build projects. Moreover, Belout and Gauvreau (2004) argued that cost and schedule control are considered crucial measures of capital project success leading to client satisfaction. Setting the criteria for the success of any construction project must take into account the clients' levels of satisfaction as a measurement of the project's performance. Bryde and Robinson (2005) stated that contractors and clients measure project success from different perspectives, where contractors see reductions in cost and time as measures for project success, while clients focus on meeting stakeholders' requirements. Nevertheless, in their recent study, Nudurupati et al. (2007) proposed a new methodology for measuring performance in the construction industry through a structured performance measurement system (PMS) with appropriate management information systems (MIS). They added new measures such as identifying critical improvement areas, successfully addressing all stakeholders' requirements, and a change in culture. Freeman and Beale (1992) identified eight main criteria for measuring the success of projects including: technical performance, efficiency of project execution, managerial and organisational implications, personal growth, project termination, technical innovativeness, manufacturability performance and business performance.

The ability to deliver high standards of both quality and efficiency was considered by many researchers as a high priority for assessing the success of a project. Pariff and Sanvido (1993) regarded success criteria as a question of perspective, which varies from one person to another. Therefore, the measure of the criteria depends on the situation and varies with the expectations of management and differs among individuals, including all the parties involved in each project. Wateridge (1998) stated that there are two categories of success criteria: user criteria and project manager's criteria. User criteria, which are used to identify whether a project is successful or not, are those that allow the project to meet user requirements, produce satisfied users, meet the budget target, meet the allocated time target and achieve the identified purpose. On the other hand, the criteria used by project managers include: meeting user requirements, commercial success, meeting quality, meeting budget and achieving purpose. In a different way, Frodell et al. (2008) indicated that the most important characteristics of systems for measuring project performance are simplicity and credible results.

Sadeh et al. (2000) linked project success measures with four success dimensions: achieving design goals, which is associated with the preparation of the contract; tangible benefit to the end user, which depends on customer satisfaction regarding the final product; benefit to the developing organisation, which depends on executing the project successfully; and benefit to the national infrastructure and the firm that wishes to improve their technological infrastructure during the development process (see Table 3.1). Chan and Chan (2004) proposed a consolidated framework presenting different criteria for measuring project success. The criteria cover many aspects of project success such as: schedule, safety, participant satisfaction, user satisfaction and expectations, environmental performance, profitable value, quality and cost. Figure 3.1 shows a new conceptual framework for factors affecting project success. Similarly, Ashley et al. (1987) and Jaselski (1988) reported that six measures are often used to measure project success: budget performance, schedule performance, client satisfaction, functionality, contractor satisfaction and project manager/team satisfaction. Takim and Akintoye (2002) noted that once time and cost have been taken into consideration, then project success can be measured according to the percentage of profit, absence of claims and agreement with the owner without going to court.

Table 3.1: Success Dimensions and Measures for Projects (Sadeh et al. 2000)

Success Dimension	Success Measures
Meeting design goals	● Functional specifications. ● Technical specifications. ● Schedule goals. ● Budget goals.
Benefit to the end user	● Meeting acquisition goals. ● Answering the operational need. ● Product entered service. ● Reached the end user on time. ● Product has a substantial time for user. ● Meaningful improvement of user operational level. ● User is satisfied with product.
Benefit to the developing organisation	● Had relatively high profit. ● Opened a new market. ● Created a new product line. ●Developed new technological capability. ● Increased positive reputation.
Benefit to the defence and national infrastructure	● Contributed to critical subjects. ● Maintained a flow of updated generations. ● Decreased dependence on outside sources. ● Contributed to other projects.
Overall success	● A combined measure for project success.

The extant literature with regard to construction project performance suggests that project success criteria is a controversial issue, and two different approaches dictate the debate in the field. The first approach is the addition of more dimensions to the basic criteria of time, cost and quality. Reasonably, this approach is not easy to implement, because there are many considerations that should be taken into account, such as the variety of projects, parties and differing circumstances.

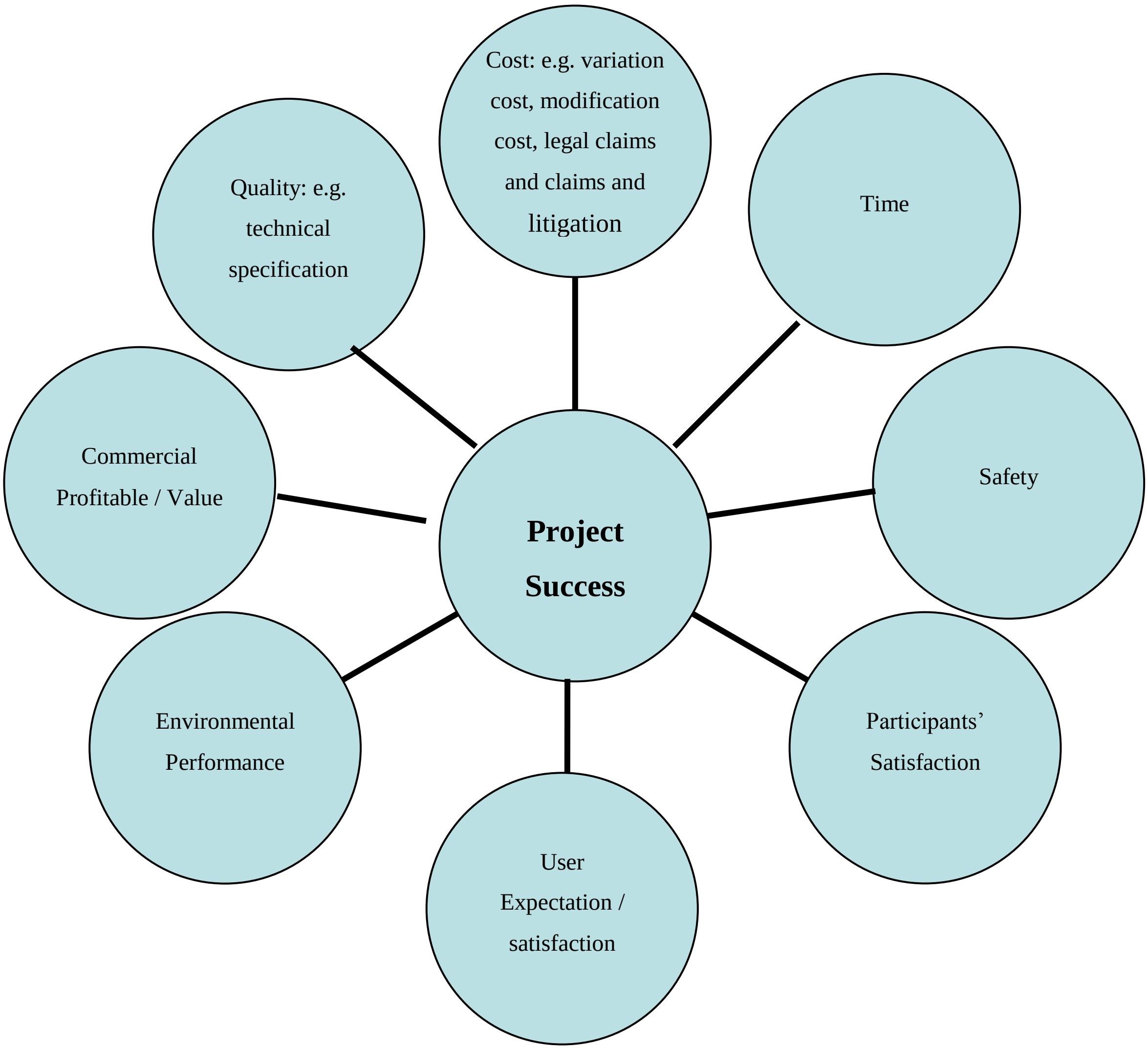

Figure 3.1: Consolidated Framework for Measuring Project Success (Chan et al. 2004)

3.3.1 Project Success Criteria Approaches

Consequently, decisions on project success may differ according to the viewpoint taken (Morris and Hough 1987; Hamilton and Gibson 1996; Shenhar et al.1997; Atkinson 1999; Lim and Mohamed 1999; and Bryde 2003; Chan and Chan 2004). On the contrary, the second approach focuses on the reduction of dimensions regarding project success. This approach sees the "Golden Triangle" as both inordinate and partial. The explanation for this thinking depends on the existence of a relationship between cost and time for a given quality, which means that time should not be used to measure project success because it is not an independent variable (Khosrowshahi 1997). Furthermore, regarding partiality, quality is considered to be one of the product features but should not be used as the only means of assessing project success for the product (De Wit 1988; and Baccarini 1999; Morris 2004).

3.3.2 Categorisation of Project Success

Hayfield (1979) identified two groups of project success: the macro and the micro. The macro include a realistic and thorough definition of the project, an efficient manner of project execution, an understanding of the project "environment", and the selection of the organisation to realise the project. On the other hand, micro include the formulation of sound project policies, a clear and simple project organisation, the selection of key personnel and the creation of efficient and dynamic management controls as well as reliable management information systems. Similarly, Lim and Mohamed (1999) grouped project success into two categories: date of completion and client satisfaction as a macro viewpoint of project success. On the other hand, the micro viewpoint of project success can be determined by the completion criterion alone. Figure 3.2 shows the micro and macro viewpoints of project success.

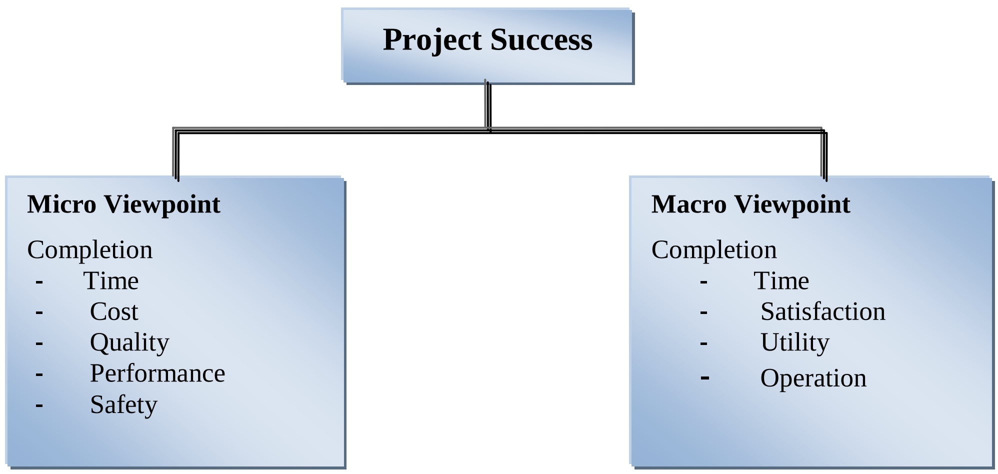

Figure 3.2: Micro and Macro Viewpoints of Project Success (Lim and Mohamed 1999)

In contrast, Chan and Chan (2004) classified project success into two categories based on objective and subjective methods, namely the Key Performance Indicators (KPIs) as shown in Figure 3.3. The objective category comprises several factors: construction time, speed of completion, time variation, unit cost, percentage net variation over final cost, net present value, accident rate, and Environmental Impact Assessment (EIA) Scores. The subjective method comprises aspects such as quality, functionality, end-user satisfaction, client satisfaction, design team satisfaction and construction team satisfaction.

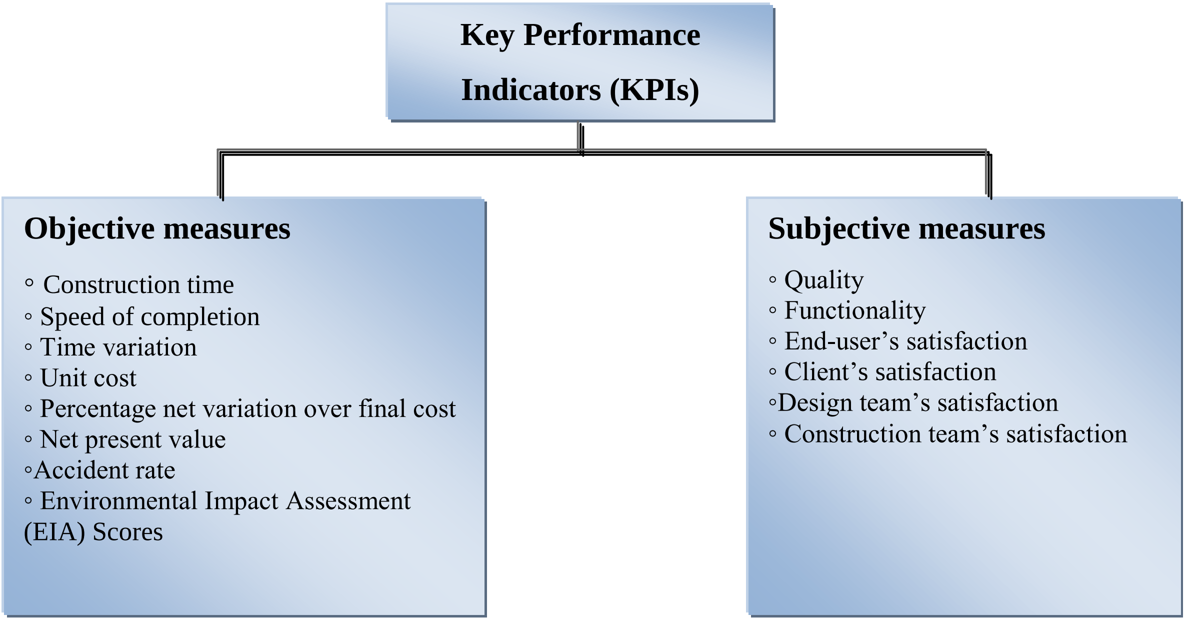

Figure 3.3: Key Performance Indicators for Project Success (Chan and Chan 2004)

Atkinson (1999) suggested that there are three stages with regard to project success as shown in Figure 3.4. The first stage is "the delivery stage (the process) - doing it right ; the second is "the post delivery stage (the system) - getting it right" and the third stage is " the post delivery stage (the benefits) - getting them right".

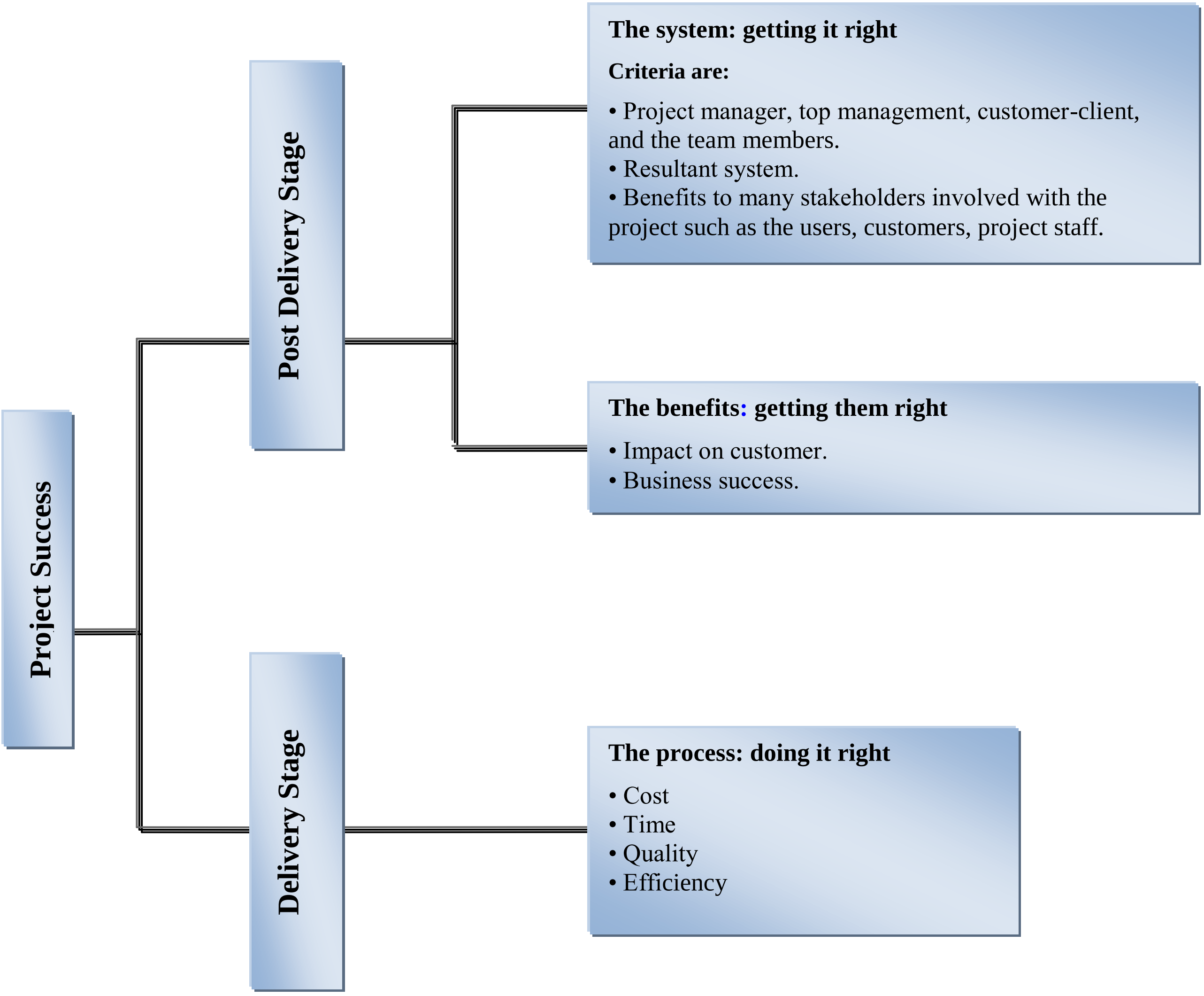

Figure 3.4: Atkinson's Model of Measuring Project Success (Atkinson 1999)

Shenhar et al. (1997) suggested four dimensions to evaluate project success (see Figure 3.5): the view to the future, customer satisfaction, the efficiency of the project and the degree of business success.

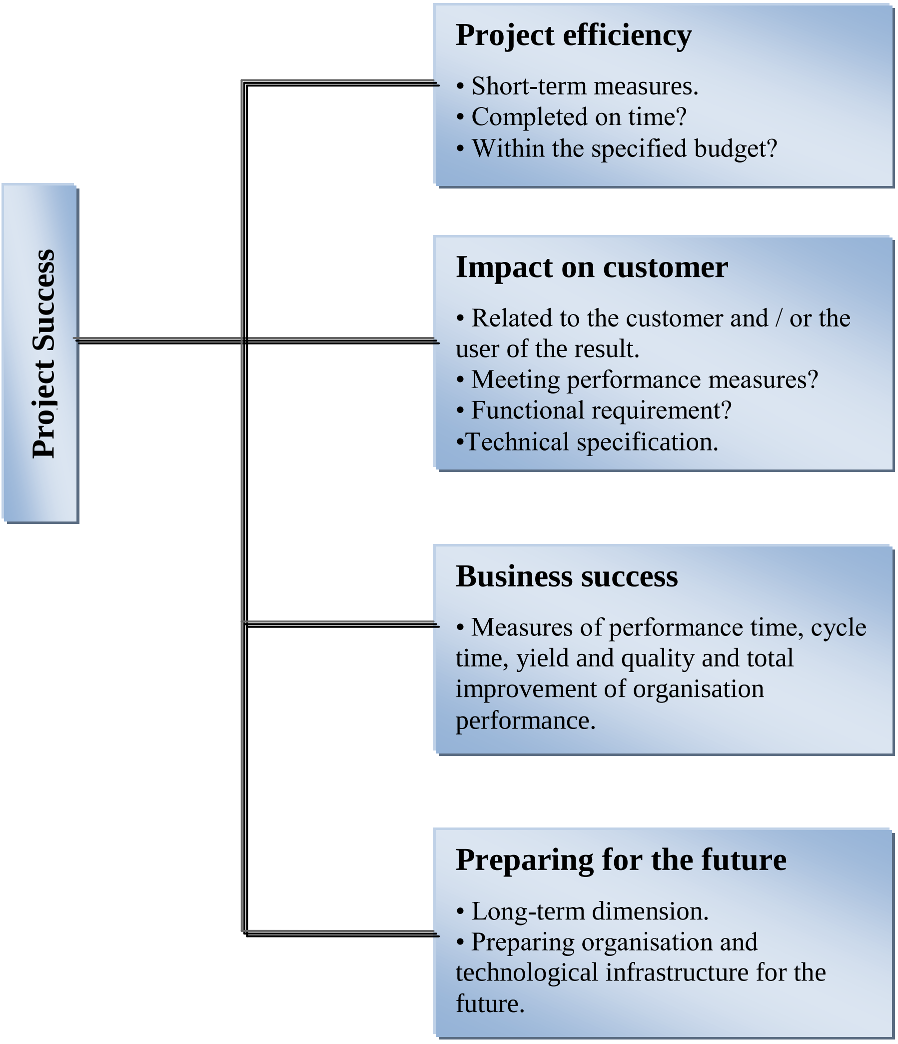

Figure 3.5: The Four Dimensions of Project Success (Shenhar et al. 1997)

3.4 CRITICAL SUCCESS FACTORS (CSFs)

The term "Critical Success Factors" (CSFs) was first used by Rockart in 1982. However, Toor and Ogunlana (2009) described that CSFs are the potential factors that contribute to the success or failure of a project. Many studies have been conducted to identify the CSFs that significantly lead to successful project delivery (Chan et al. 2001; Cooke-Davies 2002). The studies involved different construction projects, for instance: general construction projects (Ashley et al. 1987; Pinto and Slevin 1988; Savindo et al. 1992; Chua et al. 1999; Egbu 1999; Phua and Rowlinson 2004; Fortune and White 2006), design-build projects (Songer and Molenaar 1997; Ng and Mo 1997; Chan et al. 2001), public-private-partnerships or BOT (Tiong 1996; Jefferies et al. 2002; Zhang 2005; Li et al. 2005), international and multi-firm projects (Mohsini and Davidson 1992; Phua 2004; Gale and Luo 2004), large-scale construction projects (Nguyen et al. 2004) and various other project management issues (Hatush and Skitmore 1997; Cooke-Davies 2002; Nicolini 2002; Yu et al. 2005; Fortune and White 2006). Belassi and Tukle (1996) noted that the first emergence of success and failure factors was addressed by Rubin and Seeling (1967) in the context of project management. Wegelius-Lehtonen (2001) observed that while the construction industry is a project-oriented industry, where each project is unique and could be considered a prototype, it has a similar set of process stages in every project. Liu (1999) argued that there a specific set of success factors related to one project and these may not be transferable to another project. Chua et al. (1999) noted that there is a general agreement by experts regarding the variety of CSFs for different project objectives. Low and Chuan (2006) argued that the dependence upon the traditional definition of project success in terms of time, cost and quality is neither adequate nor comprehensive. Takim (2005) proposed a comprehensive framework for successful construction project performance. The framework comprises a group of CSFs divided into four phases which include: strategy formulation phase-related CSFs; procurement phase-related CSFs; implementation phase-related CSFs; and completion phase-related CSFs. In this research it was identified that the CSFs are based on three phases: design development, contract management and construction management. These are discussed within the following sections.

3.4.1 Design Development-Related CSFs

The design stage is an essential stage in the project life cycle. Therefore, the integration between the design stage and the construction stage is important, since design faults/mistakes and the need for improvement can be recognised and identified throughout the construction stage and therefore the opportunity for project performance improvement is possible.

3.4.1.1 Identification of design faults

Scott and Harris (1998) demonstrated that when a design's faults are identified, recognised and then presented in an accessible way to designers for future projects, improvement could be achieved. Kaplanogu and Arditi (2009) noted that peer review of design and design documents is often practised in construction projects. They mentioned that peer reviews can be defined as "*a process by which something proposed is evaluated by a group of experts in the appropriate field*" (Webster's Dictionary 2007). In this regard, Pitman (1991) emphasised the importance of LL when avoiding past mistakes. They criticised the unstructured and informal way of using learning and experience to improve future projects. Accordingly, the integration between the design and construction teams could lead to a better outcome based on the LL from past experience. Denison et al. (1996) confirmed that up until the mid-1990s, scholars did not provide an effective treatment for team design. Nevertheless, since then, empirically-based New Product Development (NPD) research has identified the importance of cross-functional team composition, team member experience and continuity of team membership across the entire project life span. Chan and Kumaraswamy (1995) identified that design team related factors have a direct impact on project success, these factors include: design team experience; project design complexity; and mistakes and delays in producing design documents. Significantly, the availability of standard designs stimulates the integration between all parties, provides a suitable environment and therefore allows the achievement of both continuous improvement and innovation.

3.4.1.2 Design standardisation

Design standardisation, where possible, can play an important role in improving construction performance through learning and feedback. The use of product architecture as a basis for standardising parts, modules and interfaces is one of the appropriate ways to increase the effectiveness and efficiency of product development, as well as the whole value-adding chain (Meyer and Lehnerd 1997). In this regard, Sanchez (1996) argued that standardisation plays a significant role in managing development resources and seeking to achieve innovativeness and differentiated products. It has been demonstrated that improvements in manufacturing performance are partly attributable to the standardisation of components and processes. Similarly, the expected level of performance improvement in construction could be achieved by adopting this approach (Griffith et al. 2000; Kondo 2000). Additionally, standardisation has significant potential for achieving improved performance in development schemes for major clients, such as the NHS (Edum-Fotwe et al. 2004). Stability is considered the essence of standardisation and its degree is a measure of the performance improvement to be embedded in potential processes. Notably, the impact of standardisation on performance improvement is apparent through the cycle of learning (the learning curve) associated with construction processes (Edum-Fotwe et al. 2004).

Egan (1988) emphasised the importance of adopting standardisation in improving the design of construction. Similarly, Latham (1994) argued that improving the performance of the design and construction process could be achieved by reducing variations and confrontation. According to (CIRIA 1983) it was discovered that good buildability could lead to major benefits of cost for stakeholders, and therefore, this can be attributed to the simplicity and standardisation of the design components (Lam and Wong 2009). As such, standardisation provides an opportunity for using LL due to the similarity of product components, and therefore these lessons can be reused in order to improve the performance of future products and projects, particularly in the construction industry.

Globally, however, the recent trend is prefabrication, which is being increasingly used in the building industry, alleviating some of the environmental burdens associated with conventional construction. According to CIRIA (1999) prefabrication is a manufacturing process, generally taking place at a specialized facility, in which various materials are joined to form a component part of the final installation. Precast construction was made feasible with the advancement of adapted equipment for transportation and erection. In 1996, the highest level of use of precasting was located in Denmark since the introduction of modular coordination legislation in the 1960s (MOM and MND 1999). In Asia, Japan and Singapore achieved a precast level of 15% and 8% respectively in 1996, but Singapore aims to achieve a figure of 20% by 2010 to increase productivity and buildability (CIDB 1992; BCA 2005). Specifically, in 1980, the Saudi National Guard (SNG) used the precasting in implementing huge construction buildings to house its staff, however, recently the use of precasting has been limited (MOMRA 2008). Recently, many studies have acknowledged the benefits of prefabrication in buildings (Yee 2001a, 2001b; Gibb and Isack 2003; Pasquire et al. 2005; Blismas et al. 2006; Goodier and Gibb 2007). Benefits of prefabrication tend to focus on cost, productivity and quality. In Hong Kong, prefabricated buildings were first developed along with the public housing programme. In the mid-1980s, prefabrication combined with standard modular design, was introduced in public housing projects (Mak 1998). Significantly, the use of SDM projects provides a suitable environment for adopting the prefabrication due to the characteristic of standardisation of design

3.4.1.3 Communication and coordination between design and construction

In assessing the quality of communication and coordination between the design team and the client or even the contractor, Oyedele and Tham (2007) stated that many success factors were identified which affect design development. These include: interactive processes (e.g., formal and informal design communication, level of modularisation and level of automation); project characteristics (Chua et al. 1999); project-related factors (Chan et al. 2004); committed leadership and establishment of integrated work teams between designers and contractors (Egan 1998) and design team-factors (Chan and Kumaraswamy 1994). Similarly, Egan (1988) stressed that design needs to be properly integrated with construction and performance. This emphasised the importance of integration between the design and construction phases, which means the work is conducted in close collaboration between the designer and supervisor. Cheng and Shiu (2008) developed a framework that consists of CSFs of re-innovation. One of these factors is the firm integrated ability (internal coordination and external cooperation). Rogers and Agarwala-Rogers (1976) identified that communication and the environment are CSFs in design development.

3.4.1.4 Design Quality Indicators

According to CIC (2010), the Design Quality Indicator (DQI) is "*a method of evaluating the design and construction of new buildings and the refurbishment of existing buildings*". The Design Quality Indicator (DQI) was developed as an extension of the Rethinking Construction agenda for targeting, mapping, measuring and managing performance improvement in construction (Gann et al. 2003). It was developed explicitly to measure quality of design embodied in the product – buildings themselves. It was not intended to assess the design process, although the tool has subsequently been used at various stages of design to help inform design decision-making during the process. The report Accelerating Change (Egan 2002), which updates the Rethinking Construction agenda, makes explicit reference to the DQIs and calls for their adoption across the construction sector. It also highlights the role of clients in promoting value through design in new buildings and refurbishment projects. The major focus was previously on the performance improvement agenda, while the value of building design may have been relegated to a secondary issue (Gann et al. 2003). Nevertheless, design quality measurement is a controversial issue with regard to whether it is subjective or objective measurement. Gann et al. (2003) stated that it so hard to quantify design quality due to it consists of both objective and subjective components. Whilst some indicators of design can be measured objectively. Dewulf and Meel (2004) indicated that the DQI simply accepts that quality is subjective. It acknowledges the multifaceted, complex nature of design quality by only using subjective measurement. In turn, due to the subjective nature of the DQI tool, the application of it is limited. This was confirmed by Markus (2003) who stated that the capability of DQI to define and measure quality in a scientific sense is limited. Design is a continuous process of helping clients and users find an optimal spatial solution (Dewulf and Meel 2004). Furthermore, there is no such a thing as the user or the client, but a range of different stakeholders with diverging interests. For instance, in the design of office buildings, the decision-making process involves not only the architect and different layers of management, but also a wide spectrum of consultants and user representatives such as work councils and unions. However, Markus (2003) provided a clear overview of all the methodological problems of the DQI. It was recognized that the importance of the built environment makes it is absolutely necessary to discuss design quality with laymen, architects, government and other stakeholders (Dewulf and Meel 2004).

3.4.1.5 Construction Process Protocol

The need to construction process protocol has emerged as an attempt to reduce the highly variables construction project processes which resulted from the complexity of construction projects and the fragmentation of the construction industry (Kagioglou et al. 2000). The Latham (1994) report focused on the fragmented nature of the industry leading to the poor communication between all parties working on a construction industry. Consequently, the report concluded that there is a need to significant cost saving through the utilisation and formulation of effective construction processes to leading for increased performance. As such, it was reaffirmed by Egan' report in 1998 which identified the following five key drivers of change:

1. committed leadership;
2. focus on the customer;
3. integrated process and teams;
4. quality-driven agenda; and
5. commitment to people.

Kagioglou et al. (2000) proposed a model for process protocol. Process protocol considers the whole lifecycle of a construction project. It also identifies the various phases of a construction project with particular emphasis on "fuzzy front end" as described in the manufacturing industry. A detailed description of the process protocol model can be found in Kagioglou et al. (1998c). Kagioglou et al. (2000) identified six key principles of the process protocol, they included:

1. *Whole Project View*: An improved 'design and construction process' will have to cover the whole 'life' of a project (Egan 1998) from recognition of a need to the operation of the finished facility. This process focuses at the 'front-end' activities whereby attention is paid to the identification, definition and evaluation of client requirements in order to identify suitable solutions.

2. A Consistent Process: It was found that the problems encountered by temporary multi-organisations (TMOs) (Luck and Newcombe 1996) can be reduced by the application of a consistent process throughout a project's lifecycle.

3. *Progressive Design Fixity:* The 'stage-gate' approach found in manufacturing processes (Cooper 1994) applies a consistent planning and review procedure throughout the process. This approach was adopted in the process protocol and it is presented in terms of 'hard' and 'soft' or 'fuzzy' gates.

4. *Co-ordination:* Co-ordination is one area in which construction traditionally is perceived to perform poorly (Banwell 1964; Latham 1994).

5. *Stakeholder Involvement & Teamwork:* The effective collaboration of project members should enable the successful undertaking of projects.

6. *Feedback:* The phase review process facilitates a means by which project experiences can be recorded, throughout the process, thereby informing later phases and future projects. The process protocol included the creation, maintenance and use of a Legacy Archive which acts as a central repository, or information-spine (Aouad et al. 1998), for the information generated through each of the phases of the process.

According to Kagioglou et al. (2000), there are four elements of the process protocol, these are divided into the following four main stages.

1. *Pre-project stage:* relates to the strategic business considerations of any potential project which aims to address a client's need.
2. *Pre-Construction stage:* defines how the client's need is developed into an appropriate design solution.
3. *Construction stage:* production of the project solution.

4. *Post-Construction/completion stage:* aims to continually monitor and manage the maintenance needs of the constructed facility.

3.4.2 Contract Management-Related CSFs

There are various factors that relate to contract management and affect project performance improvement. These involve: the tendering–related process and review of project contract documents and cost.

3.4.2.1 Tendering-related process

Jha and Iyer (2006) identified that aggressive competition during the tendering stage adversely affected the quality performance of projects. The Hong Kong Housing Authority - HKHA (2002) developed a Preferential Bid Award System (PTAS) to help in assessing contractors' bids. PTAS aims to formalise a holistic approach for assessing contractors' bids so that the award of a contract is based on both price and non-price factors. Bageis and Fortune (2009) conducted a study to identify CSFs affecting the bid/no-bid decisions of Saudi construction contractors, and identified 100 factors from an intensive literature review. In the latter research, the CSFs relating to client and contractor during bid evaluation included project cash flow, the nature of the client (private, public), the availability of qualified human resources, prequalification requirements, the availability of equipment and materials and the quality of available labour. Similarly, many authors have identified the availability of equipment and materials and the quality of available labour as CSFs in evaluating contractors' bids (Hatush and Skitmore 1998; Deng 1999; Al-Harbi 2001; Lai et al. 2004; and Padhi and Mohapatra 2010). On the other hand, considering the contractor's past performance as a measure for bid selection was highlighted by a number of construction researchers as CSFs (Alarco´n and Mourgues 2002; Kashiwagi and Byfield, 2002a, b, c; Wong 2004).

Furthermore, Bageis and Fortune (2009) stressed that contract conditions, historic profile, past experience, the original price estimated by the client, the lowest price, and project procedures are CSFs during the tendering stage. Chan et al. (2004) emphasised that project procedures in terms of procurement and tendering methods are CSFs in project success. Considering the lowest price or bid as a criterion for selecting a contractor has been criticised by many authors (e.g. Hatush and Skitmore 1998; Stein et al. 2003; Al-Reshaid and Kartam

2005). They collectively argued that the serious problems which arise within the construction phase as a result of accepting the lowest bid can lead to serious overruns of time and cost, serious quality problems and eventually to increased litigation. Furthermore, they criticized the selection procedures that depend on the lowest bid rather than on technical issues, although a particular bid may have the lowest pre-qualification score. Awarding the contract to the lowest bid is particularly common for public clients because of the need to demonstrate accountability and fairness. Inevitably, bid price has been used as the sole criterion for contract award decisions (Cheung et al. 2008). Padhi and Mohapatra (2010) claimed that past work performance of contractors is not taken into consideration during the selection procedures and thus, the project will be delivered with poor quality because of the contractor's poor record of past work performance. They added another CSF relevant to the selection procedure, which relates to awarding the contractor a number of projects simultaneously regardless of looking at contractor capabilities, an outcome which is often attributed to the nature of the procurement system used by public sectors. Similarly, Toor and Ogunlana (2009) stated that the award of bids to the "right" designers and contractors was identified as a CSF. Ogunsemi and Aje (2006) highlighted that past performance; contractors' experience; workmanship quality; tender sum and plant and equipment were the most important criteria for contractors' prequalification/bid evaluation in Nigeria.

A number of contractor selection models were developed based on some of the identified factors. Hughes (1986) conducted a study in order to determine the CSFs that impact on project performance. He concluded that inappropriate basic managerial principles, such as improper concentration of the management system by granting the wrong contract, and the lack of communication of the goals can lead to an unsuccessful project. Similarly, Sanvido et al. (1992) developed a framework to identify the CSFs including minimal construction problems and the level of profit. Furthermore, Parfitt and Sanvido (1993) listed a number of CSFs involving the facility team contracts, changes and obligations, facility experience and optimisation of information, which may benefit the project's owner, contractor and facility operator.

Financial stability is considered as a selection criterion for a contractor (Kumaraswamy 1996; Hatush and Skitmore 1998; Al-Harbi 2001; and Padhi and Mohapatra 2010) since it contributes to the improvement of the project performance due to its major role in the procurement process and the availability of skilled staff and equipment. This was confirmed by Alaghbari et al. (2007) who highlighted that financial problems are considered to be a CSF resulting in a lack of improvement in construction project performance in Malaysia. Similarly, Ahmed et al. (2003) and Alaghbari (2005) discussed a number of financial CSFs including contractor financial problems; and financial problems (delayed payments, financial difficulties, and economic problems).

3.4.2.2 Review of project contract documents

Evaluation of project documents, especially contract documents, has been discussed throughout the literature as a CSF to avoid past mistakes or for improvement purposes. It has been identified that project planning documents is a CSF in achieving client satisfaction and meeting project time and budget constraints (Dvir et al. 2003) as well as contract strategy (Barnes and Wearne 1993). Chua et al. (1999) presented a hierarchical model for a construction project in order to distinguish between the CSFs based on the three key project objectives: cost, time and quality. They identified contractual arrangements as a CSF in terms of realistic obligations/clear objectives and adequacy of plans and specifications. Odeh and Battaineh (2002) identified a number of CSFs affecting project performance improvement, which are related to the client. Among these CSFs are discrepancies in contract documents.

Al-Reshaid and Kartam (2005) argued that cost estimation, value engineering and reviews of BoQ are considered to be CSFs affecting the improvement of project performance. In this regard, Davis et al. (2009) discussed the situation of BoQ in Australia’s construction projects; they mentioned the great concerns expressed by Australian construction companies regarding the quality of produced contract documentation. They added that design errors are affected by the client’s demands for the design and documents to be completed within a limited time. The BoQ takes place in both the pre-contract and post-contract periods. Thus, during the post-contract period BoQ provides many benefits including the assessment of contractors and surveyors in terms of progress payments and variations. It also provides a financial structure for contract administration. Moreover, it assists the project management of completed projects, change order management, cost estimation for future projects and BoQ errors themselves (AIQS 2001).

3.4.3 Construction Management Related CSFs

Many attempts have been made to identify the CSFs that influence project performance improvement in the construction phase. Many factors are highlighted in this section based on an intensive search of the literature conducted in order to identify the available findings related to project performance improvement as well as achieve a sufficient level of understanding of this issue.

3.4.3.1 Collaborative relationships

Collaborative relationships in the construction phase are a crucial issue, particularly between the contractor and other parties. Akintoye and Main (2007) identified that the UK contractors expressed their satisfaction with regard to their involvement in collaborative relationships for construction developments. This is because of the need to ensure that there is a shared system for all project parties in terms of risk-sharing, access to innovation and technology, response to market, resource efficiency and client requirements. Moreover, they indicated that many factors could contribute towards the success or failure of collaborative relationships. The CSFs are: commitment of adequate resources from the partners; the equity of the relationship; the recognition of the importance of non-financial benefits and the clarity of the objectives. On the other hand, the principal failure factors are a lack of trust and consolation and lack of experience and business fit. Similarly, Wi and Junge (2010) examined the CSFs that affect project performance including collaboration between project team members and the levels of their knowledge. The collaboration team includes organisational philosophy, social skills, communications, interpersonal relations, leadership, user diversity and team maturity.

3.4.3.2 Project management

Jha and Iyer (2006) identified a number of CSFs affecting the quality of construction project performance which are: the project manager’s competence; top management support; monitoring and feedback by project participants; interaction among project participants and the owner’s competence. Similarly, Pinto and Slevin (1987) reported that managerial variables have a strong impact on project success and are considered an important element among the CSFs, also depending on the type of project. Project management involves the planning, organisation and control of a vast number of complex factors and activities along with their interrelations, all of which have an impact on the success of the project (Lock

1996). A plethora of studies have attempted to identify critical or success factors for project management. It has also been demonstrated that process, communication and interpersonal relationships (trust, respect, etc.) have a significant impact on project success (Brown and Eisenhardt 1997).

Wi and Junge (2010) identified that knowledge factors have an impact on project performance. These include the project manager's competence, innovation of technical uncertainty, problem-solving, organisational knowledge and organisational learning. They stated that the knowledge competence and collaboration competence of the project members have a significant influence on project performance. They argued that this could be achieved by helping the decision-making process of the project team manager by providing information required for organising the team and also through figuring out the problems to be encountered in the behavioural styles in terms of knowledge, collaboration, time availability and the cost of running the current organisation. Furthermore, only statistically significant factors have been selected, and further prediction was not made on project performance using the chosen factors.

3.4.3.3 Standardised project procedures

The standardisation of processes contributes to expected levels of performance improvement in the construction industry, which are often demonstrated in the manufacturing sectors (Griffith et al. 2000; Kondo 2000). Egan (1998) emphasised the importance of adopting standardisation in improving the design of construction. Similarly, Latham (1994) argued that improving the performance of the construction process could be achieved by reducing variations and confrontation. On the other hand, Wegelius-Lehtonen (2001) observed that while the construction industry is a project-oriented industry, where each project is unique and could be considered as a prototype, it has a similar set of process stages unique to each project.

The degree of standardisation of project practices could help to identify the CSFs (Brown and Eisenhardt 1997). Consequently, in order to achieve innovativeness and differentiated products, standardisation can be used as an important tool in managing development resources (Sanchez 1996). Additionally, a standardised process (approach and procedure) is a CSF in project success (Toney and Powers 1997).

Kerzner (2000) suggested that standard project management (SPM) metrics and tools have an impact on project management (PM) methodology in terms of process, which therefore influences project success. He went on to name organisational culture and information management systems as other influences. One way of achieving successful project management is through striving for standardisation by adopting the use of best practice, improving inter-site communication and minimising duplication of effort and waste (Avery 1996). However, to achieve some degree of standardisation within an organisation, there is a need to make the project management approach prescriptive based on a series of checklists, guidelines and mandatory reporting forms (Clarke 1999). The achievement of common standardisation might face some barriers such as multi-cultural and multi-national variations, implicit ideas and low levels of experience and skills, all of which reduce the anticipated outcome. Ultimately, to tackle these problems, great efforts should be invested; firstly by focusing on key success factors as a first stage to standardisation, and secondly by developing an auditing tool for project management (Clarke 1999).

3.4.3.4 Post -project review

Reviewing a construction project is regarded as an essential task in order to evaluate all its aspects with a view to mitigate any problems that might occur in future projects. Pitman (1991) argued that valuable LL can be captured from previous projects and therefore, many faults/mistakes can be avoided. Disterer (2002) identified that a project must be subjected to post-project reviews, post-project appraisals, a project post-mortem, debriefing, reuse planning, reflection, the corporate feedback cycle and experience in order to capture the lessons that can be learnt and used in future projects.

Anbari et al. (2008) highlighted that a post-project review is a CSF affecting future projects, the improvement of overall performance, the development of the learning process and for providing a historical database, based on which future project teams can develop meaningful project plans. They indicated that a post-project review should include: the initiating process; the planning process; the executing process; the controlling process and the closeout process, which represent the crucial stages in the project lifecycle. Similarly, Cleland (1985) and von Zedtwitz (2002) identified the post-project review stage as one of the project evaluation stages which includes the assessment of the success of the completed project, in particular to provide lessons that can be learnt and used for future projects. Huemann and Anbari (2007) asserted that a post-project review is an evaluation of a project involving project management performance, technical processes and performance criteria.

The closing project process has been identified by numerous studies as a necessary task in the construction lifecycle. Kendric (2009) stressed that reviewing the technical aspects of project records helps stakeholders avoid some fatal mistakes to which many construction projects repeatedly fall victim. The closing project process reveals many issues related to a project such as inadequate staffing, lack of commitment, inadequate project management and many other issues all of which will be listed in the project's database after completing the project. He criticised the ignorance of conducting the closing project process in most projects, which leads to lack of learning from the mistakes that have caused problems in the past. He called for an improvement process to obtain better results through a continuous cycle of measurement, small modifications, new measurement, and comparative analysis, which could help achieve consistently better results and minimise future risk. He identified a number of project close-out activities which often involve:

- formal acceptance of the project deliverables (for successful projects);
- the final written report;
- close-out of all contracts, documents, and agreements for the project;
- acknowledgment of contributions; and
- a post-project retrospective analysis to capture the lessons learned.

In addition, Kendric (2009) emphasised that holding a meeting is an effective way to review project objectives and determine the pros and cons that occurred during project execution. He focused on giving more attention to meeting agendas and the ground rules of meetings in order to encourage capturing the ideas provided by participants and avoid attacking individuals and "blame storming". Furthermore, he argued that the outcome of the meeting should be documented to become shared knowledge for all participants to take action either in on-going projects or future projects.

3.4.3.5 Contractor capabilities

Contractor capabilities during the execution of a project are considered a success factor. These capabilities include financial strength, technical features, relevant experience and the skills of communications and collaboration. These capabilities are considered as a powerful influence on contractor performance and therefore, their success is affected by having these capabilities. Soetanto et al. (2001) indicated that there are a number of criteria that could be used for measuring contractor performance. These include: the construction stage (site management, resources management, quality of site personnel, variations and drawings); the completion stage and ease of delivery and the principal criteria in terms of cost, quality and time, quality of services and attitude. The Hong Kong Housing Authority-HKHA (2002), cited in Cheung et al. (2008), developed the Performance Assessment Scoring System (PASS) in the early 1990s to assess the contractor's performance based on a comprehensive set of pre-determined standards. This assessment is a qualitative measure to see how the contractor complies with the given standards. At the same time, PASS is a recording system used for a comprehensive assessment of contractor performance tracks during the execution of projects. The PASS form consists of two measures, which are output and input assessment as shown in Figure 3.7.

Ahmed et al. (2003) and Alaghbari (2005) argued that contractors will be affected by a lack of financial power in terms of employing skilled and experienced people and, as a result, there will be ineffective communication and collaboration. In addition, Alaghbari (2005) went further to indicate that a lack of financial power could lead to employing poor subcontractors, shortage of materials and equipment on site. Odeh and Battaineh (2002) identified that the most important factors affecting project performance improvement are inadequate contractor experience, low levels of labour productivity and slow decision-making by the contractor. Frodell et al. (2008) conducted a study in the context of Swedish construction projects and identified that the existence of high standards of quality consideration within the construction workforce and the use of team working are important project success factors.

Performance Assessment Scoring System (PASS)

Output Assessment (70%)

This includes:

Structural Works Assessment

This assesses the contractor's compliance with the pre-set standards of works in:

1) Reinforcement
2) Formwork and Falsework
3) Concrete
4) Construction quality and practice

Architectural Works Assessment

This assesses the contractor's compliance with the pre-set standards of works in:

1) Floor Finishes
2) Internal Wall Finishes
3) External Wall Finishes
4) Ceiling Finishes
5) Windows
6) Internal Plumbing and Drainage
7) Precast Components
8) Waterproofing
9) Shop front and cladding
10) External Works
11) External Plumbing and Drainage
12) Builders' Work and Test

Input Assessment (30%)

This includes:

Programme and Progress Assessment

This assesses the contractor's compliance with the pre-set standards of works in:

1) Programme Arrangement
2) Progress of work
3) Mild-stone dates

Management Input Assessment

This assesses the contractor's compliance with the pre-set standards of works in:

1) Resources
2) Documentation
3) Coordination and Control
4) Management and Organization of Works

Other Obligations Assessment

This assesses the contractor's compliance with the pre-set standards of works in:

1) Site Security
2) Assess
3) Building Materials
4) Environmental, Health and Other Provisions

Safety Assessment

This assesses the contractor's compliance with the pre-set standards of works in:

1) General site safety;
2) Block related safety; and
3) Housing Authority Safety Auditing System

Figure 3.6: Assessment Details of Performance Assessment Scoring System (Cheung et al. 2008)

3.5 SUMMARY

This chapter reviewed several issues related to construction project performance improvement. These issues include: tools used for improving project performance; project success criteria and project success categorisation; and CSFs of project performance improvement. The chapter highlighted the increasing adoption of benchmarking in many industrial sectors as a tool for improving performance, while the construction industry is still reluctant to fully adopt this tool. Partnering was highlighted as a suitable tool to be used for improving quality and efficiency rather than competitive tendering, particularly in the light of the increasing number of disputes among the contracting parties, and there is an urgent need to develop an appropriate procurement protocol for constructive partnerships. At this time, the construction industry, known for its fragmentation and traditional culture, lags behind other industries in terms of using LL as one of the best tools for achieving sustained continuous performance improvement. This requires creating a suitable environment within which LL of a project will be systematically identified, captured immediately, documented, authorized, disseminated and re-used in future projects to achieving sustained project performance improvement. The chapter identified the common project success criteria which include the "Golden Triangle" in terms of cost, time and quality. The chapter reviewed several studies related to project success. It was highlighted that project success could be categorized into: macro and micro viewpoint; and objective and subjective measures. The chapter highlighted numerous CSFs related to different construction projects industry, such as general construction projects, design & build projects, large-scale construction projects. These CSFs were classified into three main issues: design development-related CSFs; contract management-related CSFs; and construction management-related CSFs. The design development-related CSFs include: identification of design faults; design standardization; and communication and coordination between design and construction. The contract management-related CSFs include: tendering-related process; and review of contract documents. The construction management-related CSFs include: collaborative relationships; project management; standardized project procedures; post-project review; and contractor capabilities. The following chapter highlighted the learning issues and the role of Knowledge Management (KM) in achieving sustained project performance through providing shared knowledge for future projects.

CHAPTER 4

4 LEARNING AND KNOWLEDGE MANAGEMENT

4.1 INTRODUCTION

The construction industry is attempting to learn from past mistakes in order to achieve a continuous performance improvement to approach the surprising and rapid development achieved by the manufacturing industry. Therefore, the concept of learning is an essential tool to attain continuous improvement (CI) through avoiding past mistakes as well as building on positive achievements. Recently, the concept of KM has become a key factor in business thinking due to its role in improvement purposes that can create a successful organisation. The learning curve (LC) is an approach that has been receiving increasing attention since the third decade of the past century for its role in measuring project performance improvement. This chapter reviews the concept of learning within organisations; examines the learning curve as a performance measure; and assesses the role of knowledge management on learning consolidation.

4.2 THE CONCEPT OF LEARNING

Indeed, learning is regarded as a tool for improving organisation performance if there is a commitment to benefit from past mistakes for a better future. When organisations attempt to adjust to their environment, they should use change, learning and adaptation to reassess the present process (Fiol and Lyles 1985). Hedberg (1981) suggested that it is misleading to equate learning with adaptation. He emphasised that, in one form of learning, behaviour requires no understanding, which suggests that simple adaptation (with no understanding of the causal relationship) might be a part of learning, but that learning can involve a great deal more. Nevertheless, learning is emerging as one of the essential tools for driving the cycle of improvement and may soon become one of the key sources of competitive advantage (Goh and Richards 1997). Effective learning gives organisations the opportunity to achieve an improvement in the business environment (Pedler et al. 1997). Furthermore, de Geus (1997) indicated that the ability to learn from internal and external environments places an organisation in a constant condition of readiness for change and sustained continuous improvement. On the other hand, however, learning relates to how companies absorb knowledge and other stimuli from experience due to internal and external environments and thus how acquired knowledge is employed to achieve continuous improvement (Kululanga et al. 1999). Nevertheless, learning is classified into two categories and three styles. The categories are: Organisation Learning (OL) and Learning Organisation (LO), while the styles are: Single-Loop Learning (SLL); Double-Loop Learning (DLL); and Deutero-Learning (DeuL), these are discussed in the next section.

4.2.1 Organisational Learning

The aforementioned discussion focused on the learning concept and how an organisation attempts to learn from past mistakes in order to improve their performance. Next, it should recognise when an organisation could be classified as OL and LO. Accordingly, OL can be defined as the process of using the experience within an organisation to maintain or improve project performance (Nevis et al. 1995). Tsang (1997) argued that OL could be described as a certain type of activity that takes place in an organisation, while LO is a description used for a particular type of organisation. He went further by stating that the key difference between OL and LO appears to be between 'becoming' and 'being'. Earlier, Argyris and Schön (1974) described OL as a process in which detection and correction of errors could be found from both internal and external environments. However, Duncan and Weiss (1979) argue that OL is not only a process of 'detection and correction' but a behavioural change which bridges the gaps between actual and expected performance outcomes. Wong et al. (2009) went further and specifically described the OL in contractor organisations as a process of acquiring knowledge uncovered from experience and information obtained from external sources. Kululanga et al. (1999) identified that the knowledge acquired is subsequently captured by contractor organisations for improvement actions when they are necessary. Garvin (1993) identified five activities at which a learning organisation in the construction industry should be skilled:

- systematic problem solving;
- experimentation with new approaches;
- learning from their experiences and past history;
- learning from the experiences and best practice of others; and

- transferring knowledge quickly and efficiently throughout the organisation.

Accordingly, organisation performance improvement could be achieved through commitment to learning from past mistakes and employing these mistakes to change the actual performance to expected performance outcomes besides the learning from experiences and best practices of others. Therefore, an organisation could move from 'becoming' to 'being' which means it turns into an LO, which is discussed in the next section.

4.2.2 Learning Organisations

When an organisation promotes the learning concept, involving all staff in a conscious, systematic and synergistic fashion, it could move to be an LO. In this regard, the concept of an LO has been attractive for organisational learning research. A learning organization is considered to be a valuable tool used for facilitating learning and knowledge management, which has been described as an important strategy for achieving improvements in organizational performance and sustaining a competitive advantage (Buhler 2002; Korth 2007; Davis and Daley 2008). Chinowsky et al. (2007) stated that an organisation is classified as an LO when it is skilled at creating, acquiring, sharing and applying knowledge and then embracing change and innovation at all levels, resulting in optimum performance and maximum competitive advantage. Garvin (1993) describes an LO as an organisation that makes a collective effort to expand organisational capability in order to create desirable outcomes for the whole establishment through a combination of individual and group learning. Nevertheless, Leitch et al. (1996) suggest that an LO is an organisation that is distinguished through adopting collective learning, while the term 'OL' refers to the methods of achieving collective learning.

Chinowsky et al. (2007) argue that the move to becoming a learning organisation is a major transformation. However, this move requires drivers, a situation that has been documented by many researchers in domains inside business (Stata 1989; McGill et al. 1992; Goh 1998). As such, Drucker (1993) indicated that the key among these drivers is the emergence of the knowledge staff and the knowledge era as the new model for an organisation's staff. However, it might be that the concept of a learning organisation is a 'new' idea to construction organisations, although the concept is well established in the management field (Chinowsky et al. 2007). Senge (1990a), who is considered as the instigator of the LO concept, emphasised that organisations have to concentrate less on day-to-day events and more on the underlying trends and forces of change that cause the day-to-day events to occur. Therefore, organisations can learn new ways in which they can address the crucial issues and adapt their behaviour to improve processes. Such an idea requires that both generative and adaptive learning must occur in a learning organisation. Equally, Senge (1990b) and Garvin (1993) identified that generative learning focuses on an organisation creating new knowledge, while adaptive learning focuses on how an organisation changes its processes to adapt to changing environments. The adoption of such perspectives allows active learning organisations and the related 'active' or 'reactive' concepts of knowledge management and LL to be distinguished (Chinowsky et al. 2007).

An effective LO is closely related to specific measurable characteristics. Jamali and Sidani (2008) identified five distinctive characteristics of an effective LO. These include: employee participation, learning climate, systematic employee development, constant experimentation and learning reward systems. In this regard, Weldy (2009) stressed the importance of the training of staff and its direct impact on an effective LO in terms of achieving sustainable performance improvements, maximising the benefits gained and remaining competitive in the face of global competition, a constantly changing environment and unstable economic conditions. Accordingly, an organisation could be regarded as a learning organisation by promoting learning in a conscious, systematic and synergistic fashion which must involve all staff in the organisation. Achieving this would classify the organisation as being at the highest state of organisational learning, in which an organisation has achieved the ability to transform itself continuously through the development and involvement of its entire staff.

4.2.3 Learning Styles

Learning styles can be defined as the manner in which an organisation absorbs and applies the acquired knowledge for achieving continuous performance improvement (Kululanga et al. 1999; Wong and Cheung 2008). Many studies identified several OL styles (Argyris and Schön 1978; Hayes and Allison 1998; Kurtyka 2003). Argyris and Schön (1978) identified three types of learning styles: SLL; DLL; and DeuL. Kululanga et al. (1999) used this classification in their study related to investigating the OL styles practised by contractors in the UK. Moreover, these three styles were used by Wong and Cheung (2008) in order to investigate the effect of contractor organisations' ability to learn at inter-organisational level about their practices and OL styles.

There are two principal OL styles: adaptive learning and generative learning that tie in with SLL and DLL (Murray and Chapman 2003). Jashapara (2003) identified two major project learning styles, which involve behavioural and cognitive learning. Behavioural learning can be viewed as "*new responses or actions based on existing interpretations.*" On the other hand, cognitive learning depends on achieving performance improvements based on the continuous review and modification of working methods. Furthermore, Jashapara suggested that cognitive learning and behavioural learning are considered as SLL and DLL respectively.

4.2.3.1 Single-loop learning

Single-loop learning refers to the change of behaviours and actions taken when it is discovered that there is no match between the desire and what actually happens (Argyris and Schön 1978). This requires the detection and correction of errors to ensure the achievement of anticipated outcomes. Bierly et al. (2000) described SLL as the response of an organisation to changes in the environment without changing the core set of its organisational norms and practices, whereas Kurtyka (2003) described SLL as a change of actions regardless of the assumptions that lead to the differences between the anticipated and the actual outcomes. SLL is regarded by Kululanga et al. (1999) as a lower-level learning style that focuses on addressing the symptoms of problems without identifying their origins. Fiol and Lyles (1985) argued that SLL contributes partially to the improvement of organisations often through addressing symptoms.

Nevertheless, despite the inability to identify the reasons for a problem, SLL makes the organisation aware of the need to address the current situation. Indeed, McGill and Slocum (1993) argued that, despite the slow changes in the business environment that result from SLL, it indicates that there is a need to adopt new ways of working to lead to success. It is therefore considered as adaptive learning (Senge 1990b), which aims at error detection, correction and prevention (Wang and Ahmed 2001). It could also be adopted incrementally without requiring high levels of cost and time (Sun and Scott 2003). Accordingly, SLL can be used appropriately by organisations operating in an environment of slow change (Wijnhoven 2001). Consequently, SLL appears as an accidental detection of some mistakes that are corrected without referring to the original causes, which might contribute to these mistakes occurring in future, and this can be avoided by using DLL.

4.2.3.2 Double-loop learning

Double-loop learning refers to taking action to achieve changes in the environment by changing the crux of a problem and not solely by addressing its symptoms (Bierly et al. 2000). The focus is then on addressing the root causes through the use of the symptoms of the problem (Kululanga et al. 1999). Furthermore, it enables the organisation to detect and address the major causes of underperformance in order to assist in creating new and effective ways of working (Argyris 1992). Kululanga et al. (1999) provided the example of partnering as a case of DLL within the construction business environment. They argued that DLL provides a good opportunity to identify and address the root of a problem to avoid its occurrence in the future. Kurtyka (2003) clarified the difference between the DLL and SLL styles, which appears to contribute towards performance change.

In this regard, Wong et al. (2009) explained that the SLL style leads to improvement through discovering the symptoms of a problem. On the other hand, the DLL style formulates an improvement process by using the discovered symptoms as indicators of the need to change the organisational assumptions (Kurtyka 2003). Unlike SLL, DLL is considered as generative learning, which focuses on the radical thought that makes all knowledge and data within existing systems unusable (Easterby-Smith et al. 1998). Therefore, it is necessary to adopt generative learning within the highly dynamic environment in which organisations operate, where the rate of knowledge obsolescence is far greater (Wijnhoven 2001).

This type of style is considered suitable for use in the context of SDM projects due to the repetitive nature of these models, which enables the progressive detection of errors and addresses the root causes of the underperformance of projects. Additionally, the SDMs environment provides a good opportunity for adopting a DLL style, which was considered a part of an effective use of partnering in construction (Kululanga et al. 1999). This will in turn contribute to sustainable improvements in SDM project performance.

4.2.3.3 Deutero-learning (triple-loop learning)

The adoption of a Deutero-learning style depends on the ability of an organisation to establish a learning system. Argyris and Schön (1978) stated that DeuL, or so-called triple-loop learning, involves the ability of ‘learning to learn’. Francis (1997) defined DeuL as having a mechanism or system development in which an organisation enables learning to be made explicit and also as a tool for the organisation to reaffirm its continuous commitment to learning. In this type of style, organisations need to review the present system, which means continuously challenging their mission, vision, strategies and culture and continuously checking existing products, processes, structures and systems with a view to the future market place (Wang and Ahmed 2001).

This needs the operation of continuous learning cycles, which involves acquiring, creating, sharing and implementing new knowledge (Sambrook and Stewart 2000). Organisations should identify the areas that contribute towards improvement, set out to explore in depth and improve their ability to learn effectively, and therefore become skilled at addressing improvement through such a total learning strategy (Pedler et al. 1997). The DeuL style provides construction contractors with a considerable opportunity for achieving sustainable improvement (Kululanga et al. 1999). Organisations that foster a deutero-learning culture should explore the effectiveness of their entire learning process as well as the effectiveness of the mechanisms employed for addressing improvement. This should be coupled with an inquiry into the strategy that strengthens the assumptions of their practices (Redding and Catalanello 1994). However, in order to adopt the DeuL style, an organisation needs an integrated system of learning that is based on a clear strategy, mission and vision to achieve continuous performance improvement.

4.2.4 Learning Mechanisms

A learning mechanism is an essential tool to achieve the anticipated outcome of learning in terms of acquiring the knowledge that contributes to improvement. Learning mechanisms can be viewed as key organizational capabilities in terms of the key elements of the system's internal environment (Shani and Docherty, 2003, 2008). Mitki et al. (2008) emphasised that an organisation should focus on the design of learning mechanisms for the development of shared understanding, creation of system knowledge, and the transformation of the shared understanding and system knowledge into action.

Barnett (1994) stated that organisations employ learning mechanisms to acquire knowledge for maintaining continuous improvement in their performance. Therefore, such organisations attempt to create learning through a corporate activity by utilizing various learning mechanisms for acquiring appropriate knowledge from their internal and external environments (Nonaka 1994). Kululanga et al. (1999) outlined the main mechanisms to create knowledge, which are based on:

- learning through collaborative arrangements. This occurs when organisations, although they remain distinct, still learn from others or each other for instance through corporate mentoring, partnering/alliancing, joint-venturing, etc., (Badaracco 1991); symbiotic relationships, such as corporate mentoring (Chang 1996); providing a forum for knowledge acquisition (Hamel 1991); engaging in joint research schemes; and through the results of team working (Luffman et al. 1996: Mendelsohn 1998);
- learning through non-collaborative arrangements. This involves the combination of enterprises, as in mergers and acquisitions between organisations operating in the same industry or different industries (Kululanga et al. 1999);
- learning through networks based on international institutions (e.g., the Construction Industry Institute and the European Construction Institute), research and development-based networks (e.g., the Building British Research Establishment), technology-based networks (e.g., Construction Information Technology), theme- focused networks based on a topic that professionals want to address for industry, learning networks (e.g., Construction Productivity Learning Network), professionally-based networks (e.g., the Institution of Civil Engineers), inter-company networks based on the value chain, socially-based networks and employee-based networks (Walter and Brantley 1992; Construction Policy Directorate 1992);
- learning through in-house research schemes such as team learning, failure/success reviews, benchmarking, shows and exhibitions (Nam and Tatum 1992; Garsden 1995); and;
- learning through individual staff as they acquire new competencies and understand new processes and functions that result in effectiveness and efficiency improvement at the operational level (Maloney and Federle 1995) through staff training, internal and external seminars, attracting staff from other organisations, inviting experienced practitioners to tutor the organisation, contracting staff from

companies with innovative methods, individual learning initiatives and employee learning contracts.

Schindler and Eppler (2003), on the other hand, classified the methods used for fostering learning from project experiences into two groups:

- process-based methods of gathering LL from concluded projects, stressing the relevant steps and their sequence in the course of a project's time line. Thus the concentration is on a procedural approach to the capture of key learning from a project; and
- documentation-based methods to learn from project experiences by focusing on features of the content-wise representation of the experiences and the storage of content within the organisation. These serve as appropriate representation formats or structures for project insights.

Indeed, there are multiple learning mechanisms that can be used for acquiring knowledge in order to maintain a continuous improvement. These mechanisms are based on the organisation's capabilities that can contribute towards adopting these mechanisms. Significantly, in the light of adopting such SDMs, there is availability of using effective mechanisms that lead to continuous performance improvement.

4.2.5 Learning Framework Models

Several frameworks have been proposed to clarify learning styles and mechanisms. In this regard, Yeo (2002) proposed a framework that combines the learning styles and learning mechanisms as shown in Figure 4.1. The framework comprises three stages: SLL, which involves learning relevant to individual goals; DLL, which involves learning relevant to team goals; and DeuL, which involves learning relevant to organisation goals and is concerned with strategic management. Therefore, the chronological stages of learning contribute to changes in behaviour, positive attitude, work commitment and result in organisational success.

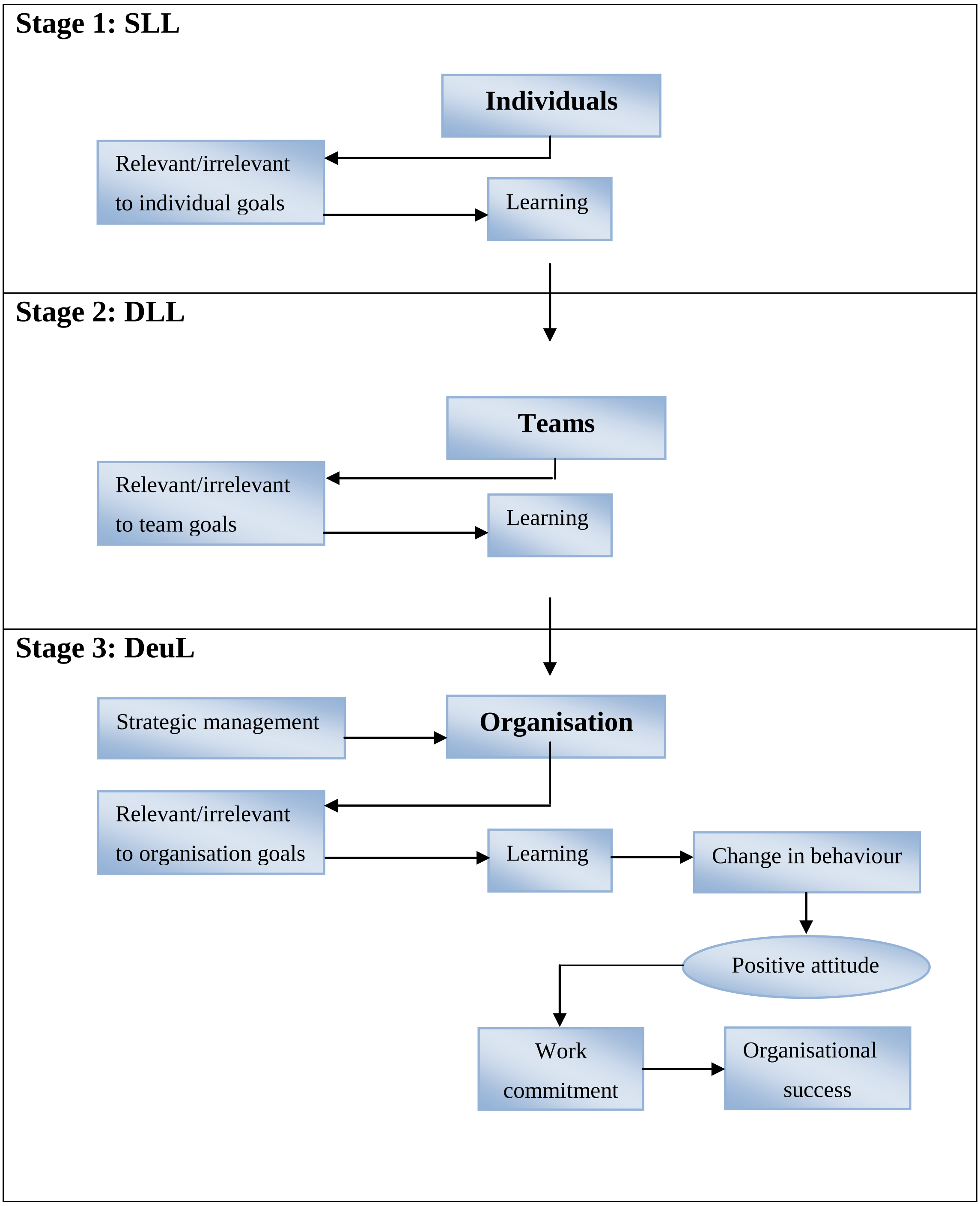

Figure 4.1: Stages of Organisational Learning and Development (Yeo 2002)

Similarly, Crossan et al. (1997 and 1999) proposed an organisational learning framework, which, whilst taking the environment into consideration, shows the transfer of knowledge through three levels: individual, group and organisation (Figure 4.2).

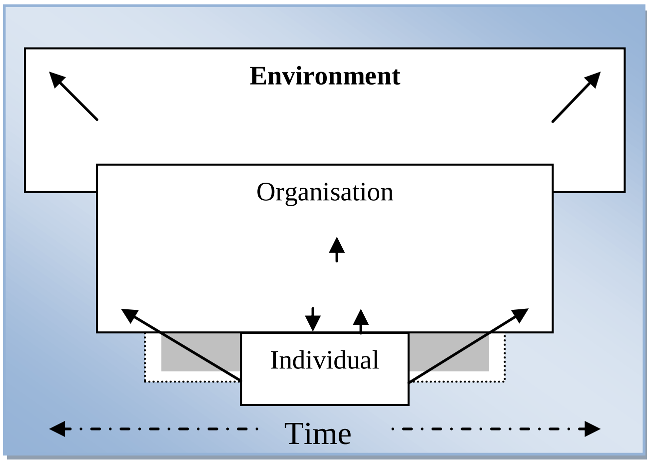

Figure 4.2: Organisational Learning Framework (Crossan et al. 1997 & 1999)

Furthermore, specifically, Gieskes and ten Broeke (2000) conducted a study to investigate achieving continuous improvement in infrastructure construction projects through learning. They proposed a learning framework in a project-based organisation. As shown in Figure 4.3, the framework illustrates the stages of learning through three projects (A, B, C), where each project has multiple phases. Moreover, the framework proposes three stages of learning: (1) intra-project learning, which refers to the acquisition and use of knowledge and experience within the same project; (2) inter-project learning, which refers to the transfer of knowledge and experiences from one project to other projects within the same time frame or over different periods of time, and (3) a learning process that is not directly related to the projects, but to other organisational processes, for instance, to the standing line organisation.

The same authors focused on investigating whether repetitive work processes are a suitable environment for achieving continuous improvement. Nevertheless, in such a framework, it is assumed that there are only repetitive processes in the three projects, while each project is unique, which echoed the findings of Wegelius-Lehtonen (2001), who stated that each project is unique and can be considered as a prototype, although a similar set of process stages is involved in every project. In this research, the models in the SMoI's projects are typical in terms of design, material specifications and procurement except for the size of projects; therefore, SDMs are very well suited to achieving continuous performance improvement through the learning concept.

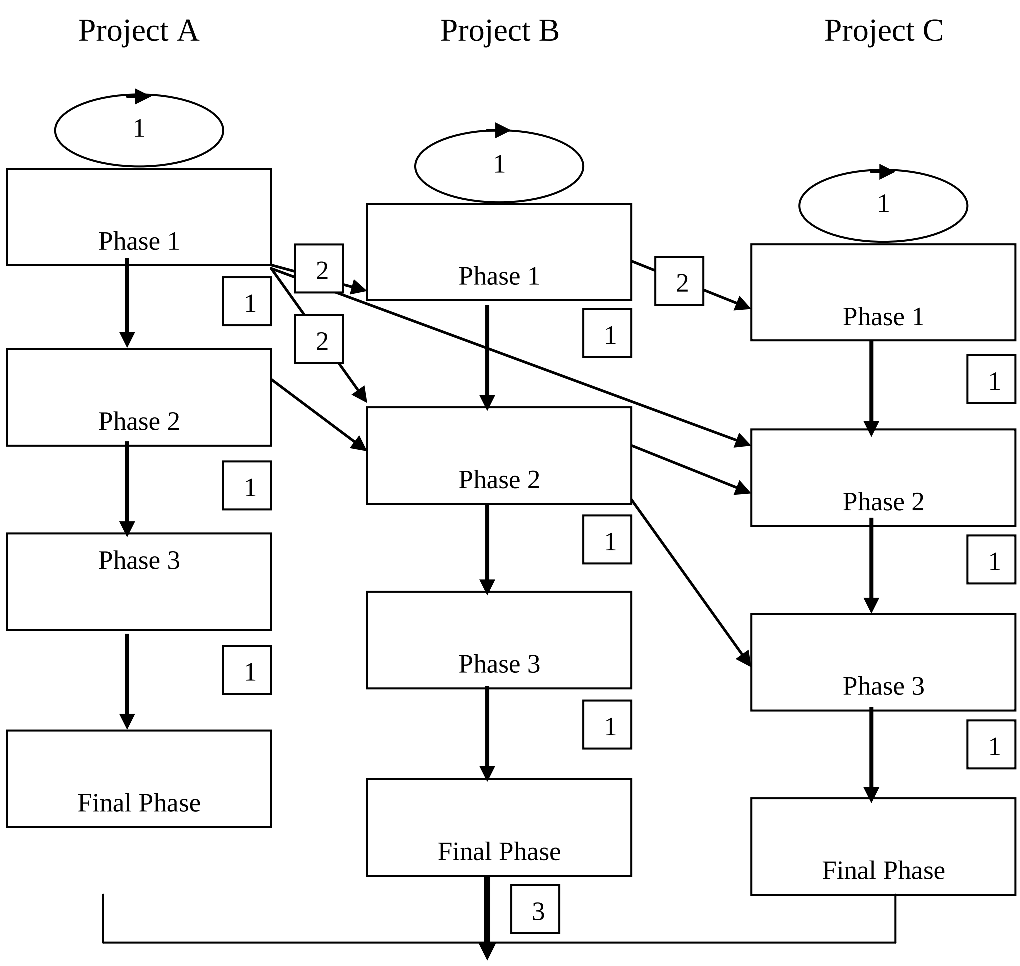

Figure 4.3: Learning in a project-based Organisation (Gieskes and ten Broeke 2000)

Similarly, Law and Chuah (2004) proposed a project action-learning framework, as shown in Figure 4.4. This framework applies the concept of OL to a specific function or project team, which integrates learning and a project in an organisation, to support organisational learning ideas. It was built based on two concepts: performance improvement and transfer of information between individuals and teams. Therefore, the latter contributes to the building of a knowledge base correlated with performance evaluation and the creation of integrated, project-based, action learning. Nevertheless, this framework could be valid for a specific project, but not necessarily for other projects due to the variations existing among these projects.

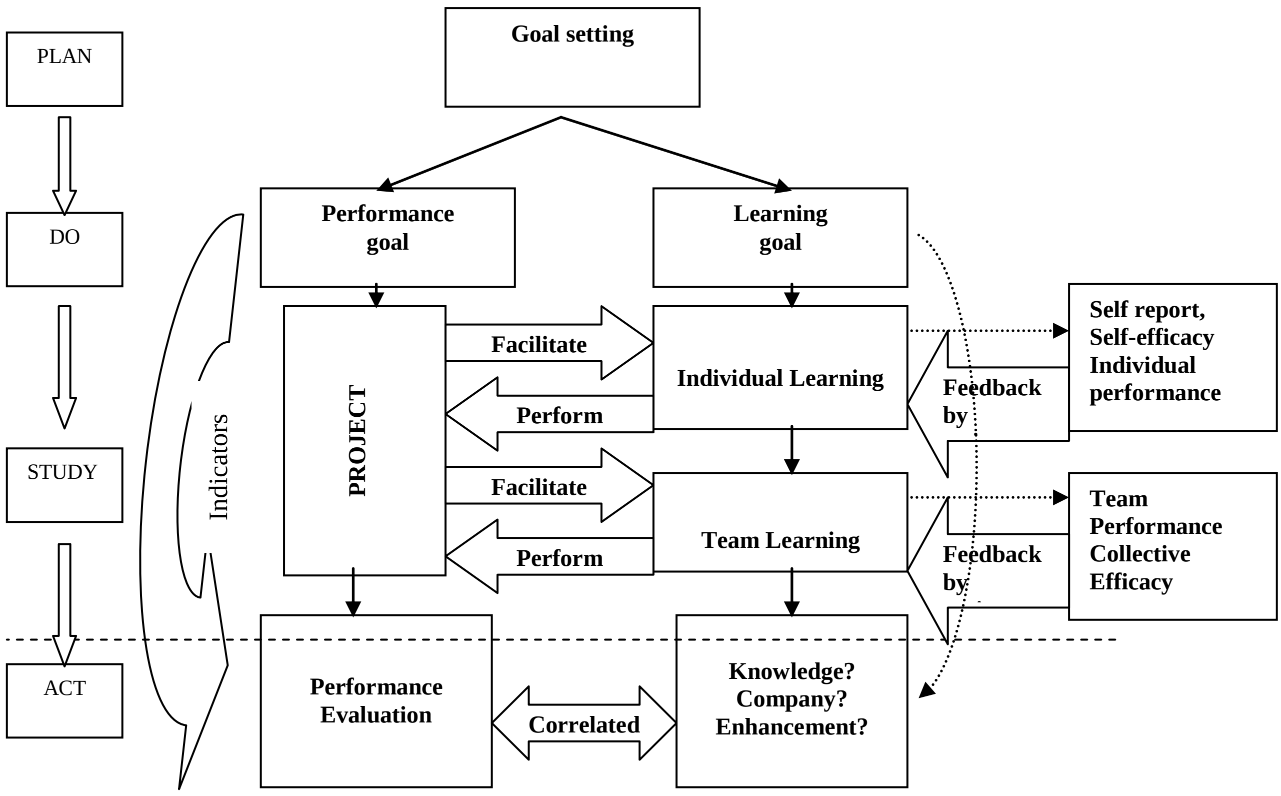

Figure 4.4: Project Action-learning Framework (Law and Chuah 2004)

4.2.6 Factors Affecting Learning

Undoubtedly, there are many factors - either internal or external – that affect learning within the nature of the working environment and influence the anticipated outcome of the learning cycle. Yeo (2003) conducted a study to examine the relationship between OL, organisational performance, and success in Singapore. He identified a number of factors affecting learning, which are summarised in Table 4.1. Nevertheless, learning can be strengthened through a strong commitment to learning, training programmes and effective communication to encourage staff to learn.

On the other hand, learning becomes very weak when human resource policies are not in place and also as a result of managerial absence. Learning can be revived through recognising the importance of learning in organisation performance improvement and by the existence of an organised management that is able to draw up its goal as well as undergo continuous assessment. In contrast, factors that terminate learning are: unorganised management leading to a full absence of commitment and lack of a clear vision; disappointed staff due to punishments; and lack of collaboration with other organisations.

Table 4.1: Learning Factors (Yeo 2003)

Factors that strengthen learning	
	• strong interface between training programmes and work • strong management commitment to learning • staff empowerment • strong team spirit • open culture that promotes trust and respect for one another • communication of clear vision, mission and outcomes
Factors that weaken learning	• absence of concerted effort • lack of reward and recognition • weak leadership • information overload • narrow/myopic human resource policies
Factors that recover (revive) learning	• frank assessment and a sincere wish to change for the better • supportive environment • strong leadership and clear direction • recognition that learning improves project performance • assistance from an external consultant
Factors that terminate learning	• no commitment and support from top management • lack of need • being punished or penalised unnecessarily • entrenched habits • poor incentives • learning by firms outside the focal firm (suppliers and other firms in the industry)

Furthermore, Yeo (2003) stated that there are a number of learning activities that have a significant influence on learning outcome, these include:

- learning climate;
- self-development;
- inquiry and dialogue;
- flexible organisational structure;
- team-building;

- flexible reward system;
- participatory policymaking;
- systems thinking; and
- learning strategies.

Organisation capabilities play a vital role in organisational learning. In this regard, Dimitriades (2005) demonstrated that to achieve learning more quickly and effectively, organisations are required to promote innovation, as well as how learning takes place and evolves within the context of the organisation. This requires the development of strategic learning capabilities by linking learning with knowledge management within the context of the organisation.

The role of staff is also critical in the learning process, since they are regarded as the core of the learning cycle. Lee-Kelley et al. (2007) stated that due to the dependency on individual learning, there are three initial strategies that should be implemented by Human Resources (HR) managers in order to reduce possible staff turnover: first, linking shared vision, challenges and systems linking together via personal mastery; second, being more critical of which mental models are developed and shared within the organization, and finally, developing team-learning systems throughout the organization. They emphasized that HR managers should recognize specific career needs for their knowledge staff and that adopting appropriate strategies will increase retention. In turn, there are many factors which influence the process of learning and therefore, continuous improvement. However, learning can be strong through effective management, clear vision and strategies and commitment to learning as an improvement tool.

4.2.7 Learning Situations

Learning situations are a range of circumstances emerging during the course of a project where new learning can be captured, and these can be either some critical events or the normal day-to-day operations (Kamara et al. 2003). Tan et al. (2007) described learning situations as special events where new learning or knowledge can be created. The identification of the various learning events in advance can help in the planning and consequent development of a methodology for the capture of reusable project knowledge.

However, learning is considered as a continuous phenomenon that could occur at any place or time, providing opportunities for identifying and capturing knowledge.

There are two broad categories of learning situations: formal and *ad hoc*. Formal learning situations involve routine events such as site meetings and project reviews conducted at the end of each of the project stages or at predetermined intervals as well as post project reviews (Tan et al. 2007). Formal learning situations can be identified through the RIBA Plan of Work (RIBA 2000) or the Process Protocol (Kagioglou et al. 1998). The *ad hoc* learning situations identified are centred on the management of change (e.g. the change in political climates and clients, the involvement in new types of project in another country), problems (e.g. undiscovered condition of a project and the supply of major building fabric) and the adaptation required in response to the changes and problems (Tan et al. 2007). Furthermore, *ad hoc* learning situations have been identified by Egbu et al. (2003) and described as ‘triggers of knowledge production’ where knowledge is being produced and captured. The latter categorised the triggers of knowledge production in construction organisations into three groups: problem-solving; managing change; and innovation.

4.3 THE LEARNING CURVE (LC)

The use of the Learning Curve (LC) has attracted attention from many organisations in recent years due to its effective role in improving performance. It is used to measure project performance through cost, time and quality. Zangwill and Kantor (1998) stated that the LC could be used for almost any performance measure, such as cycle-time, defects, customer satisfaction and costs. They noted that the LC is also called the experience curve or the progress curve.

4.3.1 The Learning Curve Concept

The LC is regarded as an aggregate model that might be adopted to represent both individual learning and group or organisational learning (Anzai and Simon 1979; Argote 1999; Yelle 1979). The adoption and effective implementation of LC could lead to savings of 10 to 30 per cent of time and cost each time a company’s experience at producing a product doubles (Kerzner 2006). In fact, since its emergence over half a century ago, Wright (1936) stated that the LC has been widely used to forecast cost and other performance measures. Moreover, the adoption of the LC started gradually as private companies applied their experiences of manufacture using the LC (Asher 1956). Kerzner (2006) indicated that the LC was adapted from historical observation that the repetitive tasks performed by an individual are improved by frequent repetition. He mentioned that empirical studies of the LC phenomenon yielded three conclusions on which the current theory and practice are based:

- the time required to perform a task decreases as the task is repeated;
- the amount of improvement decreases as more units are produced; and
- the rate of improvement has sufficient consistency to allow its use as a prediction tool.

Accordingly, the effective use of the LC can significantly contribute to tangible benefits for company performance. There is a consistency in the achievable improvement shown by a constant percentage reduction in the time required as the quantities of units produced are successively doubled. Therefore, crucially, the significant improvement from using the LC for manufacturing projects has been recognised. Furthermore, Zangwill and Kantor (1998) stated that the LC is considered as one of the best ways in which improvement can be observed and tracked. They proposed an approach of continuous improvement by using the LC as part of the learning cycle. During each period this can be achieved by management taking action to improve the process, observing the results and then learning how to improve the process further over time. Accordingly, the information gained through each cycle will be employed to develop better strategies for future projects/products. Significantly, the inherent feedback and adaptation capabilities obtained from learning cycles seem fundamental to the achievement of rapid, sustainable improvement. Similarly, Toyota staff use an analogous concept of learning cycles which involves systematic analysis of performance in the form of weekly analyses to improve the way that staff do their jobs (Adler and Clark 1991). Consequently, continuous improvement could be achieved through adopting the LC. Specifically, more benefits of the LC could be achieved in the domain of repeated tasks and projects.

4.3.2 Factors Affecting Learning Curves

Undoubtedly, there are many factors affecting the use of LC, and therefore, the anticipated outcome with respect to performance improvement. Kerzner (2006) stated that none of these factors perform entirely independently, but are interrelated through a complex network. Among these factors are listed below:

- *Labour efficiency* – This is the most common factor, which depends on effective learning achieved by the staff from a repetitive task. Therefore, less managerial supervision is required, waste and inefficiency are reduced or even eliminated and productivity is increased.
- *Work specialisation and methods improvement* - The availability of specialisation increases staff proficiency at a given task. Redesigning and improving work methods are further crucial factors (Abell and Hammond 1979).
- *New production processes* - Process improvements and innovations can be a critical source of cost reductions, particularly in capital-intensive industries (Kerzner 2006).
- *Product standardisation* - Standardisation is beneficial for staff learning through the replication of necessary tasks (Abernathy and Wayne 1974).
- *Product redesign* - The experience provides to the producer and customer a clear understanding of performance requirements. This allows the redesign of a product and the improvement of quality whilst still using less costly materials and resources as well as improving performance according to relevant dimensions.
- *Incentives and disincentives* - Compensation plans and other sources of experience can be both incentives and disincentives (Hirschmann 1964).

4.3.3 Learning Curve Limitations

The use of LCs is restricted by a number of limitations, so care must be taken to avoid misguided conclusions. Kerzner (2006) identified a number of limitations, some of which are listed below:

- The LC does not continue forever.
- The LC knowledge gained on one product may not be extendable to other products unless shared experiences exist.

- LCs are most useful on long-term horizons (i.e. years). On short-term horizons, benefits perceived may not be the result of learning curves.
- The benefits of LCs can be affected by external influences, such as government regulations and limitations on materials.

In contrast, Jaber and Guiffrida (2008) argued that the LC has limitations that restrict its use. One limitation is that "*the learning phenomenon continues indefinitely contrary to the plateau behaviour observed in learning curve data*". Another limitation is the assumption that "*all units produced are of acceptable quality*".

Within this context, SDM projects have some similar factors, namely product standardisation, product redesign and new production processes that make it appropriate to advocate employ the LC and then achieving performance improvement for these types of projects as discussed in Chapter Five. In turn, LC is a suitable tool for improving performance specifically in the domain of repetitive tasks, where this creates a familiarity between staff and tasks which contributes towards wasted time as well as money. As such, due to the repetitive nature of SDMs, they are very well suited for adopting the LC and so achieving improvements in the performance of SDM projects as well as continuous improvement over the plan implementation. Additionally, an action for improvement could be taken as a result of the amount of learning obtained from repetitive SDM projects.

4.4 KNOWLEDGE MANAGEMENT (KM)

The concept of Knowledge Management (KM) has become a key factor in business thinking due to its role in improvement purposes that can create a successful organisation. The importance of KM has led to it being embraced by many organisations, and the common suggestion is that the majority of successful organisations in the world are experts at managing their knowledge (Nonaka and Takeuchi 1995; Davenport and Prusak 1998). To achieve success from the use of KM, an organisation should pay considerable attention to the effective and efficient deployment of various KM strategies and tools within its own specific context (Udeaja et al. 2008). Two available definitions of 'knowledge management' are: (1) *"knowledge management represents a systematic and organised approach of using knowledge for storing and extending knowledge in order to increase companies' output and performance"* (KPMG 1998); (2) *"knowledge management is equivalent to the strategies and* *processes for knowledge identification, documentation and influence with the aim of making companies competitive"* (APQC 1996).

4.4.1 Knowledge Management Concept

Any attempt to identify faults/mistakes, even for development purposes, is affected by how effectively an organisation has captured and saved its history. Knowledge is considered as one of the most crucial resources in any organisation (Ofek and Sarvary 2001; Smith 2001). Accordingly, a great reduction in the time spent on problem solving and an increase in the quality of work can be achieved through the reuse of existing organisational knowledge gained by experience (Dave and Koskela 2009).

Dave and Koskela (2009) indicated that two types of knowledge exist within organisations: tacit and explicit. They reported that there is a developed and implemented system made by the construction sector to manage the capturing, storing and the retrieval of explicit project-related information. Some examples of explicit knowledge include: procedure manuals, organisation maps, work breakdown structure, document management systems, collaborative intranets and extranets, etc. (Nonaka and Takeuchi 1995; Dave and Koskela 2009). On the other hand, Lin et al. (2005) indicated that tacit knowledge can be defined as the way of storing experience, LL and other valuable information in the construction professional's mind without transferring them to another person or storage system. Dave and Koskela (2009) argued that the management of tacit knowledge is of crucial importance to the construction industry due to its fragmented nature and the many unique features of construction projects. Hence, they argued that it must benefit from a significant amount of knowledge becoming available during project implementation. However, Kazi and Koivuniemi (2006) argued that this knowledge is mostly not used effectively and sufficiently due to its remaining stored in the minds of project team members, and therefore, will be unavailable for transfer across the organisation to be used in future projects. Lin et al. (2006) and Newell et al. (2006) criticised the insufficient attention paid towards managing tacit knowledge.

There are a number of critical success factors (CSFs) affecting KM. In this regard, Koenig and Srikantaiah (2004) identified a number of CSFs that were categorised into five main categories:

- Leadership;

- Culture;
- Structure, roles and responsibilities;
- IT infrastructure; and
- Measurement.

Significantly, the suitable way of improving organisation performance is the effective adoption of KM. Managing knowledge in terms of capturing and documenting can lead the organisation to identify problems in order to solve them and thus, improve performance.

4.4.2 Knowledge Management in the Construction Industry

The nature of the construction industry is considered to be a key factor in adopting KM. In fact, a construction project is regarded as unique in that there is a sharing process between a number of stakeholders who collaborate with each other at various stages during the construction phase (Dave and Koskela 2009), and eventually, they may or may not continue to work together once the project is completed (Kamara et al. 2002). Furthermore, there are large amounts of information communicated between stakeholders across the various stages of a project. Consequently, the combination between information management and KM is a very difficult task for the construction industry, resulting in the poor efficiency of the overall process. Accordingly, due to the fragmented nature of the construction industry, the anticipated benefits from KM are underestimated, which makes construction a significantly complex process (Dave and Koskela 2009).

Nevertheless, despite the aforementioned difficulties, KM has been embraced widely in the Architecture, Engineering and Construction (AEC) industry (Udeaja et al. 2008). A survey carried out in UK project-based organisations revealed that about 50 per cent of the respondents noted that KM plays a significant role in deploying new technologies and new processes that will benefit their organisations (Egbu 2002). This was confirmed through a subsequent study that revealed that 40 per cent of construction organisations already had a KM strategy and another 41 per cent planned to have such a strategy within a year (Carrillo et al. 2003).

Despite the progress made towards adopting KM, there are still challenges in the management of project knowledge as pointed out by Udeaja et al. (2008) who argued that there are some practical difficulties preventing the effective use of KM. These include:

fragmentation of the knowledge required to deliver projects due to it being held by different staff in different organisations, and the fact that the knowledge acquired depends on different resources or previous experiences. Consequently, there is no holistic system that organises the process of KM.

In practice, there is a major problem related to passing information to other staff in the organisation or involved in a project. This was further explained by Kamara et al. (2003) who indicated that in the current practice, the reuse of captured knowledge is often associated with persons rather than projects, which means this knowledge can be reused in the projects executed by those people, and therefore, in the post-project reviews (PPR) used within each participating organisation. Additionally, Udeaja et al. (2008) argued that a common problem with PPR is concerned with the insufficient time available for captured knowledge use in the same project, however, captured knowledge can be reused in future projects. They suggested that, in order to mitigate this problem, the approach of 'live' capture and reuse of project knowledge is essential if it is to be made available for use during and after the project's implementation.

4.4.3 Knowledge Management Process

Most of the knowledge in the construction industry is generated during the progress of a project in order to achieve a successful outcome in terms of meeting the client's requirements. Tan et al. (2007) argued that to benefit from the knowledge captured from the project, the manager should be able to prevent the "reinvention of the wheel" and the repetition of similar mistakes. This should serve as the basis for innovation, overall improvement and the maintenance of competitive advantage. Accordingly, to achieve KM successfully, there are a number of key processes that should be followed. Bhatt (2001) described a sequence of the KM process, including: knowledge creation; knowledge validation; knowledge presentation; knowledge distribution and knowledge application. Demarest (1997) went further to identify the level of interaction between these processes, some of which may exist simultaneously. Nevertheless, four main KM processes were identified through the KM process models that have been developed within the domain of construction (i.e., Robinson et al. 2001; Kululanga et al. 2001): knowledge capture; knowledge sharing; knowledge reuse; and knowledge maintenance. These processes are explained below.

1- Knowledge Capture

Knowledge capture consists of three steps:

- Identifying and locating knowledge - This step involves managing the identification of the types/categories of knowledge and the location of the learning situation (Kamara et al. 2003).
- Representing and storing knowledge - This covers indexing, organising and structuring the knowledge (Robinson et al. 2002; Rollett 2003). This could be achieved through theme-specific knowledge areas and authoring knowledge (Markus 2001). Davenport and Hansen (1999) identified the way in which knowledge can be organised according to the standard or format specified along with the details required and the adding of context to the knowledge depicting where the knowledge was generated and used. Therefore, the knowledge may be recognised as being useful and so made available for reuse.
- Validating knowledge - This step is to ensure the validation of knowledge in terms of its acceptance and storage with the relevant contextual details and in accordance with the specified and required format (Tan et al. 2007).

2- Knowledge Sharing

This step involves the provision of the right knowledge to the right person at the right time (Mertins et al. 2001; Robinson et al. 2002) or within the shortest time (Tan et al. 2007). Markus (2001) claimed that this process can be passive (e.g., publishing a newsletter or populating a knowledge repository for users to browse), or active (e.g., passing knowledge by an electronic alert to those who need to know). Significantly, there are necessary tools and methods used to activate knowledge, these include: information and communication technology (ICT) applications (Mertins et al. 2001), and a supportive organisational culture and trust between the people involved (Newell et al. 2002). In this regard, Dave and Koskela (2009) focused on the importance of effective communication among stakeholders in sharing knowledge.

3- Knowledge Reuse, Adapting and Applying

Knowledge reuse is a crucial stage in achieving sustainable improvements in performance for ongoing or future projects. In this regard, Szulanski (2000) mentioned the reapplication of best practice and that this could be applied to knowledge. Furthermore, Majchrzak et al. (2004) went further to emphasise the importance of reusing the knowledge for innovation with necessary adaptation or integration. They added that the reuse of knowledge through adaptation involves reconceptualising the problem and searching for reusable ideas (i.e. knowledge). It also involves scanning and assessing reusable ideas, analysing the ideas in depth and selecting the best idea, and fully developing the re-used idea, which might finally lead to innovation.

4- Maintain Knowledge, Knowledge Maintenance, Archiving and Retirement

The rapid revolution in technology may affect the effectiveness of knowledge unless this knowledge is updated in line with this revolution. Accordingly, Pakes and Schankerman (1979) acknowledged that knowledge may become obsolete over time. This could occur due to the development of a discipline and the employment of new information, rules and theories (Bhatt 2001). Maintaining knowledge encompasses reviewing, correcting, updating and refining it to keep it up to date by preserving knowledge in the archive whilst removing that which is obsolete (Rollett 2003).

4.4.4 'Live' Capture and the Reuse of Project Knowledge

Undoubtedly, the live capture of project knowledge is considered a critical approach in which this knowledge can be captured 'live', identified and shared easily, saved immediately and then reused effectively both intra-project and inter-project. Whetherill et al. (2002) confirmed that whether a construction organisation is able to be in a competitive position is linked to its capability to learn faster than its competitors and that this is reinforced by the external environment, so it needs to embrace effective learning based on day-to-day work processes. According to Kamara et al. (2003) and Tan et al. (2007) the benefits of 'live' capture and reuse of project knowledge are as follows:

- facilitates the reuse of the collective learning on a project by individual organisations and teams involved in its delivery;
- provides knowledge which can be used at the operation and maintenance stages of the project lifecycle assessment;

- provides a comprehensive approach due to its involving members of the supply chain to provide a collaborative effort which is able to capture both learning and project implementation, regardless of the contract type used to procure the project from the basis of both ongoing and postproject evaluation;
- offers valuable knowledge to a client organisation to assess the development, construction and management; and
- provides multiple benefits to the whole construction industry, including: effective management for project teams, better planning for future projects and effective collaboration with other organisations through the capture and transfer of learning from previous projects.

Other potential benefits identified include:

- The live capture of knowledge provides a safer approach to prevent knowledge loss due to time lapses in capturing knowledge (Tan et al. 2007). This is advocated by the studies conducted by Ebbinghaus (1885) and Linton (1975) which revealed that the knowledge stored in the human memory could be depleted over time;
- The value of reusing the knowledge captured will increase through live reuse (Tan et al. 2007). McGee (2004) pointed out that the true benefit of capturing knowledge comes only when it is being used. This is more beneficial, particularly when it can be reused immediately, and therefore, it significantly contributes to saving time and cost and improving quality (Siemieniuch and Sinclair 1999).
- It accelerates the dissemination of captured knowledge if it can be reused (Tan et al. 2007; McGee 2004), in particular in active projects, before its value is reduced.

Tan et al. (2007) have recently proposed a methodology for 'live' capture and reuse of project knowledge in the construction industry. This approach, as shown in Figure 4.5, consists of a web-based knowledge base, an integrated workflow system and a project knowledge manager as the administrator. This allows project knowledge to be captured live from ongoing projects. It also incorporates mechanisms to hasten knowledge validation and the dissemination of the knowledge once it has been validated.

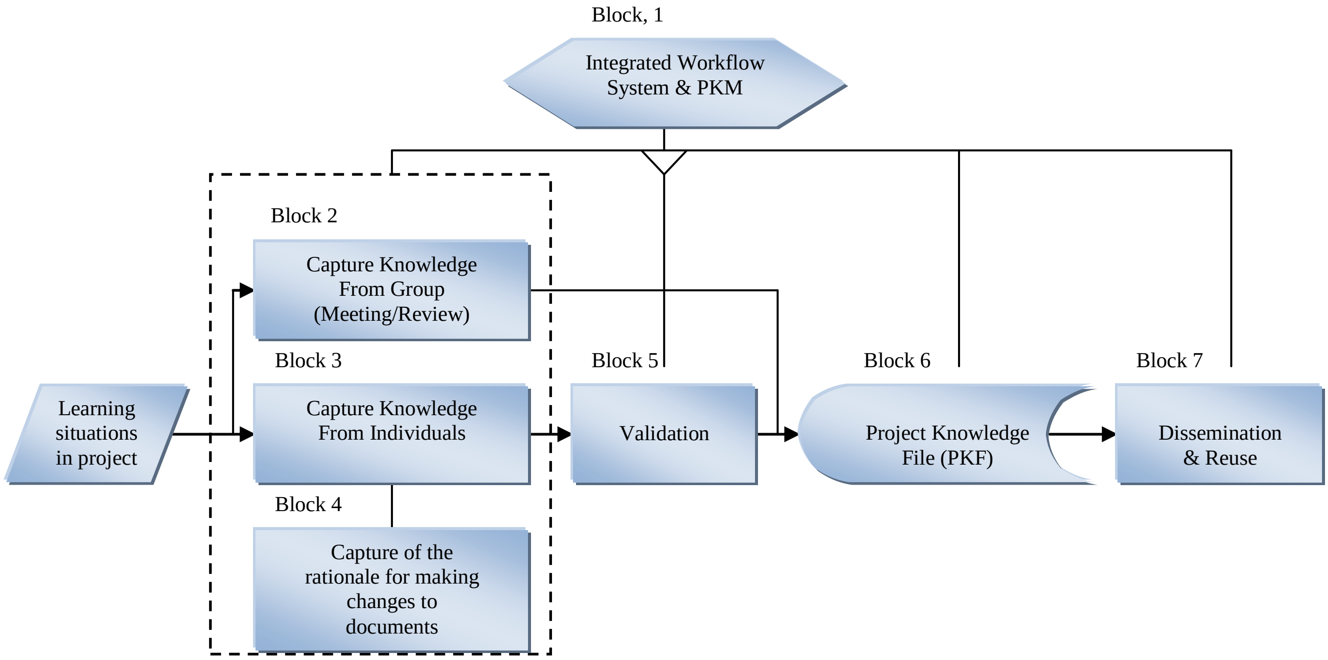

Figure 4.5: Methodology for Live Capture and Reuse of Project Knowledge in Construction (Tan et al. 2007)

4.4.5 Types of Reusable Construction Project Knowledge

A number of types of reusable construction project knowledge were highlighted by many studies (Robinson et al. 2001; McLoughlin et al. 2000; Kamara et al. 2002b). Additionally, according to a case study of six organisations in the UK, Tan et al. (2007) identified types of reusable construction project knowledge. Among these types are:

- Process Knowledge – This is the knowledge pertaining to the execution of various stages of a construction project. The types of reusable project knowledge belonging to this group include briefing, design, tendering and estimating, planning, construction methods and techniques and operation and maintenance knowledge.
- Knowledge of Reusable Details – Reusable details comprise standard design details, specifications and method statements. These details may be reused with adaptations. They help to avoid recreating similar details from scratch and also lead to time and cost savings.
- Knowledge of Best Practices and Lessons Learnt – These are the proven ways of working that contribute to the success of projects, and the mistakes made that must be avoided in future projects.

- Knowledge of the Performance of Suppliers – The suppliers referred to are consultants, contractors, subcontractors, materials suppliers, etc. who have contributed services or goods to a project. The capture of this knowledge facilitates the better selection of suppliers for future projects.
- Knowledge of Who Knows What – This is the knowledge about the skills, experience and expertise of each of the members of staff. It helps to locate the right people with the right knowledge for the sharing of knowledge, particularly tacit knowledge, which is difficult to codify.

Crucially, the knowledge captured from a project should be organised, understandable, easy to find and reuse. It is important to indexing, organising and structuring knowledge (Goodman and Chinowsky 2000; Robinson et al. 2002; Rollett 2003). Tan et al. (2007) stated that it is important to introduce the concept of a Project Knowledge File (PKF),: such as, background on the project, details and reference.

4.5 CONTINUOUS IMPROVEMENT (CI)

Continuous Improvement (CI) has been given more attention, and is concerned with organisational developments including the adoption of "lean manufacturing" techniques, Total Quality Management (TQM), employee involvement programmes, customer service initiatives and waste reduction campaigns (Caffyn 1999). Originally, Japanese industry adopted the concept of CI from the USA after the Second World War in order to assist in the reconstruction of its industry (Schroeder and Robinson 1991). The philosophy of CI as described by Deming consists of *"Improvement initiatives that increase successes and reduce failures"* (Juergensen 2000). However, Bessant et al. (1994) defined CI as *"a company-wide process of focused and continuous incremental innovation".* Additionally, Bhuiyan and Baghel (2005) reviewed the history of CI and described CI as *"a culture of sustained improvement targeting the elimination of waste in all systems and processes of an organization. It involves everyone working together to make improvements without necessarily making huge capital investments"*. However, CI in the domain of SDM projects means that achievement of sustained improvement could be achieved through learning from one SDM project to another due to the repetitive nature of these models.

4.5.1 Importance of Continuous Improvement

Crucially, every organisation, either private or public, should look at achieving sustainable performance improvement to fight for survival by being competitive, particularly in rapidly changing times. Fryer et al. (2007) mentioned that there is now a serious challenge for organisations in both the public and private sectors to “do more with less”. The situation in the public sector is different to that in the private sector, where the motivation for improvement is not multi-dimensional with demographic and societal changes, diminishing funds and political drivers for quality (Fryer et al. 2007). They discuss the importance of providing “best value” to people along with increased accountability and transparency. Therefore, the public sector organisations and governments should drive for improvement by following Bounds et al. (1994) who have identified four key CI qualities: inspection; statistical quality control; quality assurance and strategic quality management.

4.5.2 Benefits of Continuous Improvement

The benefits of CI have been covered by many studies. Bessant et al. (1994) argued that there are significant benefits to be achieved from CI through the required financial investment and the ability to utilise the ideas of all the staff. Equally, Woods (1997) indicated that CI provides benefits for employees through an available healthy workplace, satisfied customers and increased financial revenues for a company. Cole (2001) listed a number of benefits of CI, which are as follows:

- Improving employee commitment and also increasing the source of ideas.
- Gradual success leading to a magnification of results, and then making large changes possible.
- Revolutions can be based on a series of small successes.
- Gradual successes promote learning that is based on practice, and this will find wide acceptance, particularly in the environment where the changes are being proposed.
- Those gradual successes that occur within the organisation can provide useful knowledge about the whole system and encourage the learning concept.

- The way of achieving gradual successes is often based on tacit knowledge, which will be in-house and so difficult to export outside the organisation.

Additionally, the literature identified other benefits to CI, including: low capital investment – continually making small improvements, not large, dramatic changes (Jha et al. 1996); ideas and suggestions that come from those who are actually doing the job - there is no monopoly on good ideas (Jha et al. 1996; Goh 2000; Taylor and Hirst 2001); increased employee commitment (Temponi 2005); improved performance/quality (Chassin 1997; Goh 2000); reduction of waste (Gallagher et al. 1997); reduced costs (Gallagher et al. 1997) and improved customer satisfaction (Gallagher et al. 1997; Taylor and Hirst 2001).

4.5.3 Critical Success Factors of Continuous Improvement

Rockart (1982) defined CSFs as *"the limited numbers of areas in which results, if they are satisfactory, will ensure competitive performance for the organisation"***.** Brotherton and Shaw (1996) defined CSFs as the areas that form the base for producing the greatest "competitive leverage". However, Fryer et al. (2007) emphasised that defining CSFs is considered to be crucial when taking actions to increase the success rate, reduce costs and prevent disillusionment with continuous improvement programmes.

An extensive literature review covered the CSFs of CI. Among these CSFs are: management commitment (Claver et al. 2003; De Jager et al. 2004; Seetharaman et al. 2006), teamwork (Tsang and Antony 2001; Rungasamy et al. 2002; Rad 2005), communication (Zhang et al. 2000; Motwani 2001; Baidoum 2003), process management (Sila and Ebrahimpour 2003; De Jager et al. 2004; Rad 2005), ongoing evaluation, monitoring and assessment (Sohal and Terziovski 2000; De Jager et al. 2004; Bhuiyan and Bagehel 2005), training and learning (Watson and Chilesbe 2004; Bhuiyan and Bagehel 2005; Karuppusami and Gandhinathan 2006), employee empowerment (Watson and Chilesbe 2004; Karuppusami and Gandhinathan 2006), product design (Sila and Ebrahimpour 2003; Karuppusami and Gandhinathan 2006) and organisational structure (Zhang et al. 2000; Antony 2004). However, the nature of the public sector is that it consists of organisations that deliver different services, and also the size of the public sector varies from country to country, throughout the world and over time, in modern, developed countries. There are many types of public sector usually including: Education; Public Transportation; Electricity and Gas; Fire Services; Healthcare; Police

Services; Waste Management; Water Services; Housing; Social Security. Accordingly, these differences could influence the identification of CSFs of CI.

4.5.4 Challenges and Hindrances in Implementing Continuous Improvement Programmes

There is a relationship between effective learning and achieving CI. Hill (1996) argued that learning and CI are inextricably linked such that learning is the most compelling rationale behind undertaking any CI within an organisation. Equally, Whetherill et al. (2002) asserted that an organisation's capability leads it to learn faster than its competitors and the rate of change imposed by the external environment, and that there is a need to 'integrate learning within day-to-day work processes'. Pettigrew and Whipp (1991) argued that development of effective learning processes at all levels of organisation could lead to more successful firms. Barlow and Jashapara (1998) indicated that the nature of organisational learning in a particular industry is dependent to a large extent on factors such as the influential competitive environment and the size and underlying cultural assumptions and values of organisations in the industry. Failure when implementing CI programmes is affected by factors such as an organisation's culture, structure and background (Fryer et al. 2007). With regard to the construction industry, according to Egan (1998) and Latham (1994), the highly fragmented nature of the market and structure of the sector as well as an over-emphasis on contractor selection based on the lowest bid often result in underachievement of performance. Additionally, they argued that the unique and transient nature of many construction projects also deters any attempt to standardise the process steps, consequently resulting in lost opportunities in feeding back the experiences obtained on projects for the benefit of future projects. This means that organisations need to change their competitive environment as well as cultural assumptions in order to improve the level of learning. This is in line with Tenant et al. (2002), who recommended the development of an organisational culture and management style to support the CI of daily working practices, management of change against the achievement of appropriate quality targets, and training of teams in problem solving.

According to Barlow and Jashapara (1998), long-term relationships can provide considerable opportunity for learning from project to project, thereby facilitating CI of project performance.

4.6 SUMMARY

This chapter reviewed four parts: learning, LC, KM and CI. The chapter highlighted the learning concept which focuses on acquiring knowledge through a commitment to the employment of learning in order to achieve a continuous performance improvement. The types of learning were discussed through identifying OL and LO and their description. The chapter reviewed and discussed the learning styles, mechanisms and frameworks that were developed in this field. Three learning styles were highlighted named SLL, DLL and DeuL. A number of learning mechanisms were also highlighted, for instance, learning through collaborative arrangements, learning through non-collaborative arrangements and learning through networks. Factors affecting learning and the learning situation were reviewed and discussed. It was identified that there are two broad categories of learning situations: formal and *ad hoc.* The chapter highlighted the role of LC as an effective tool for measuring time and cost, defects and therefore achieving performance improvement. It also examined factors affecting LC and its limitations. KM and its importance in a successful organisation were highlighted in this chapter. Focus was also placed on the role of KM in the construction industry, by reviewing and discussing the KM process, the importance of 'live' capture and the reuse of construction project knowledge. Additionally, the chapter reviewed and discussed the types of construction project knowledge as well as the representation of knowledge. CI was reviewed and discussed through highlighting its definition, stressing the importance of CI for every organisation and the benefits that should be gained from addressing the CI programmes as a major target for organisations. The CSFs of CI and the challenges and hindrances in implementing CI programmes were also addressed. The following chapter aims to review the Saudi construction projects, the process of producing the SDMs and the current status of performance of SDM projects.

CHAPTER 5

5 USE OF STANDARD DESIGN MODELS BY THE SAUDI MINISTRY OF INTERIOR

5.1 INTRODUCTION

Construction is one of the major industrial sectors of the Saudi Arabian economy, accounting for 7.3 per cent of Gross Domestic Product (GDP) in 2006. There has been a steady and rapid increase in both the number and size of building construction projects during the past decade. However, there have been concerns regarding the achievement of high performance and value-for-money projects. The Saudi Ministry of the Interior (SMoI) has a 20-year strategic budget of more than £4.5 billion for constructing buildings such as police stations, civil defence facilities and hospitals. In order to improve project performance, the SMoI has recently adopted the use of Standard Design Models (SDMs), which have the same design, material specifications and process.

This chapter provides an overview of the performance the Saudi construction industry, and reviews the new SDM approach adopted by the SMoI. The aim and objectives of SDMs are covered as well as the expected benefits from adopting this approach. The chapter also covers the whole process of producing SDMs including the pre-design phase, design phase, adaptation phase and the construction phase. Finally, the chapter examines the current performance of SDM projects and the major issues related to their adoption and implementation.

5.2 SAUDI CONSTRUCTION PROJECT PERFORMANCE: AN OVERVIEW

The construction sector plays an important role in the Saudi economy and is closely related to other economic sectors. It is also regarded as an important and reliable indicator of the trends and health of the national economy. The Saudi construction industry has witnessed numerous changes from the 1980s until now due to the dependency on revenues coming from oil. During the 1980s, the Saudi construction industry boomed when the country's oil revenues brought financial ease to support massive infrastructural development projects (Al-Sedairy

2001). At that time, it was estimated that two-thirds of all construction activity was believed to have been commissioned by the government (MOFNE 1994). However, the fall in the oil price in 1986 resulted in a global economic slowdown, particularly for Saudi Arabia. By and large, projects - in particular on-going major infrastructure projects - and development plans were deferred or delayed (Al-Sedairy 2001). The economic problems also affected payment flows, financial assistance and guarantees for contractors, which consequently aggravated competition, usually by lowering profit margins and wages.

In 1994, the government encouraged the idea of joint ventures between foreign companies and local, Saudi-owned, private companies. This was in the belief that they would be able to operate at a high capacity due to the experience, high levels of capital and the favourable image of the foreign partner combined with the adeptness and influence of their Saudi partners. The latter have become highly competitive and now offer a large variety of specialised professional services, including operation and maintenance of the completed facilities (Al-Sedairy 2001).

5.2.1 Saudi Construction Project Performance

A significant number of construction projects are currently being implemented in both the public and private sectors, due to a rapid growth in the Saudi Arabian economy. There, however, are concerns about the underachievement of project performance, breakdowns, delays, cost and time overruns, and client dissatisfaction.

However, the literature revealed that there are limited publications related to Saudi construction project performance, specifically with regard to SDMs. A study by Al-Kharashi and Skitmore (2009) established that the most influence on underachievement performance in Saudi construction projects is the lack of qualified and experienced staff in relation to the considerable amount of large, innovative, construction projects and the associated current undersupply of manpower in the industry. Additionally, Al-Kharashi and Skitmore (2009) identified that financial issues are of great concern to client, since lack of finances, non-payments and delay in the progress of payments are considered to be major causes of underachievement performance on public projects. They argued that, in some cases, clients attribute the reasons for this to the level of underfunding by the Saudi Ministry of Finance; therefore, contractors, in particular those with low liquidity, will experience difficulties. However, this is often a long process and has continually affected Saudi public construction projects for the past three decades. This was confirmed by many authors (Al-Mudlej 1984; Al-Hazmi 1987; Al-Subaie 1987; Al-Khalil and Al-Ghafly 1999; Al-Sedairy, 2001) who highlighted that non-payment, or delays in payments to contractors in Saudi Arabia have become the major cause of delay of public projects. Additionally, other delay factors have been highlighted by Al-Kharashi and Skitmore (2009) including suspension of work due to additional requirements requested by the client. Assaf and Al-Hejji (2006) highlighted change orders by the client and slow decisions in approving plans, materials, etc. This has been confirmed by Al-Hazmi (1987) and Al-Khalil and Al-Ghafly (1999).

Assaf and Al-Hejji (2006) and Assaf et al. (1995) studied the underachievement performance on large building construction projects in Saudi Arabia and stated that clients attributed the underachievement performance to contractors and labourers. Clients and consultants agreed that awarding projects to the lowest bidder is considered the most frequent factor causing this underachievement in performance. On the other hand, contractors considered that the more severe factors are caused by clients. In particular, change orders are often triggered directly or indirectly by the client. Further factors were identified as being common between the parties, such as delay in progress payments, ineffective planning and scheduling and poor site management and supervision by the contractor. Client and consultants identified labourers and contractors as important sources of underachievement performance, while contractors identified the clients and consultants as crucial sources of this issue.

Asif (2003) conducted a study in Saudi Arabia to investigate the most Critical Success Factors (CSFs) for different project objectives i.e. time, cost and quality. He concluded that clients, contractors and consultants ranked adequate planning and controlling techniques, client satisfaction, and clearly defined project mission objectives and scope as the most important CSFs. The study reiterated that time was considered the most crucial project objective by all the project stakeholders. They defined a successful project as one that starts with clearly defined objectives and scope; advances with meticulous planning, monitoring and control and ends with results that encourage client satisfaction.

5.2.2 Design Impact on Project Performance

Arain et al. (2006) identified that the inconsistencies between design and construction have a significant impact on construction project performance in Saudi Arabia. They stated that several factors have caused this issue including: the involvement of the designer as a consultant; communication gaps occurring between the contractor and designer; insufficient details in the working drawings and a lack of coordination between the parties. Also included is a lack of human resources in the design firm, the designer's lack of knowledge of available materials and equipment and the use of incomplete shop drawings and specifications. In 2002, the same authors stated that inexperienced clients had led to the adoption of inadequate designs resulting in many changes to drawings, specifications and contract terms, and therefore, underachievement in project performance. Furthermore, Arain et al. (2006) also reported that, in order to achieve maximum project performance, there must be a significant presence and participation of the designer in both the design and construction phases.

Change orders are considered a major cause of underachievement in project performance in Saudi Arabia, where they result in cost and time overruns. This was confirmed by Al-Dubaisi (2000) through a study of the causes, effects and controls of change orders in large building construction projects in Saudi Arabia. The results revealed that cost overruns due to change orders were in the magnitude of 6 to 10 per cent of the original contract value. Time overruns were reported as being less than 10 per cent of the original contract duration. The study also concluded that the client was the major source of changes and that most changes occurred during the design phase. Additionally, design faults are regarded as first causes of change orders in large buildings projects. Mutauwaa (1988) identified that deficiencies in both the design and construction phases, financial problems and the behaviour of the different construction parties were the most severe reasons for change orders in Saudi construction projects. The quality of management in both the design and construction phases is a key factor in achieving a successful project. In this regard, Al-Abdulrazzak (1993) indicated that quality management activities in the design phase, such as drawing checks and the provision of clear, concise and uniform plans and specifications have a significant influence on project performance. According to Bubshait et al. (1999), the factors affecting quality practices in design offices are: the significant need for improvement in the quality of the 'working relationship' section; the need to avoid design mistakes that influence project performance, namely: staff training and education and performance quality audit. Additionally, the study revealed that there was a need to launch a design code and assessment of performance of design offices. Al-Musallami (1992) reported that client dissatisfaction due to the high percentage of change orders resulting from design errors which affected project performance.

Assaf and Al-Hejji (2006) studied the underachievement in performance in construction projects in Saudi Arabia. Their results revealed that many factors relating to design were causes of underachievement in project performance. These factors include: mistakes and discrepancies in design documents; delays in producing design documents; unclear and inadequate details in drawings; the complexity of project design; insufficient data collection and surveying before beginning the design; misunderstanding of the client's requirements by the design engineer; inadequate design-team experience; and the non-use of advanced engineering design software.

However, according to DPC (1999), problems such as these encouraged the SMoI to adopt the SDMs approach to produce developed models within one package to ensure the achievement of a high quality and flexible design to be suitable for different places and different periods. This requires the selection of a qualified designer study in the planning stages in order to avoid the serious faults/mistakes resulting from poor design. This is because the system of giving a permit for engineering offices is not managed and organised very well.

5.2.3 Contractors' Performance

Many construction projects in Saudi Arabia, in particular projects executed by small contractors, have underachievement in performance for different reasons, including contractors' poor performance which can cause long delays, breakdowns, disputes and therefore, time and cost overruns as well as poor quality. This is confirmed by the findings of a recent study conducted by Al-Kharashi and Skitmore (2009) who grouped the reasons behind the underachievement performance of Saudi public construction projects into seven categories, of which one is for contractor-related causes. These causes include: contractor inexperience (Assaf and Al-Hejji 2006; Al-Ojaimi 1989); poor qualification of the contractor's technical staff (Assaf and Al-Hejji 2006); contractor difficulty in financing projects; poor site management and supervision by contractors; conflict between contractors with other parties and ineffective scheduling of the project by the contractor. These are linked to poor scheduling by the contractor and lack of experience.

Al-Ghafly (1995) considered a contractor's performance as a major cause of underachievement in project performance in Saudi construction. As Al-Barak (1993) established, lack of experience in the line of work required by the contract, neglect, poor estimation practices, bad decisions in regulating a company's policies and a national slump in the economy are the most severe factors causing poor performance of contractors leading to unsuccessful projects.

The current tendering system used in Saudi Arabia depends basically on the lowest bid, regardless of other considerations, in terms of technical measures and historical records. In this regard, in an early study conducted by Aitah (1988), it was found that projects awarded only to the lowest bidder had, in general, a lower performance. Recently, Bageis and Fortune (2009) studied the factors affecting the bid/no bid decision by Saudi Arabian construction contractors. The study revealed that the most crucial factors affecting the decision of selecting contractor bid are: contractor size; classification status of the contractor; and the main client type. Nonetheless, Bubshait (2003) argued that the use of incentive/disincentive (I/D) contract provisions encourages contractors to effectively manage and control project duration and/or project cost, as well as labour productivity.

Currently, according to the Ministry of Economy and Planning (MOEP 2007) due to unstable conditions, the construction industry in Saudi Arabia is in the process of creating a process of adopting high-standard criteria for improving contractors' performance. This is mainly due to global competition, an ever-increasing focus on sustainable construction, the need to meet clients' needs and expectations and the desire to achieve a cost-effective lifecycle approach to the delivery of buildings. However, the MOEP (2007) argued that there is considerable variation in the performance of contractors in the Saudi Arabia and there are only a few construction companies that meet international standards.

The MOEP (2007) has suggested that there is a need to apply many new criteria to improve performance, requiring the development of effective regulations, improvement of management and the technical qualifications of staff and the encouragement of contractor specialisation (MOEP 2007). Although a number of major contractors in the Saudi Arabian construction industry already perform very well, particularly when they are encouraged financially, i.e. with regular payments, many small and medium companies are often responsible for project delays and poor quality work. These problems/shortcomings have been attributed to the non-availability of adequate financial resources, credit facilities or other financing instruments to improve their capabilities (MOEP 2007).

Currently, the system of bids and purchases used in Saudi Arabia is based on rules issued by the Saudi Ministry of Municipalities and Rural Affairs (MOMRA 2008). Table 5.1 summarises the classification of Saudi contractors.

Table 5.1: Classification of Saudi contractors (MOMRA 2008)

Cost of project (£)	Classification
26,953,968	First degree
26,953,968	Second degree
6,738,492	Third degree
2,021,548	Fourth degree
673,849	Fifth degree
404,310	Under fifth degree

Economic, technological, social and political issues today have arisen to force leaders of both the public and private sectors in Saudi Arabia to become developers for their sectors through promoting innovation and reducing costs, as well as achieving high-quality built environment assets. As such, the SMoI has adopted the concept of SDMs, which is based on producing a typical model of a design that uses the same materials specification and quality requirements.

5.3 THE SAUDI MINISTRY OF INTERIOR STANDARD DESIGN MODELS

The Saudi Ministry of the Interior (SMoI) is considered to be in the public sector, which comprises many sub-sectors that have different responsibilities. Accordingly, in relation to infrastructure projects, it is considered as a client, the sub-sectors and end-user, which means that it is responsible for planning, designing, implementing, and funding these projects as well as maintaining the assessment of completed projects.

5.3.1 The Standard Design Models Approach

In the context of SDMs in the SMoI, there is integration between design and construction, where the consultant is responsible for design adaptation of SDMs to context and construction supervision (CAD 2003). According to the contract (CAD 2003), there are three main parties in the system as follows.

1. Client – means the SMoI represented by the Centre of Development of Programmes for the SMoI' projects, and who manages all works related to projects (planning, design, construction).

2. Consultant – means the firm of the consultant or consultative body, which implements the works identified within the contract which involve design (architectural, structural and services) as well as design adaptation of SDMs to context and managing and supervising the construction projects.
3. Contractor – means the company that is awarded the project for execution according to the contract, where the project's activities are executed under the supervision of the consultant, and the contractor should refer to the consultant in relation to technical features, such as approval of designs, engineering studies, details and drawings, etc.

However, in this research the term "representative" is used to refer to the individuals who were involved in the data collection process and were representing the client, consultant and contractor in the project.

This approach aims to produce SDMs for SMoI projects by stressing the importance of reducing design and construction costs, increasing quality, improving procurement and effectively monitoring the construction phase, and therefore achieving sustained performance improvement (Alotaibi et al. 2007). The Kingdom of Saudi Arabia is one of the world's largest countries in terms of land area, estimated at about 2,250,000 km^2, and comprises 16 regional administrations (RA). The SMoI is one of the largest organisations in the Kingdom of Saudi Arabia and, according to the Development Projects Centre (DPC 1999) has 17 security departments that are controlled by the SMoI, each of which contains a number of sub-departments. Over the last decade, it has faced serious space shortages in housing its own departments. According to the DPC (1999), the number of construction projects being considered by the SMoI is estimated to be around 3600.

The large number of projects has prompted the SMoI to create a flexible design system, where changes are allowed to fit local needs. The SMoI has thus sought standard design solutions to avoid huge expenditure in its projects. This target is being achieved through a new strategic approach in the form of a long-term plan over the next twenty years. This is divided into five stages with each stage spanning four years. This approach is named the Standard Design Models (SDMs), for SMoI buildings. The approach was created for executing the SMoI plan that focuses on constructing all the buildings needed by the SMoI departments. It involves launching different types of design models which are intended to be reused over a number of projects.

The SMoI sought through adopting this approach production a number of categories of SDM that are typical in terms of design, shop drawings, material specifications, cost and time (see Appendix B). Consequently, preparation of SDM achieving flexibility, simplicity and informality, so the SMoI can implement it according to different periods and sites covering all regions of the Kingdom (CAD 2000). Additionally, designing modifications will be prepared for the approved standard designs which should allow for possible variations in nature and circumstances of the sites and/or the site probably falling under earth-quake open area. Additionally, the SDMs were classified into different categories to be allocated/adapted in matching cities. This variety of categories was based on a number of criteria: size of city; number of population; number of towns and countryside belonged to this city; and the distance between city and city. For example, by referring to categories of SDMs listed in Appendix B, Police Department (PD) was designed to be allocated in a catchment-area inside the city, police station was designed to be allocated in countryside, and city police category was designed to be allocated in a city. For more details of SDMs, lists of SDMs, sample of plans and photos included in Appendix B.

According to DPC (1999), this approach has many advantages regarding the uniqueness of its designs and the reduction of design costs by using only 85 SDMs instead of 3,600 buildings being designed in isolation (see Appendix B), thus representing a huge financial saving for the Ministry. The approach has also helped to introduce unified standards for materials, specifications, building forms and control operations during the construction phase. In the long term, the strategy is expected to achieve significant benefits in terms of Lessons Learnt (LL); the development of unified standards for furnishings; reduced procurement costs through a more strategic approach to bulk purchasing; improvements to the supply chain management; and reduced maintenance costs. This research will contribute to the attainment of the long-term benefits aimed at improving the performance of the projects.

5.3.2 Pre-Construction Activities

The SMoI has sought to establish a strong base to ensure the success of the adoption of the SMDs approach (DPC 1999). Accordingly, it emphasised the importance of clearly identifying and articulating the needs of the projects prior to the commencement of construction. There were deliberate attempts to follow identified processes by cooperating with the SMoI sectors to accomplish the required information. These processes have been outlined below.

1- Determine the SMoI department's needs for the building.
2- Estimate the overall amounts which are spent annually on rented buildings.
3- Identify all rented buildings.
4- Study all the buildings owned by the SMoI.
5- Study all the land owned by the SMoI.
6- Estimate the amount of land required for these building projects.
7- Distribute to, and collect from all sectors, the requirements of the approach.
8- Implement the design phase through engineering consultants.
9- Ensure that the practical application of SDMs on projects is put out to tender.
10- Invite contractors to tender.
11- Ensure readiness to start the construction phase.

5.3.3 The Expected Benefits of the Approach

The SDMs approach has been adopted based on a strategic plan including achievement of tangible benefits through the implementation of SMoI projects. The expected benefits addressed by the SMoI are listed below (DPC 1999).

- Programming of projects according to priority and a specific plan based on the building, whether it is government-owned or rented, and the availability of land.
- Deliver better value for money and a more sustainable built environment.
- Best designs are obtained for the least cost.
- Reduced project execution cost.
- Reduced maintenance and operation costs.
- The use of Lessons Learnt (LL) for achieving a continuous improvement for SDM projects performance.
- Flexibility in updating the designs and specifications for the unified model according to the necessary requirements.
- Flexibility in assessing these designs after implementation in projects and avoiding the defects, if any, in future projects.

- Flexibility of convincing the end-user to reduce the models based on actual needs that will appear clearly after completion, and apply this to future projects.
- Provide evidence to convince the Ministry of Finance to increase the budget allocation of some projects due to their repetition.

5.4 DEVELOPMENT AND IMPLEMENTATION STAGES OF SDMs

This section aims to describe the process used to produce the SDMs as shown in Figure 5.2. It seeks to detail the stages that are to be followed in order to achieve the main target of the SMoI plan. These stages involve drawing up a comprehensive inventory and requirements list, designing SDMs, adapting them to the site, tendering and construction (CAD 2000). It should be notified that stages one and two represent the early stages of producing SDMs. However, the proposed framework in this research was developed to agree with the current stages: three, four and five which are being used in implementing the SDM approach.

5.4.1 Inventory and End-User Requirements

5.4.1.1 Inventory

To ensure better working practices of adopting SDMs, a comprehensive inventory of the needed projects for the SMoI has been built up. This involves designating staff across the country to collect the information required from each SMoI department, and as such specific applications were designed to gather this information. The main target of the inventory was to provide a clear figure relating to the number of items owned by each department. It also provides information about the level of expenditure on rented buildings and the current status of facilities belonging to the SMoI. In other respects, the building priorities for each department could be identified according to greatest need. The SMoI made a priority for identifying the available sites specified for constructing its projects. Hence, the priorities and needs for each department of land have been identified. As a result, there was successful coordination between the SMoI and the Saudi Ministry of Municipality in finding land for the planned projects and avoiding obstacles that might introduce delay (DPC 1999).

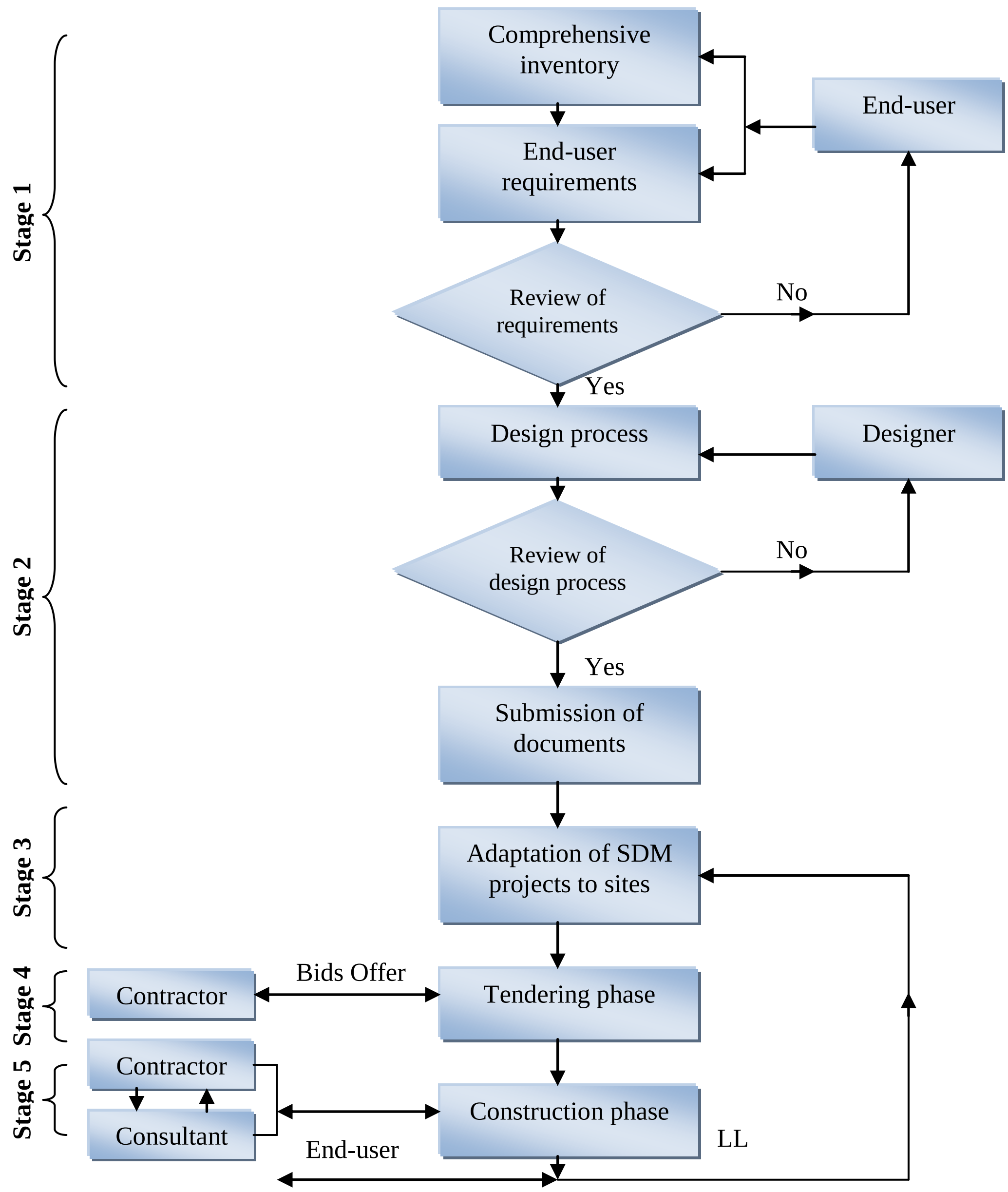

Figure 5.1: Development and Implementation stages of SDMs

5.4.1.2 End-user requirements

The distribution of requirements over all departments was carried out to build a database of all information related to building needs. The major aim of this task was to gather information considered essential for the preparation of the SDM of a target project. The collected information provided the means to identify the necessary elements pertaining to project components for all departments. These requirements were subjected to numerous processes in order to ensure the gathering of sufficient and important information (DPC 1999).

a) Collecting the relevant information regarding the SDMs

The aim of this task was to gather relevant information regarding the preparation of the SDM for the target project including the following (DPC 1999).

- General information.
- Information about the administrative system.
- Information about needs and requirements.
- Support services.
- Information about the site.

b) Processing of collected information of SDMs

This phase aimed to fill in any incomplete information related to the SDMs; discuss seemingly over-ambitious requirements and needs; establish the relationships between design elements; determine future requirements and eliminate any shortfall in information as indicated in the first statement (DPC 1999). This will take place through meetings with authorised people in the relevant departments to cover the following points:

- General information.
- Discussion of the additional needs and requirements.
- Identification of the working relationships between different directorates, departments and units.
- Filling of any information gaps through discussions with the end-user and the technical team.
- Adaptation of this information to the particularities of a specific site's situation.

c) Collecting additional relevant information regarding the SDMs

This task refers to gaining additional information regarding the SDM, particularly administrative and technical information, which includes the following (DPC 1999).

- Information regarding staff working overtime.
- Number of entrance gates.
- Information about security requirements.
- Information about electrical requirements.
- Information regarding fire safety systems.

The outcome of the above task provided useful information, which formed a basic model for the requirements of all departments. Moreover, this information enabled the specialists to map the design process and supported the idea underlying the need for SDMs. The information gathered was reviewed to provide a database for the design phase (DPC 1999).

5.4.1.3 Review of the SDMs' requirements

The participation of the end-user is critical for the SMoI and is one of its priorities. The aim of the review of SDMs requirements is to ensure that all comments sent by departments are filed in accordance with applications. Meetings between all relevant parties are regularly organised to discuss and resolve any issues or ambiguities which might lead to mistakes in the design phase. This part of the process results in significant end-user satisfaction with respect to requirements. The information gained from the above process provides guidelines for planning the design phase. A comprehensive review covers all the details related to the design elements in terms of area, number of floors, relationship between divisions and any special needs related to a building's functionality. The reviewed information is documented and prepared as official documents ready for tender. The next step is that design of SDMs that was carried out through three groups based on the priority of needed project in accordance to design plan. (DPC 1999).

5.4.2 Design Phase

The SMoI adopted the SDMs for Departmental Buildings surveyed and prepared in accordance with the contents of the special conditions of the contract documents (CAD 2000). This involves finalising the documentation of all requirements to start the design phase. This phase starts with a number of meetings with the consultants in order to discuss and draw up a detailed needs analysis. It also involves agreements on the regular meetings between the SMoI and the consultants. Although the end-user only participates in the previous stage, the SMoI nevertheless attaches great importance to this participation, since it appreciates the vital role end-users play in ensuring the success of the project. Requirements for the consultant are linked to the SMoI's requirement for SDMs, which can be implemented by the SMoI over different periods and in different places throughout all regions of Saudi Arabia. Therefore, the consultant shall be obliged to prepare SDMs as specified in the needs analysis, and will take into consideration the following.

- While preparing these standard designs, usual (analogous) circumstances shall be taken into consideration.
- The design modifications will be prepared for the approved standard designs and to allow for any possible variations in the nature and circumstances of the sites and/or location in an earthquake zone.
- The consultant, after having signed the contract, shall suggest the dimensions of the model site for each category separately and obtain the approval of the Ministry before entering the phase of producing the standard design.

The following are the proper procedures that must be followed in this phase.

- Take into account all the standard site considerations during the preparation of the SDMs.
- Take into account all considerations regarding possible variations in sites in terms of relief or seismic activity risks when formulating modifications to the SDMs.
- Provide the suggested dimensions for each prototype design.
- Prepare SDMs that can achieve flexibility, simplicity and low cost, as well as the possibility of executing these models over different periods and locations covering the whole area of Saudi Arabia.
- Achieve all the project requirements.
- Study the relationship between project components and attempt to improve the connection between them, by considering the flexibility regarding movement inside the site.
- Consider any future growth.
- Select high-quality and locally-produced construction materials.
- Select a recognisable and homogeneous style, which reflects the functionality of building.
- Consider maintenance operations and their costs during the preparation of the design.

- Appreciate social and religious considerations.
- Use the most contemporary technology regarding project preparations.
- Prepare the design to enable savings in energy consumption.
- Ensure that the final cost does not exceed the initial cost estimate.

The outcome of this stage involves the submission of design documents according to sequential stages, where they are subject to technical review by a committee representing all relevant parties. This is in order to avoid mistakes at an early stage and to reduce any defects that may affect the construction phase. These processes involve providing a number of models for the client to review the architectural aspects and then select the best and most suitable model. Subsequently, the selected model will be subjected to structural, mechanical, electrical and civil reviews. Eventually, it is possible to produce a number of re-usable models of this type. However, this phase was used during design of SDMs and the current used phase is the Design Adaptation of SDMs to context which is explained through the following section.

5.4.3 Design Adaptation of SDMs to Context

The SDMs are intended to be implemented in any required project, by adapting them to individual sites (CAD 2000). It is considered one of the key stages for ensuring the success of the approach and for executing the comprehensive development plan drawn up by the SMoI. This stage aims to adapt each SDM in accordance to site requirements, for instance, structural requirements, electrical and mechanical requirements. To achieve this aim, essential procedures are required in terms of survey data, soil investigation and the necessary design adjustments for each model.

Adaptation of SDMs to individual sites

There are many common issues involved in fitting the model to the site, such as: area, soil investigation, the direction of the building and the entrances and exits. The following procedures describe the following adaptation stages.

a) Stage 1: Preliminary adaptation to the site

Having undertaken the topographical survey and before conducting a soil investigation, the consultant should conduct a preliminary adaptation to identify all factors that will be changed due to the adjustment of the SDM, such as the number of parking spaces, the area and dimensions of the site, Qiblah (prayer) direction, changes in entrances, suggested service locations and all other factors in the project. The consultant should then submit the adaptation to the site report to the SMoI for approval, supported by an initial study explaining the extent of this adaptation (CAD 2000).

b) Stage 2: Pre-final adaptation and necessary modifications

After completing the preliminary adaptation, gaining the SMoI's approval and undertaking a soil investigation, depending on the previously collected information, the consultant should conduct the pre-final adaptation and make the necessary modifications. These include drawings and contract documents, identifying the plans that will be modified according to the variables related to the actual site and where it is possible to start the construction phase. The drawings and design documents that will be modified are as follows (CAD 2000).

- All plans related to master plans of the site in all engineering aspects, whether involving walls, gates, external extensions and/or site works.
- Foundations and other structural works, according to the soil investigation.
- Air conditioning and electrical works.
- The bill of quantities and specifications.
- All drawings which need to be modified.
- Cost estimate for construction.

5.4.4 Tendering Phase

This phase is subject to the government procurement system, which is based on low-bid selection. This phase starts by inviting bids from contractors through advertisements, where they are given a specific period to return their bids for analysis. Added to the low-bid criterion, are many other criteria used to identify the winning bid, such as: contractor qualifications, previous experience and project cost (CAD 2000).

5.4.5 Construction Phase

The construction phase is equally regarded as key to the success of the SDMs approach (CAD 2003; 2004). As a result, the SMoI pays attention to this phase in order to realise the planned benefits of the SDMs approach. Moreover, the SMoI established a substantial supervision and reporting contract for the construction phase to help control and monitor this phase as there are many projects awarded annually. Such comprehensive supervision and reporting can reduce client costs, increase quality control, reduce and resolve site problems, improve performance, and ensure timely project completion. The main aim of the supervision contract is to improve project performance through best practice. This can be done by providing all necessary technical views and decisions regarding the plans, specifications and drawings to the contractor in accordance with the contract documents. The supervision contract involves the following procedures.

- Review the studies, specifications and detailed drawings, and ensure that all are correct, accurate and according to contract, thereby meeting the client’s requirements and needs.
- Study and review the approach taken to ensure project implementation, report all comments and discuss them with the contractor, suggest any suitable modifications and take all necessary steps to ensure work progresses according to the approved schedule without any delay for whatever reason.
- Study all technical problems which may arise during the construction phase, propose recommendations and legal solutions to the client within one week during the contract period, where these problems do not lead to a delay in the project.
- Study the qualifications of the contractor, supply chain and subcontractor; propose the technical view regarding any modifications suggested by the contractor or client; review and study specifications and drawings concerning these modifications and their impacts on the schedule; propose effective ideas that affect project performance.
- Issue detailed monthly reports to the client regarding the progress of the project and the extent to which this progress is in line with the schedule. These reports must be supported by documents, pictures, bar graphs and soil investigation results. The reports must clarify the extent of overall project performance, the percentage of the work implemented and the progress of payments.

5.5 CURRENT PERFORMANCE OF SDM PROJECTS

Recently, it has been realised that the current performance of on-going and recently completed SDM projects is both underachieving and making slow progress overall. This causes long delays, breakdowns, disputes between clients and contractors and, therefore, dissatisfaction of the client and the end-users (SAD 2006; 2007; 2008). A review of the regular reports issued by the Supervision Administrative (SAD) and relating to the SMoI reveals that, despite the significant characteristic of adopting SDMs in terms of gaining tangible benefits from the LL to improve the ongoing and future projects, projects are currently suffering from long delays, breakdowns and time overruns as well as increasing the money spent on renting buildings.

According to SAD (2006) regular monitoring reports reported on SDM performance in three different contracts: contract one includes 61 SDM projects; contract two includes 55 SDM projects; and contract three includes 40 SDM projects. The projects involved in these contracts were executed by different contractors with only one consultant for supervision, and over a period that ranged from 2003 until 2006. The majority of contractors were executing a group of projects simultaneously. The report depends basically on several criteria to measure the progress of a project. These measures include: (1) percentage of time of contract spent by the contractor to execute planned activities (number of days); (2) percentage of actual achievement; (3) percentage of money paid and in some cases an additional measure which is (4) percentage of financial achievement. In more detail, Measure (1) indicates the total number of days that were spent from the start of project up to the issue of the report, Measure (2) indicates how the total activities achieved compared with planned activities, Measure (3) indicates how much money was paid to the contractor, and Measure (4) indicates the value of activities achieved practically in the form of finances. Figures 5.2 and 5.3 are samples representing the two contrasting cases: good performance and poor performance. Statistically, in the report,

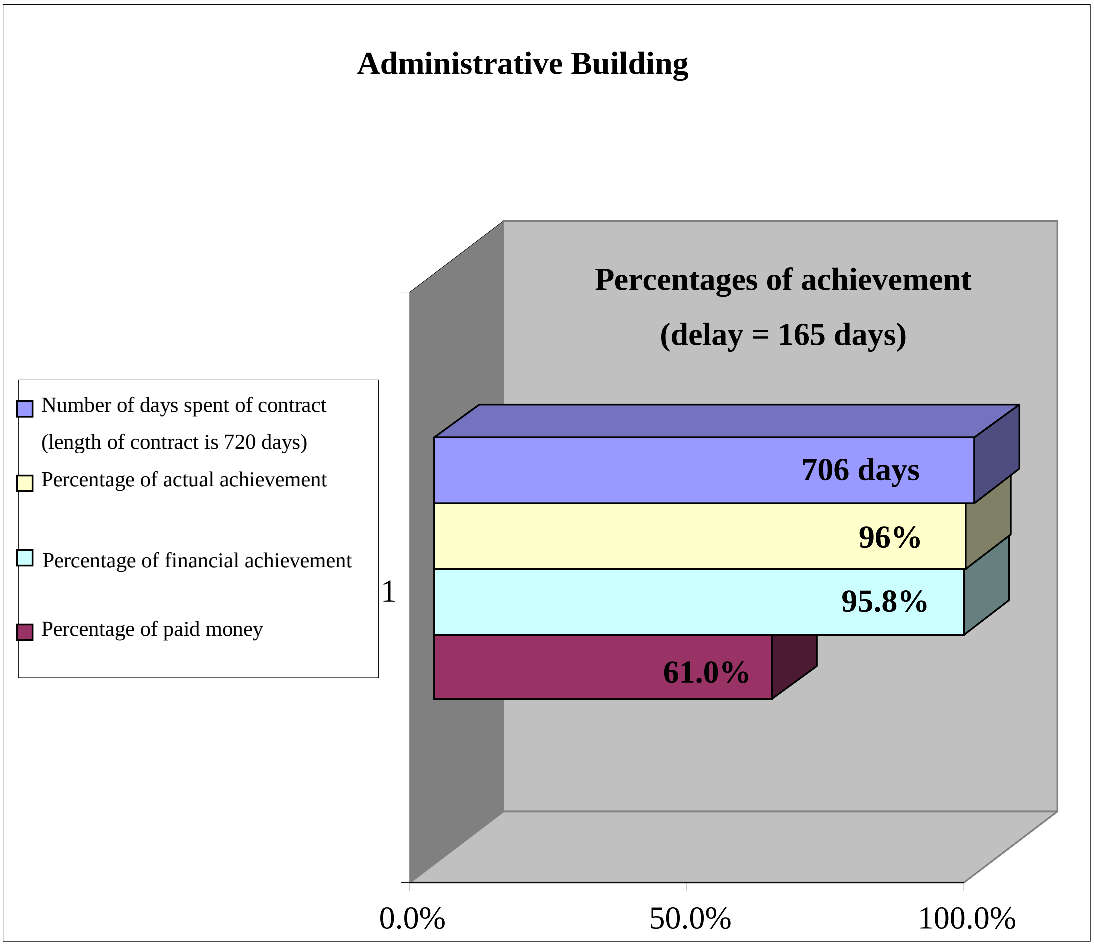

Figure 5.2: Distribution of Achievement Percentage: An example of Good Performance of SDM Projects (SAD 2006)

the percentage of delay in SDM projects involved in Contract one was estimated at about 15.3 per cent as an overall delay for all SDM projects. Specifically, the number of projects suffering from a high percentage of delay (73.03 per cent) was identified as 19 projects out of a total of 61 projects, while the acceptable percentage of achievement ranged from 90 to 100 per cent for the other projects. The report concluded that there was a variation in the percentage of achievement due to unforeseen circumstances, which were often due to external factors related to other sectors such as municipalities.

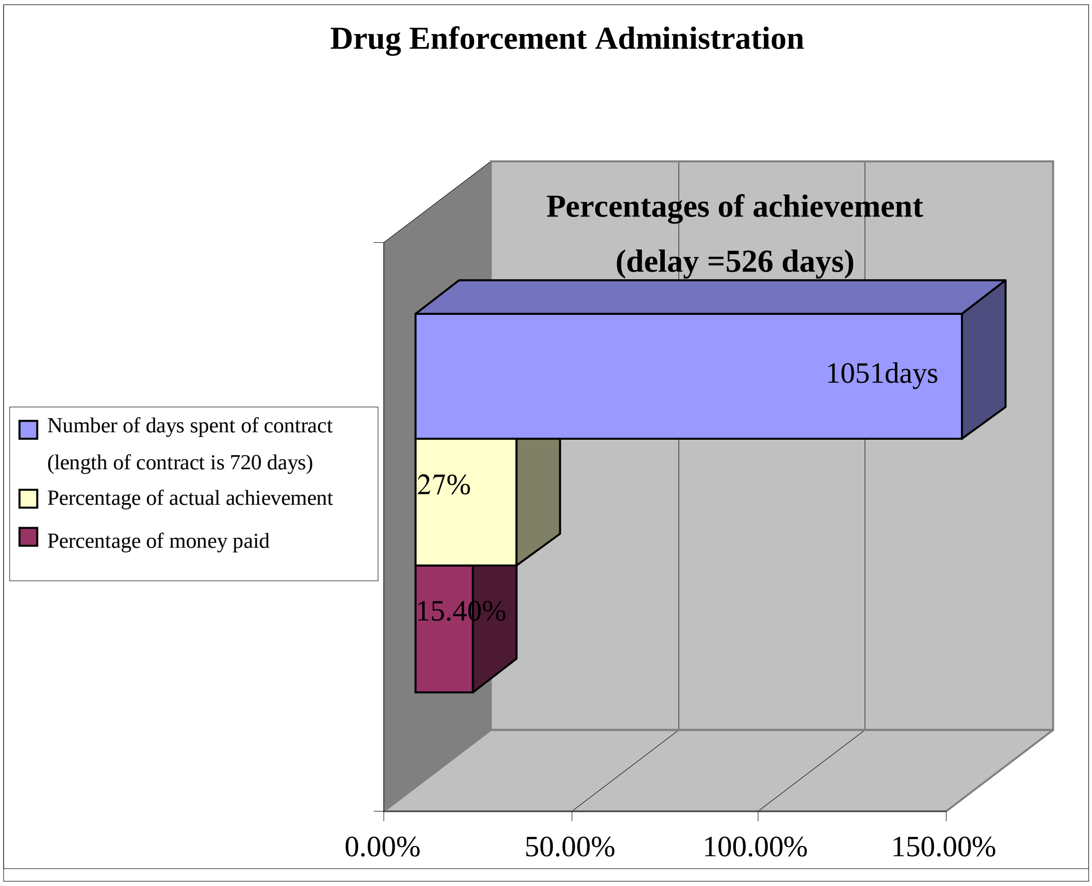

Figure 5.3: Distribution of Achievement Percentage: An example of Poor Performance of SDM Projects (SAD 2006)

In Contract two, the overall percentage of delay for all projects was estimated at about 28.5 per cent. Specifically, the number of projects having a high percentage of delay (96.5 per cent) was identified as 31 projects out of a total of 55 projects (56.4 per cent). In this contract only about 24 projects achieved good progress of between 90 per cent and 100 per cent.

In Contract three, the overall percentage of delay for all projects was estimated at about 16.46 per cent. Specifically, the number of projects having a high percentage of delay was identified as 20 projects out of a total of 40 projects (50 per cent). In this contract, projects were achieving very slow progress, where 50 per cent of projects suffered from long delay, therefore, percentage of delay reached 60 per cent.

The report highlighted the major reasons behind the delays in SDM projects as follows.

- Contractor-related factors — a lack of relevant experience; lack of skilled staff, equipment and general labour; shortage of liquidity; unsupportive management;

delay in requesting approval of materials and drawings and a lack of commitment to adhere to the project schedule.

- Client-related factors — non-readiness of the project site, slow decision–making and slow payment process.
- External –related factors — these include some factors that are out of the control of the client as well as the contractor, for example, those that are related to governmental regulations, political issues and sudden changes in markets.

However, the report acknowledged that the projects in Contract one achieved good progress, and an acceptable overall performance, but within Contract two, there was a marked decrease in the progress of projects, where the percentage of delay reached 28.5 per cent, and therefore, there was poor overall performance. Notably, the reduction of progress continued to fall, where the downward trend was identified within the future projects. It has been recognised that there are a number of crucial issues that contribute to the marked fluctuation. These issues include:

- projects in Contract two were commissioned by new contractors who were less well qualified than those involved in Contract one;
- the success achieved in Contract one was due to the use of good contractors as well as to the fact that a group of projects was awarded to one contractor, who was able to manage these projects successfully based on exchanging the LL between these projects to avoid past mistakes and then improve the other projects; and
- future projects suffered from a lack of learning from past mistakes in previous projects due to deficiencies in knowledge management, and simultaneously, the valuable LL by previous contractors were lost as they left.

Additionally, a recent regular report issued by SMoI identified the progress of projects based on the concept of the S-curve (SAD 2007). This reveals that the progress of projects continued a marked decrease, where the percentage of delay was estimated at about 37 per cent, which is equivalent to 19 months for all projects. Therefore, the overall performance of all projects was unsatisfactory. Additionally, time overrun was considered a serious concern; on the other hand, the report did not highlight cost or quality as problematic issues. Moreover, Figure 5.4 shows that there is a big gap between the planned activities in the form of cost, and the actual achievement of activities. The same figure shows that the overall progress of all SDM projects suffered from lengthy delays, shown as a gap between the planned and actual curves.

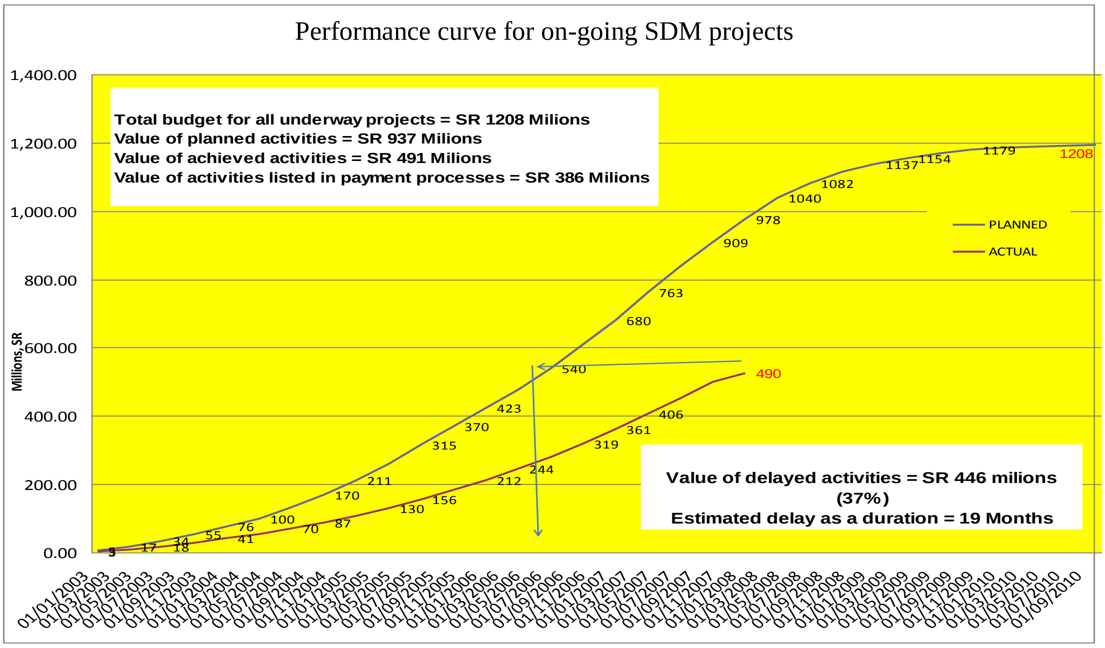

Figure 5.4: Performance Curve for On-going SDM Projects in 2007 Planning and Actual Progress (SAD 2007)

With regard to the SDM Police Department (PD), which is the same category selected for conducting the case studies of the research. Accordingly, reports reveal that no improvement has been achieved on the performance of this category of project; on the contrary, the situation became even worse with a marked increase in the delay of projects. As mentioned before, the performance of the first group of projects executed under Contract one was by and large satisfactory, but there was a gradual decrease within Contracts two and three. For example, in Contract one, the percentage of delay of 15 projects during implementation (the projects started in 2003) was estimated at about 3 per cent, and projects were delivered on time, while this increased to 14 per cent for five projects in Contract three.

In a different report, it has been established that there was no improvement achieved on SDMs' project performance over the period of report. As shown in Figure 5.5, the percentage of delay increased from 37 per cent to be more than 52 per cent, and the gap between the planned and actual curves increased (SAD 2008).

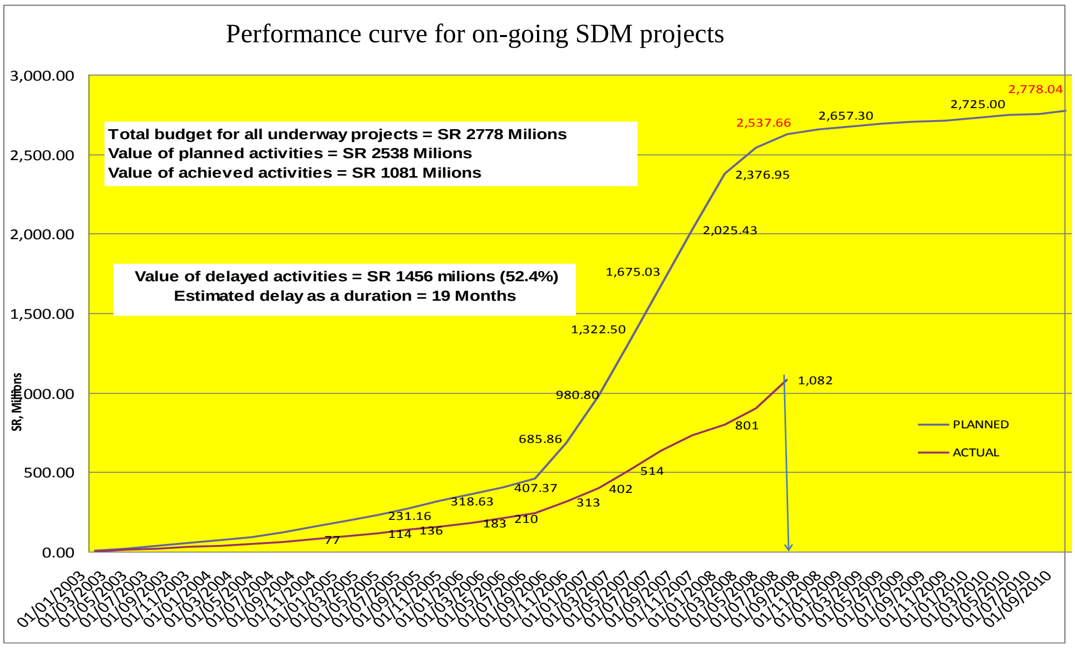

Figure 5.5: Performance Curve for On-going SDM Projects in 2008 Planning and Actual Progress (SAD 2008)

Specifically, the percentage of delay of PD-SDM projects increased from 14 per cent to 28 per cent. Figure 5.6 shows that no improvement has been achieved during report period through learning from previous projects (accumulative learning) and the proportion of projects suffering from delay reached about 45 per cent.

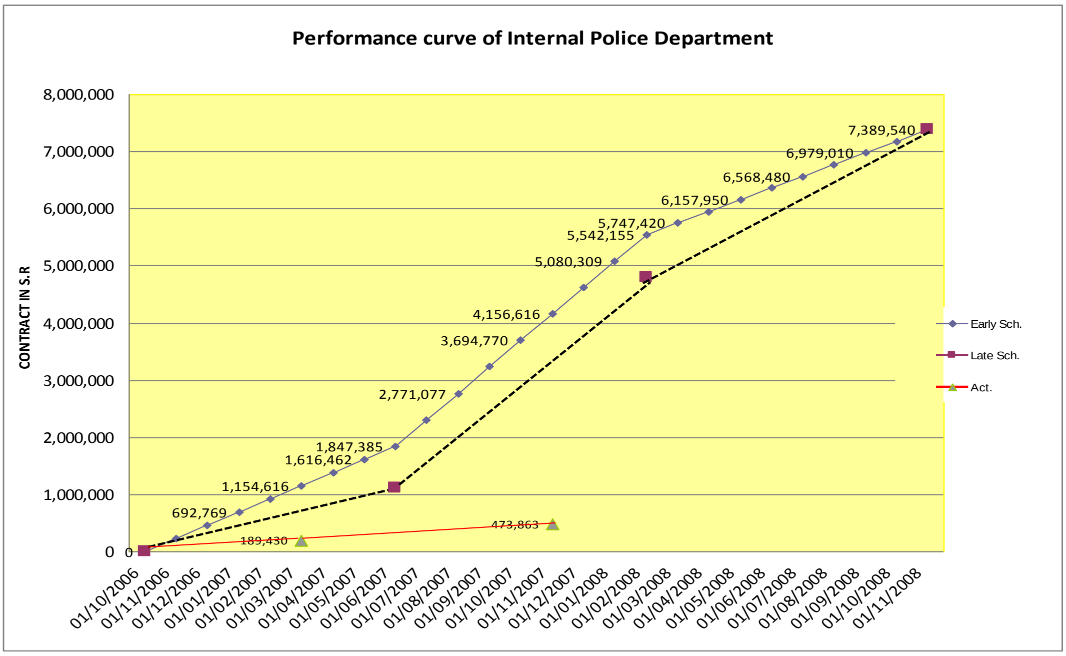

Figure 5.6: **Performance Curve of Police Department: Planning and actual progress (SAD 2008)**

The reports published by SAD (2007) and SAD (2008) outlined a number of reasons that cause the delay of projects and prevent the planned progress for all projects. These reasons are listed below:

- the delay of payments paid to contractors by the client;
- lack of contractor's skilled staff;
- inadequate and irrelevant experience of contractors;
- delay in approving change orders, particularly with respect to contract extension;
- delay in approving the amended bill of quantities;
- poor communication and cooperation between consultant and contractor;
- delay in approving shop drawings and as-built plans;
- site problems as well as delays in starting projects;
- inflexible and bureaucratic procedures used by clients in terms of innovation for improvement;
- insufficient information about sites provided to contractors; and
- sudden increases of prices in the market.

The key findings of SAD (2007) and SAD (2008) reports established that there was no improvement achieved on project performance based on reusing the LL from completed and on-going projects. Additionally, increased gaps between the planned and actual curves indicate that faults and mistakes, or even improvement requirements, had never been identified, captured and then effectively addressed so that they could be avoided during on-going and future projects. It is possible that discrepancies might have been identified and captured by some contractors, but these were not recorded and then disseminated to the client. These were therefore missed when the contractors were not involved in new SDM projects. Remarkably, the reports did not highlight how improvements could be achieved through the reuse of LL for future projects, which indicates the absence of a clear methodology for implementing this tool as an improvement tool. Accordingly, it is noticed that there is a significant gap in the use of learning as an improvement tool for SDM projects. The SDMs' approach was launched during 1999, and implementation began during 2003, and the outcome performance is considered to demonstrate an underachievement in contrast to the anticipated improvement on SDMs performance. Therefore, this research attempts to investigate the problems related to the underachievement in performance of SDM projects through identifying its specific CSFs and developing a framework for improving the performance of SDMs based on the learning concept.

5.6 SUMMARY

This chapter reviewed several issues related to the Saudi construction industry. These issues include: an overview of Saudi construction project performance; the SDMs approach; stages of producing the SDMs; and the current status of SDM project performance. The chapter has highlighted the Saudi economy and its impact on Saudi construction projects. The performance of Saudi construction projects was reviewed and discussed. Many problems were addressed which include: underachievement of project performance; breakdowns; and time and cost overruns. Additionally, these problems are concerned with clients and contractors, or designers. The review revealed that there are inconsistencies between design and construction due to many factors, such as communication gaps between contractor and designer and insufficient details in project drawings, and specifications, which contributed in increasing the change orders. The chapter reviewed and discussed contractors' performance in Saudi Arabia, and highlighted the low performance of contractors due to insufficient experience, skilled staff, and financial problems. These problems were linked to the current procurement method used in Saudi Arabia which is based on the lowest price regardless of other measures. The production process of SDMs was reviewed and discussed, and it was realised that this approach aims to reducing design and saving time, and therefore, achieving a sustainable improvement for SDM projects performance through LL. The SDMs approach has six phases: a comprehensive inventory and requirements phase; feedback on requirements approach; design phase; adaptation of SDMs to site; tendering phase; and construction phase. The chapter also reviewed and discussed the current status of SDMs project performance, and highlighted that SDM projects suffered from long delays, and breakdowns. Additionally, frequent requests were made by contractors for an extension in time in order to complete projects. No considerable performance improvement was achieved although these SDM projects are repetitive, and further, LL were not in place effectively. This justified the need for this research to develop a framework for improving the performance of SDM projects. The following chapter presents the preliminary study findings conducted in the context of SDM projects in Saudi Arabia.

CHAPTER 6

6 RESULTS AND ANALYSIS OF THE PRELIMINARY INTERVIEWS

6.1 INTRODUCTION

To provide sufficient justification for the research, a preliminary study was conducted to give details about the current performance of the SDMs and to understand the situation of this new phenomenon. Preliminary studies provide a useful starting point for such research. They highlight potential research issues and areas and, therefore, provide general feedback on major research issues. As discussed in Chapter Two, when not much data is known about the situation at hand, or no information is available on how similar problems or research issues have been covered, a preliminary study needs to be conducted. Such a study allows us to gain familiarity with the phenomena in the situation, and to understand the current status before setting up a rigorous design for comprehensive investigation. Therefore, broad areas of research in the area of general interest can be established through such a study.

Indeed, not much has been published in the area of SDM project performance in the Saudi construction industry. Consequently, a preliminary investigation was conducted to address the literature gap on the one hand, and to act as a precursor for the in-depth case studies in this research on the other hand. This chapter presents the results of a preliminary qualitative data collection to evaluate the performance of SDM projects and the actual achievement of adopting the SDMs approach. Semi-structured interviews were conducted with three stakeholders (clients, consultants and contractors' representatives) involved in the SMoI SDM-based construction programme. The chapter is divided into three sections: sampling approach, interview results, and a summary of the main findings.

6.2 PARTICIPANTS' INFORMATION

As discussed in Chapter Two, the participants were selected based on three scales: their experience in the field of SDM projects, their qualifications and their position. Table 6.1 illustrates the interviewees' details with respect to their positions, organisational affiliations as well as SDMs project status and category.

Table 6.1: Interviewees' Details

Project	Project Status and category	Interviewees	Coding
1	Completed project (Police Department)	Client representative Consultant representative Contractor representative	CL1 CONS1 CONT1
2	Completed project (Civil Defence)	Client representative Consultant representative Contractor representative	CL2 CONS2 CONT2
3	Ongoing project (Police Department)	Client representative Consultant representative Contractor representative	CL3 CONS3 CONT3
4	Ongoing project (Civil Defence)	Client representative Consultant representative Contractor representative	CL4 CONS4 CONT4

Four SDM projects - two completed and two ongoing - were selected. For each project, semi-structured interviews were held with the representatives of client, consultant and contractor; resulting in a total of twelve interviews. The interviews were all conducted as individual sessions and each lasted an average of 50 minutes. The interview template (see Appendix C) covered the key issues related to SDM projects.

6.3 INTERVIEW RESULTS

The "framework analysis" (Ritchie and Spencer 1994), which is an inductive matrix-based method of qualitative data analysis used for ordering approach and synthesising data under conceptual headings emerging from the field of enquiry, was adopted for the preliminary interviews (see Chapter 2 for further details regarding the analysis method as well as a justification). The findings of the interviews revealed the key themes related to SDM project performance. These themes include: performance criteria used in SDM projects; planning and control methods used in SDM projects; contractors' competence; project procedures; design modification; communication and coordination in construction; lessons learnt in SDM projects; tools used for achieving continuous project improvement and their benefits; the suggested components that should be involved in the framework, and the recommended category of models to be selected for conducting the case studies during the main data collection phase. The key themes emanating from the findings of the interviews are discussed below.

6.3.1 SDM Project Performance Criteria

Interviewees were asked to identify the performance criteria used in the SDM projects. There was an agreement between all the interviewees about identifying cost, time and quality as the main project performance criteria. Almost all the interviewees emphasised that the time schedule was usually a decisive factor. Client satisfaction came second in priority where all the interviewees argued that this is a measure of a successful project. In completed projects, all contractors cited the size of defects associated with project performance criteria. Additionally, the contractors added “profitability” as one of the project performance criteria. However, the aforementioned main project performance criteria: time, cost and client satisfaction are being used in the completed and on-going projects, and the assessment depends on overall performance, not individual criteria.

6.3.2 Planning and Control Methods Used In SDM Projects

Interviewees were asked to identify current planning techniques used for SDM projects. All clients indicated that there was some guidance given to the contractors to use Primavera, PERT and CPM programs as planning techniques, in all the sample projects. As highlighted by all clients those who were not familiar with these programs tended to use MS Project. All the participants stated that Gantt charts were not used as the planning technique in the sample projects, and the common planning techniques intended for use in these SDM projects were Primavera and MS Project, in both completed and on-going projects. All the interviewees appreciated the role of both Primavera and MS Project techniques as being effective, but Primavera gives all the details of each phase of the project, and seems more sophisticated. In the two on-going projects, all consultants and clients argued that those projects suffered from ineffective planning particularly by contractors, since some contractors consider the time schedule as only an official requirement, and did not comply to this schedule. On the other hand, all contractors in those projects referred to delays made by consultants and clients regarding approval procedures which led to not achieving the activities in accordance with the time schedule. With regard to improvement in planning techniques, in the sample projects, all the interviewees believed that planning techniques could be improved by increasing staff knowledge, skills and experience in programme application. As confirmed by one of the interviewees *"we generally used Primavera and MS Project techniques, but other planning techniques like PERT and CPM or Gantt chart were not used in the project"* ***CL1.***

Additionally, all interviewees were asked to identify the control methods used in the completed and on-going projects. All clients stated that projects could be controlled through depending on the consultant's reports, monthly meetings and client site visits, after which, based on the feedback, the progress of the project could be assessed, and this was employed through completed and on-going projects. On the other hand, the majority of contractors stressed the importance of control for the progress of the project, productivity and the system of delivering supply materials. All contractors indicated that the proper estimation of the number of workers allocated to the various phases of a project within an allocated time schedule allowed good progress to be achieved. One of the contractors concluded that the time schedule was followed by two other programmes: the labour force programme and the execution programme, which control the performance and indicate the level of achievement. Consultants and contractors agreed that conclusions should be drawn from the study and analysis of the feedback provided by all stakeholders. This should be a cooperative effort to avoid any problems affecting the progress of a project. On the other hand, all consultants and contractors stressed that, in order to learn about the past problems, and also improve control methods, a project's performance should be benchmarked against previous projects due to the repetition of the SDM projects. By and large, all the participants established that Primavera and MS Project were the main planning techniques used in completed and on-going projects. All clients and consultants stated that regular reports and meetings or visits were used as control methods, while the majority of contractors highlighted different methods, such as the number of workers allocated to projects.

6.3.3 Contractors' Competence

Interviewees were asked to identify the factors affecting the achievement of successful SDM projects. All the interviewees in the two completed and on-going projects argued that contractors' competence in terms of relevant experience, having skilled staff and financial power should be available in order to be able to deliver a successful project. They added that the commitment to the time schedule was seen as detrimental to determine the progress flow and its relation to the time allocated or delay, review project documents, and arrange the project procurement. One of interviewees quoted that *"the most important factor is that the* *contractor should display a full commitment to the time schedule and to demand the material supplies on time"* ***CONS3.***

Additionally, all the contractors in the two completed projects were of the opinion that the commitment to the time schedule should precede the start of the project in order to study project elements as a number of activities are based on the time schedule, such as project procurement, drawing submission, inspection requests and materials submission. Essentially, "*a contractor should have an integrated system of capabilities because the existence of any fault in this system will undoubtedly influence other elements"****CONS4.***

On the other hand, all the participants in the two completed and on-going projects pointed out that financial problems are serious and affect both the contractor and client. For example, where a contractor suffers from a shortage of liquidity and at the same time the client delays providing the regular payments to the contractor, this can influence the contractor's ability to progress the project and thus cause a major delay. "*Contractor's role forms 70 to 80 per cent of the success of the project in terms of his administrative and/or financial potentials*" ***Cl2.***

In the two on-going projects, all clients and consultants identified that employing skilled staff was affected by the contractor's financial problems, and thus adversely influenced project performance. Furthermore, all clients reported that some contractors had inexperienced and unskilled subcontractors and site personnel, who were not familiar with the shop drawings and high standards, such as SDM projects specifications. One of the consultants emphasised the need for relevant experience in construction projects. In turn, clients and consultants both emphasised that contractors should have an adequate preparation and be attentive to all unexpected project challenges and problems, and should have sound problem-solving capabilities.

On the other hand, all contractors in the two on-going projects acknowledged that they had encountered some difficulties that affected their abilities, particularly financial matters, due to delays in receiving their payments from the client. As recognized by all clients the importance of supporting the contractor through prompt payments, particularly for contractors who were suffering from insufficient liquidity, to reduce any negative impact on project performance. However, all consultants stated that a contractor should also submit a request for money to the client on time to process the expenses reserves and allow payments to be available on time. Indeed, some contractors delay submitting such requests and then blame the client for late payment.

According to all clients it was reported that some contractors are involved in a number of projects, and in so doing they become overloaded and therefore unable to manage these projects successfully. This indicates that there are shortfalls in the tendering system, which should assess the contractor's capacity before awarding new projects. This was reiterated further by consultants who stated that the contractor submitting the lowest bid is not necessarily the most suitable selection, particularly in terms of the quality of the outcome. Clients and consultants appreciated the performance of the two contractors who implemented the two completed projects, where they had full capabilities in terms of skilled staff, good experience and financial stability.

6.3.4 Project Procedures

Among the factors affecting the success of SDM projects, all interviewees agreed that, despite the repetitive nature of SDM projects, the procedures used through all SDM projects vary from one project to another across all the regions. In the two completed and on-going projects, all contractors highlighted the long timescale and the complicated processes used by the client and consultant for approving the materials and drawings. One of the clients confirmed that some contractors complained about supply approvals issued by the head office of the SMoI. However, all interviewees acknowledged that the current procedures used for giving approval for payments to the contractor for materials and shop drawings were ineffective and bureaucratic. This was attributed to the fact that each region has special procedures to be followed in a project. According to a full agreement made by all the interviewees the approval of drawings and materials requests should be given within the region rather than by the H.O, except in the case of major changes such as design or material specifications. This was confirmed by CONT3 "*in one of the projects, we waited two years to start the implementation of project, during that time, prices increased***".** Additionally, another interviewees stated that *"One of the barriers is the delay of sample approvals, which usually go through* a *long and complicated process that involves* consultants, the *client's region office, and the H.O"* ***CONT4.***

The majority of consultants argued that the approval of change orders is a major hindrance in terms of causing long delays due to multi-department approval requests which caused extra costs. One of the consultants suggested that the use of Information Communication Technology (ICT) tools should be adopted in project procedures to achieve tangible benefits in terms of saving time and cost, utilising information directly between stakeholders, increasing the speed of taking action and reducing mistakes in documents as well as the possibility of missing documents. These would yield a positive outcome for project performance. This was confirmed by one of the contractors, who emphasised the use of such tools rather than paper to avoid routine procedures, and could take the form of specifically-designed electronic applications.

The other issue related to project procedures is the difficulties in the decision-making process. As highlighted by all the interviewees the authorities given to the project management are not determined in the SDM projects contracts, therefore, they suggested that the Contracts Management (CM) in the H.O should clarify all responsibilities and authorities given to both client and consultant representatives to avoid any ambiguity. As quoted by CL1 "*decision-making should go through an uninterrupted channel of communication among all the stakeholders in order to derive the appropriate advice and recommendations that help us manage any unexpected problem*".

A CL2 queried how a project manager could cope with projects without sufficient authority. He stressed that the reality is that taking decisions is considered as a barrier; therefore, the parties who have the responsibilities for a certain stage of performance may show reluctance to take a decision. As a result, their hesitation in the process of decision-making leads to a delay in the project performance.

In the four projects (completed and ongoing), there was general agreement by all the interviewees about the variations between the SDM projects procedures used from one region to another, where procedures are based on regional administration. This resulted in a reduction in the use of standardised procedures despite the potential for standardisation implicit in the repetitive nature of SDM projects. Additionally, decision-making brought to light another important issue, namely a delay in making decisions by project management due to the ambiguity of SDM projects contracts in relation to determining the responsibilities and authorities between stakeholders.

6.3.5 Design Modification

The researcher investigated about the barriers that affect the achievement of successful project performance in SDM projects. It was highlighted by all the interviewees that design modification is considered as a major issue, not only in achieving improvement in SDM project performance, but also in achieving continuous performance improvement. According to all the interviewees who agreed that less improvement than anticipated had been made in SDM projects because of the repeated faults in design, drawings and material specifications from project to project. This was confirmed by CONS1 "*the more defects occur, the less performance is being achieved*".

Moreover, as reported by all participants the same design defects in completed projects reoccur in the ongoing projects, for which all stakeholders bear a share of the responsibilities. This was confirmed by all interviewees. However, all the interviewees indicated that not only the designs, but also the drawings, specifications materials and Bills of Quantity (BoQ) for a whole project, need to be modified and developed.

CL2 highlighted that the idea of SDM projects depends on reducing the need for change orders during the project; however, there were massive numbers of change orders made due to reoccurrence of past mistakes such as design and material specifications. One of the contractors stated that "*change orders become a reoccurring poor practice for SDM projects*" CONT2. He stressed that these change orders are being repeated in ongoing projects because of failures in reporting their causes and the solutions. As argued by all the interviewees there is a need to modify and further develop the designs to introduce some needed improvements, due to numerous inefficiencies detected during the execution of projects.

All the interviewees confirmed that material specifications were amended in some cases for suitability and quality purposes. The majority of the consultants noted that design modification sometimes incur extra costs exceeding the permitted cost limits in the project contract, which is usually 10 per cent. Thus, stakeholders are forced to reduce the required improvement, or eliminate unnecessary items in order to carry out the improvement in full.

However, as established by all the interviewees in the four projects (completed and on-going) the same design defects, mistakes in material specifications as well as BoQ in completed projects reoccur in the ongoing projects. This resulted in delay in on-going projects and sometimes incurred extra cost, and therefore reduced performance improvement.

6.3.6 Communication and Coordination

In response to the question related to the factors affecting the achievement of successful SDM projects performance, all the interviewees concurred that communication and coordination were the key factors in the performance improvement of SDM projects due to the repetitive nature of these projects. As such, detection of faults/mistakes, reasons for improvement and experience contribute to the Lessons Learnt (LL); therefore, stakeholders could benefit from these lessons as long as good and effective communication and coordination exists. This was confirmed by all the interviewees emphasising it as a crucial issue. However, the majority of contractors claimed that consultants should coordinate more effectively. On the other hand, the majority of consultants indicated that contractors should use their initiative in order to search for necessary skills and experience that could contribute towards the improvement of project performance either in-house or externally rather than wait for guidance from other stakeholders. All the clients stressed that project performance was affected by the level of coordination between the contractor and other stakeholders, which could be achieved through improving planning and control methods to ensure that the progress of a project was satisfactory. The majority of interviewees stressed that communication and coordination should be activated through increasing the weekly progress meetings involving the client, consultant and contractor to allow them to review the progress of the project and discuss all the decisions that need to be taken, where it is recognised that these progress meetings are not scheduled effectively.

However, in light of adopting the SDM projects, in the four projects (completed and on-going) all the interviewees emphasised the importance of communication and coordination between stakeholders within the SDM projects if the necessary skills and experiences were to result in better improvement performance for SDM projects through weekly progress meetings.

6.3.7 Lessons Learnt in SDM Projects

Interviewees were asked to identify the current situation of LL and the role of LL in improving the performance of the SDM projects. There was a consensus among interviewees that the current situation in LL is disorganised**,** fragmented and ineffective. As a result, ongoing projects suffered from repeated mistakes. Additionally, all the interviewees acknowledged that LL, particularly for typical SDM projects, are a powerful tool for achieving sustainable performance improvement. However, practically, the adoption of LL as an improvement tool was not in place due to a complete absence of mechanisms for identifying, capturing and reusing LL in ongoing and future projects. In demonstrating the failure to adopt a clear methodology for capturing LL, the contractors acknowledge that they did not actually provide a project close-out report at the end of a project. Significantly, there should be a consultation meeting to revise all aspects of a project including its problems, those of its users and any technical issues, which could be summarised and form the basis for a close-out report to be reused for future projects.

All the interviewees raised a serious concern related to the reuse of LL, which is associated with the continuity of the staff involved in working on the SDM projects due to the LL being saved in the staff's heads rather than being documented. Such a situation is not guaranteed due to the implementation of construction projects being dependent on the procurement system. For example, one of the contractors indicated that since contractors implemented a number of typical projects, there were valuable lessons gained through these projects, such as familiarity with their models in terms of specifications, procurers, drawings, the detection of some design faults and making some improvements in terms of quality, which make it easier to deliver a project on time. Moreover, none of the interviewees mentioned a sustainable adoption of LL. They only expressed their personal experience during their work on SDM projects and what they had learnt in terms of skills, detection of design faults and inappropriate material specifications. Therefore, none of these lessons were documented and subsequently reused. All clients stressed that police department projects for example represent about 60-70 per cent of the total SMoI projects being implemented; therefore, improvement should be made through exchanging the lessons between these projects. The majority of contractors argued that clients should be aware of the importance of LL and their impact on the improvement of SDMs' project performance; therefore, a clear approach should be identified for capturing and reusing LL.

The majority of interviewees agreed that contractors and consultants should continue to implement and manage respectively the SDM projects in line with the good experience and skills that have been learnt from completed projects. However, clients and consultants stressed that the client should develop the procurement method to select the suitable contractor based on multi-measures such as experience, and skills of staff rather than only basing their decision on the lowest price.

It was established that in the four projects (completed and on-going) LL is a powerful tool for achieving a sustainable continuous performance improvement for SDM projects, but it suffered from disorganisation, fragmentation and ineffectiveness. This resulted from a complete absence of mechanisms for identifying, capturing and reusing LL in ongoing and future projects.

6.3.8 Continuous Improvement Tools and Techniques

Interviewees were asked to identify the tools and techniques used for achieving continuous improvement in SDM projects. All the interviewees reported that Total Quality Management (TQM) and Benchmarking were not used for this purpose in all SDM projects. On the other hand, they acknowledged that because of the nature of SDM projects, the LL are considered to be a suitable tool for achieving continuous performance improvement through reducing the number of shortfalls and defects from project to project, which undoubtedly will achieve sustainable project performance improvement. The majority of consultants and contractors confirmed that the emergence of the same defects that occurred in completed projects means that no improvement has been achieved. This also shows that there has been no learning from past faults.

6.3.9 The Expected Benefits of Continuous Improvement

Interviewees were asked to give their views on benefits gained from continuous performance improvement. The results revealed different viewpoints which focus on ensuring client and end-user satisfaction, meeting the needs of the project, quality improvement, reducing wasted time, saving costs, modernising project methods, and ensuring contractor profitability and the productivity of the workers.

6.3.10 Suggested Components of an Improvement Framework

Interviewees were asked to suggest crucial components that should form part of a framework for improving the performance of SDM projects. The majority of clients suggested that the evaluation of performance of SDM projects should include ways in which design modifications and development can be achieved based on the LL from previous projects. Further details include the development of material specifications, communication and coordination between stakeholders at all levels, allocation of responsibilities and contractor fitness. All clients and consultants suggested that the tendering process is a crucial factor in which a contractor's bid can be subject to comprehensive financial and technical assessments, development of materials' specifications, and the improvement of project procedures. The majority of contractors suggested that advanced technology such as Knowledge Management (KM) rather than hard copies on paper should be used in improving SDM project performance and LL documentation. They agreed with the consultants with regard to the improvement of project procedures, in particular the approval of materials, drawings, and other design documents, better communication and coordination between stakeholders, and identification of the authorities and responsibilities for each party. On the other hand, all the interviewees suggested that client satisfaction, cost, time and quality should form the backbone of project performance criteria.

6.3.11 SDM Projects Recommended for Case Studies

Finally, the interviewees were asked to identify an SDM category model suitable for conducting case studies during the main data-collection stage of this research. They collectively singled out the Police Department (PD)-SDM for the following reasons: the availability of completed projects of this category; the availability of on-going projects of this category which are underway during the data collection stage; and the existence of 200 PD-SDM among SMoI' future projects planned to be implemented over the next twenty years.

6.4 SUMMARY

The preliminary interviews provided relevant data about SDM projects, which was missing from the literature. Moreover, findings of the interviews highlighted current important and critical issues related to SDM project performance. They provided the research with a sound foundation on the core issues on the performance of SDM projects as perceived and currently practised by the key stakeholders involved in SDM project implementation.

Results revealed that the project performance criteria used to measure the performance of SDM projects are often focused on time, cost, quality and client satisfaction. However, contractors identified the profitability as a crucial measure for SDM projects performance. The study also examined the main tools used for planning and control, which are Primavera and MS Project, while regular reports and meetings were used as a control technique. Further key issues affecting SDMs' project performance improvement have been addressed through the interviewees' responses. These issues were identified as contractor abilities, project procedures, design modification, communication and coordination and LL in SDM projects. Furthermore, the study revealed that TQM and Benchmarking are not used for achieving continuous improvement in SDM projects; however, LL was considered by the interviewees as the best tool for achieving continuous performance improvement on SDM projects. The expected benefits of continuous improvement include client and end-user satisfaction, meeting the needs of the project, achieving quality improvement, reducing wasted time, etc. The results provided the interviewees' viewpoint with respect to suggested components that should be included within the framework for improving the performance of SDM projects; for instance, LL documentation, tendering criteria development, communication and coordination, LL as a major tool, etc. Finally, the recommendations provided by interviewees regarding the available categories of models which might be suitable for conducting the case studies during the main data-collection stage of this research were identified, where PD was selected to be the suitable case study. The chapter provided salient issues from practical situations from the perspectives of stakeholders involved in the SDM projects. Chapters Three, Four, Five, and Six contribute to a sound theoretical foundation for this research. Significantly, such a theoretical foundation supports the need for an in-depth investigation in order to identify the critical issues affecting the improvement of performance of SDM projects. Accordingly, a case study strategy was selected to investigate in depth the critical success factors affecting the improvement of the SDM projects performance and therefore develop a framework for improving the performance of SDM projects. The following chapter presents the analysis and results of the four case studies conducted in this research.

CHAPTER 7

7 RESULTS AND ANALYSIS OF CASE STUDIES

7.1 INTRODUCTION

Results and analysis, which were presented and discussed in the previous chapter, as well as the literature review, led to the need to conduct an in-depth investigation. This chapter aims to present the results and analysis of four case studies of SDM projects to be used for developing a framework for improving the performance of SDMs. Semi-structured interviews were conducted with 12 key stakeholders involved in SDM projects to identify Critical Success Factors (CSFs) affecting the improvement of SDM project performance. Additionally, documents relevant to the four case studies were collected and analysed. Results and analysis of four case studies identified 14 CSFs, which were divided under three umbrellas, namely, the adaptability of SDMs to the context; contract management and construction management. The chapter is divided into five sections: sampling approach; background of case studies; analysis and results of documents relevant to case studies; analysis and results of interviews and, finally, a summary.

7.2 PARTICIPANTS' INFORMATION

As discussed in Chapter Two, the sampling method used for selection of the stakeholders was purposive, based on three scales: their experience in the field of SDM projects, their qualifications and their position. Three representatives of each case study - a total of 12 key stakeholders - were selected representing the clients, consultants and contractors who were involved in the SDMs adopted by the Saudi Ministry of Interior (SMoI) as illustrated in Table 7.1. Each interview lasted between 90 and 120 minutes. The case study protocol is designed to be a systematic approach to increasing the reliability of case study research and is intended to guide the researcher in carrying out the case study. Well-designed steps within protocols ensure that the operations of the study can be repeated with the same results.

Table 7.1:Case studies participants

Case studies	Number of interviewees	Interviewees	Coding
Completed project CS1	1	Client Representative	CLR1
	1	Consultant Representative	CONSR1
	1	Contractor Representative	CONTR1
Completed project CS2	1	Client Representative	CLR2
	1	Consultant Representative	CONSR2
	1	Contractor Representative	CONTR2
On-going project CS3	1	Client Representative	CLR3
	1	Consultant Representative	CONSR3
	1	Contractor Representative	CONTR3
On-going project CS4	1	Client Representative	CLR4
	1	Consultant Representative	CONSR4
	1	Contractor Representative	CONTR4
4	12		

The case study protocols were discussed earlier, in Chapter Two. The template of the interviews comprises three sections: case study and personal background; learning in SDM projects and SDM project performance (see Appendix D). Background information about the four case studies is presented in Table 7.2.

Table 7.2: Background to the four case studies (CAD 2003)

Case studies	Location	Allocated budget (£)	Area (m^2)	Length of contract (Days)	Start Date Finish date
Completed project CS1	Jeddah	1,090,501	3,084	720	January 2003 December 2004
Completed project CS2	Makkah	1,114,272	3,084	720	January 2003 December 2004
On-going project CS3	Taif	1,001,790	3,084	720	June 2006 May 2008
On-going project CS4	Qassim	912,055	3,084	720	January 2007 December 2008

As discussed in Chapter Two, a cross-case synthesis technique was used to analyse the collected data from both interviews and documents. Cross-case synthesis is an aggregation of findings across a series of individual cases (Yin, 2008). By employing this technique, the findings are likely to be more robust and this will strengthen them even further.

7.3 SMoI SDM-RELATED DOCUMENTS ANALYSIS AND RESULTS

The document analysis aims to help the researcher target specific subjects using the collected information. It also helps the researcher to probe additional questions about critical issues during interviews based on document analysis to produce robust data. A number of documents relevant to the four case studies were employed in this research, such as invitation documents, tendering documents, BoQ documents, the project contract documents, financial requests, minutes of meetings, change order documents, submittal request documents, prequalification request documents, disseminated documents and the project handover to end-user document. The researcher had been granted access to all these documents in all the four case studies.

Again as discussed in Chapter Two, the documents were analysed by using qualitative content analysis. Consequently, the available documents were analysed through extracting and categorising information from the text in order to develop themes. 12 CSFs affecting the process of improving the SDM projects were identified from the analysis of relevant documents. These findings are summarised in Table 7.3.

Table 7.3: Summary of document findings on CSFs of SDMs project performance improvement – Four case studies

CSFs for the improvement of SDM project performance	Findings of Four Cases' Documents
Invitation to tender	●*The invitation documents clarify that contractors were invited through "open invitation"; the same system used in all the four case studies.*
Tender criteria for selection of contractor	● *In all four case studies, the tendering process documents show that the criterion used to choose the contractor was the lowest price regardless of the other considerations such as the financial situation, skill and experience of the contractor.*
Payment process	● *Financial request documents illustrate that in all the four case studies there were complicated processes for the clearance of regular payments to contractors. Additionally, the same documents show that there was an outstanding amount for the two contractors in CS1 and CS2 despite those projects being delivered over two years ago.*
Contract documents for future SDM projects	● *Contract documents identify that in all the four case studies, terms and conditions are typical and they were not updated from project to project. Additionally, estimated cost is typical and not*

	updated in all the four case studies despite the rapid changes occurring in prices and markets. ● *In CS3 and CS4, BoQ documents clarify that there were a number of change orders provided to the H.O for adjusting the BoQ due to existing mistakes repeated in the quantities, although they were detected through CS1 and CS2.*
Collaboration between the client's Supervision and Design Departments	●*In all the four case studies, change order documents show that there was ineffective collaboration between the client's supervision and design departments.* ● *As shown in change order documents, in all the four case studies all LL provided to the supervision department are reviewed and discussed with the consultant and action taken if necessary and then returned to the same projects without notifying the design department about these lessons, despite the design department being responsible for adapting the SDM to context for future projects.*
Design modification and material specifications amendment	●*In CS1 and CS2, change order documents clarify that there were some design modifications and material specifications amendments, some of them were carried out by the regional administration and the others by the H.O.* ● *In CS3 and CS4, change order documents illustrate that the majority of previous design modifications and material specifications amendment were again requested to be carried out, this means they were not taken into consideration during the adaptation of SDM to context for future projects.*
Central database	● *In all the four case studies, through inspection of all relevant documents, such as disseminated documents, change order documents and progress reports, no reference to any database, either in projects or in the H.O, was found as all documents were saved as hard copy.*
Dissemination of LL	●*Disseminated documents show that there was ineffective dissemination in all the four case studies, however, in CS1 and CS2, there were a number of LL documents that were disseminated unlike CS3 and CS4, which received few LL. Due to CS3 being located in the same region as CS1 and CS2, some disseminated documents related to CS1 and CS2 were used in CS3.* ●*CS4 is located in a different region, so the majority of disseminated documents which were delivered to CS1 and CS2 were not delivered to CS4.*
SDM Project procedures	● *Submittal request documents such as material and shop drawings submission clarify that CS1, CS2, CS3 followed the same project procedures due to their being located under the same regional administration.* ● *CS4 is located in a different region so this project used completely different procedures.* ● *In all the four case studies, submittal request documents show that there were no standard procedures for all SDM projects that were issued by the H.O.*
Decision-making process	●*In all the four case studies, change order documents show that there were vast numbers of change orders sent to the H.O to get permission to take any decision, which contributed to long delays in granting approval. Additionally, project contract documents show that there was ambiguity with regard to the level of the decision-making process.*

	● *As shown in change order documents, design changes or materials amendments had to be sent to the head office of the client, and this was followed in all the four case studies.*
Methodology for identifying, capturing, documenting and re-using the LL	● *Analysis of relevant documents for all the four case studies, such as project contract documents, progress reports, minutes of meetings, disseminated documents and the project handover to end-user document revealed that there was no methodology for identifying, capturing, documenting and re-using the LL to be followed by the stakeholders. Additionally, there were no documents specified for LL, holding a regular meeting to discuss events that have arisen, or appointing a lessons-learnt coordinator.* ●*In all the four case studies, it was realised that there were no documents that could provide evidence about the situation involving LL.*
SDM project close-out report	●*The project handover to end-user documents show that in CS1 and CS2 there were no project close-out reports which provide a comprehensive assessment of projects such as, project performance, contractors, consultants and suppliers delivered to the client. Additionally, project contract documents and minutes of meetings show that there were no clear instructions or terms that were stated concerning the need to issue and deliver a project close-out report.* ● *In CS3 and CS4, project contract documents and minutes of meetings clarify that there were no plans or instructions provided to the contractors and consultants focusing on preparing and issuing a project close-out report at the end of the project.*

7.4 CASE STUDIES/INTERVIEWS' RESULTS AND ANALYSIS

The main aim of the case studies was to investigate the key CSFs that affect the process of improving the SDM projects' performance. Indeed, the case studies attempt to identify how existing SDM project performance could be improved through Lessons Learnt (LL). The case studies were based principally on semi-structured interviews with the key stakeholders involved in the SDM projects. The interviews were recorded to enable any further manipulations and the conduct of a robust analysis. The data were transcribed verbatim.

Framework analysis, as described by Ritchie and Spencer (1994), is '*an analytical process which involves a number of distinct though highly interconnected stages*'. The five key stages involved in the framework and used in the interview analysis are outlined as follows: familiarization; identifying a thematic framework; indexing; charting; mapping and interpretation. As showed in Table 7.1, stakeholders were coded based on every case study. The data were sorted into main themes identified from the verbatim transcription using the framework analysis technique, as discussed in Chapter 2. Findings from cross-case synthesis identified 14 CSFs affecting the improvement of SDM project performance. The CSFs are classified under three main themes: adaptability of SDMs to the context; contract management and construction management. These themes are discussed below.

7.4.1 Adaptability of SDMs to Context-Related CSFs

The analysis of interviews revealed that there are CSFs associated with the Adaptability of SDMs to Context, which is considered to lie at the heart of improving project performance. The identified CSFs include: Collaboration between supervision and design departments; design modification and development, materials specifications amendment, a central database and the dissemination of LL. These CSFs are discussed below and illustrated in Table 7.4.

Table 7.4: Cross-Case Synthesis of Adaptability of the SDMs to Context – Related CSFs

Identified CSFs	CS1	CS2	CS3	CS4
Collaboration between the client's design supervision and departments	- Ineffective collaboration. - Repetitive faults in design emerged in future projects due to ineffective collaboration.	- Ineffective collaboration Many LL provided to the HO without action/feedback - Many faults were discovered in the design, materials & BoQ due to lack of recent and comprehensive review.	- Ineffective collaboration -No feedback on faults - Repetitive faults in design - Supervision department is not involved in the site adaptation stage.	- Ineffective collaboration - Repetitive faults in design. - Supervision department is not involved in the site adaptation stage.
Design modification	- Many faults in design were detected in this project. - Design modification due to detected faults or for improvement. - Design modification affected by ineffective collaboration. - Modification in structural design.	- Many faults in design were detected in this project. - Design modification due to detected faults or for improvement. - Design modification affected by ineffective collaboration. - There were some changes initiated by the contractor leading to innovation. -There was a mistake in the structural design solved through experience in a previous project.	- This project followed the same modification made in CS1 and CS2. -Design modification affected by ineffective collaboration. - Design modification is to improve architectural shape, project quality and innovation. - The change in design depends on the engineering experience gained from previous typical projects.	- Many faults in design were detected in this project and not be avoided. -Design modification affected by ineffective collaboration. - Commitment to design modification to maintain improvement at all projects. - Some improvements were initiated by project management.
Materials specifications amendment	- Materials specifications amendment due to the rapid changes in markets and availability and to improve quality. - Materials specifications amendment affected by experience and skill of contractor.	-Materials specifications amendment due to the rapid changes in markets and availability and to improve quality. - Materials specifications amendment affected by experience and skill of contractor.	-Materials specifications amendment due to the rapid changes in markets and availability and to improve quality. -This project benefited from amendments made in CS1 and CS2. - Materials specifications amendment affected by experience and skill of contractor.	-Materials specifications amendment due to the rapid changes in markets and availability and to improve quality. -This project was located in a remote region and material specifications amendments affected by that. - Materials specifications amendment affected by experience and skill of contractor.

Central database	-No central database in the H.O, regional administration as well as construction sites. - Lack of database caused loss of the LL needed for improvement. - No special documents for LL were provided to contractor. -LL were restricted to the project itself. - No database due to a lack of engagement from the client.	-No central database in the H.O, regional administration as well as construction sites. - Some LL left with the contractor. - No special documents for LL were provided to contractor. - The frequency of mistakes was due to lack of database of LL. - No database due to a lack of engagement from the client.	-No central database in the H.O, regional administration as well as construction sites. - No special documents for LL were provided to contractor. - Loss of past LL influenced project performance improvement. - No database due to a lack of engagement from the client.	-No central database in the H.O, regional administration as well as construction sites. - No special documents for LL were provided to contractor. - The frequency of mistakes was due to lack of database of LL. - No database due to a lack of engagement from the client.
Dissemination of LL	- Dissemination of LL affected by a lack of database affected. - No direct access due to lack of using IT. -A number of LL were provided as hard copies.	- Dissemination of LL affected by a lack of database affected. - No direct access due to lack of using IT. -A number of LL were provided as hard copies. - All LL should be provided to all projects through direct access. - Informal approach for reaching the LL or through meetings.	- Dissemination of LL affected by a lack of database affected. -No direct access due to lack of using IT. - A few LL were provided as hard copies by consultant based on his experience gained from completed projects.	- Dissemination of LL affected by a lack of database affected. - No direct access due to lack of using IT. -A few LL were provided as hard copies.

7.4.1.1 Collaboration between the client's design and supervision departments

The 12 interviewees were asked to identify the role of H.O Design and Supervision Departments in activating the LL for the SDM projects. All the interviewees in all the four case studies stressed that the collaboration between the H.O design and supervision departments had a direct impact on achieving sustained improvement in the performance of SDM projects. In all the four case studies, clients and consultants indicated that a critical gap between the two departments was identified due to insufficient collaboration. They highlighted that strengthening collaboration and communication between the two departments is a CSF in improving the performance of SDM projects. Clients and consultants in all the four cases stated that this has resulted in repetitive defects and shortcomings. As quoted by CLR4, *"the problem is that there are two departments at the head office of the client and each department has a separate head, so it seems that there is no collaboration between them to avoid the same deficiencies that occurred in previous projects witnessed by the frequency of mistakes in ongoing projects"*.

As confirmed by all clients and consultants in all the four cases, the design department manages the adaptability of the SDMs to context for new projects. The researcher investigated the way of improving the performance of SDM projects through the adaptation phase. They argued that all mistakes or suggestions that are considered as LL must be provided to the design department to be avoided or added in future projects to achieve new improvements. As a result, they emphasised that if the aforementioned faults/suggestions were not taken into consideration during the adaptation stage, the new projects would encompass the same faults. As confirmed by one of consultant "*remarkably, the majority of faults identified in CS1 and CS2 were detected again in CS3*" (CONS3). The researcher asked about the suggestion of developing this collaboration. All the interviewees in all the four cases concluded that there is therefore an urgent need to bridge the existing gap between the two departments to achieve effective collaboration in order to produce improved projects.

7.4.1.2 Design modification

All the 12 interviewees were asked about the extent of improvement that was achieved in the light of adapting the SDM projects through LL. As highlighted by all the 12 interviewees, there are two types of changes in SDM projects: change for design modification and change due to some faults detected in the design. In all four case studies, all clients and consultants argued that design modification was affected by the existing gap between the H.O design and supervision departments. The researcher probed about this type of effect. They concluded that hence, this has contributed towards the recurrence of the same faults and non-generalizing the improvements to other typical SDM projects. As argued by all consultants and contractors in all the four case studies, by and large, SDM project performance was affected by the request for the modification and development of a design due to the slow response by the H.O, and this resulted in overrun time.

As indicated by all consultants in all the four case studies, it was noticed that the H.O lacked engagement and commitment to speed up the process of design modification, except for attempts performed by the project management. In CS1 and CS2, all the consultants and contractors stated that there was a need to modify and develop the design for improvement purposes as well as detecting faults in the design. The researcher probed regarding the source of the demands for design modification. All the interviewees in all the four case studies indicated that the need for improvements to be made in design were added based on the client and end-user demands which were necessary to fulfil the building's function, and thereby achieve continuous improvement in SDM project performance through LL. This has been confirmed by CONSR4 *"LL provide a clear insight for the client and end-user to avoid the* *past mistakes in design and also a room for improvement to be modified and developed and undoubtedly will help achieving a sustainable continuous improvement for SDM projects' performance".*

The researcher investigated the types of design faults identified. In all the four case studies, all the interviewees indicated that many faults/mistakes in the design were identified, including structural, electrical and mechanical faults. These faults/mistakes emerged due to inappropriate design functionality or difficulties in implementing some design features in practice, for instance, the design of the project foundations. The clients and consultants in CS1 and CS2 established that the skilled and experienced staff, either the contractor or the consultant, play a significant role in identifying these faults in design, and this proved to be the case during the execution of those cases.

7.4.1.3 Materials specifications amendments

In addition to the importance of design modification in achieving a sustained improvement in SDM project performance, in all four case studies, all the interviewees stressed the importance of materials specifications amendments. They argued that according to the rapid changes occurring in world markets, materials must be subject to amendment to meet these changes either in terms of price increases or/and quality. The researcher probed the size of amendments carried out in all four cases. All the interviewees indicated that material specifications were subject to amendment in order to meet the aforementioned changes in markets, steer away from repeating the same mistakes in materials specifications and sustain the improvement of project quality. As established by all clients and consultants in all the cases, other critical issues were related to that SDMs were designed over ten years ago, therefore, some materials have become out-of-date and others are now unavailable, also the nature of the use of SDM projects has forced the client to make constant changes due to end-user demands.

The researcher probed regarding the importance of materials specifications amendments for performance improvement. As emphasised by all the 12 interviewees, all amendments made to materials specifications undoubtedly contributed to the continuous improvement of SDM project performance. *"The need for improvement and quality require some changes in specifications and materials without increasing time or cost and that was based on the LL captured from previous projects",* this was quoted by CLR2. The researcher asked about the factors affecting the identification of this amendment. The majority of interviewees agreed that the experience and skills of the contractor contributed to the identification of materials amendments and the encouragement of innovation without increasing the cost and time of projects. In CS3, for example, CONS3 stated that, due to a lack of sufficient skill and experience, the contractor was able neither to identify any needed amendments nor to introduce innovative work in relation to materials specifications. In CS4, all the interviewees agreed that the fact that the project was located in a remote region contributed to some amendments in materials specifications as well as some improvements demanded by the client. The location of the project created some difficulties for the contractor when seeking to procure materials so far from the major cities and this caused increases in the cost of delivering the materials.

7.4.1.4 Central database

Interviewees were asked how LL are documented and saved so that they can be shared and reused for on-going and future SDM projects. As agreed by all the 12 interviewees, there was no database for saving LL within the projects; as CONSR3 explained: *"in this project, there is no database was launched for storing project information. LL from different regions should be stored in the main office to form a database that could contribute toward improving all projects across the country".*

Equally, in all the cases, all clients and consultants added that there was also no database for saving LL in the regional administration or the H.O (see Chapter Five). The researcher investigated whether there was a database on site or in the regional administration for saving LL. All the interviewees in the four cases stated that no such database was built, however, most of the LL were restricted to the project itself or provided to the client, who neither documented nor saved them. The researcher asked the 12 interviewees about the reasons behind this shortage and what the impact on the performance improvement process was. They established that this was a result of a lack of engagement from the client and thus, by and large, on-going projects are suffering from this problem.

Clients and consultants indicated that the majority of LL captured during the execution of CS1 and CS2 were not published and disseminated, except for a few documents saved as hard copy by the regional administration. The researcher asked all the interviewees in CS3 and

CS4 whether the situation had improved. They acknowledged that only LL that are discussed through meetings are saved as hard copies.

The researcher captured the views of the interviewees, particularly clients and consultants, about the suggestions for improving this situation. All the clients and consultants reiterated that, because SDM projects would be implemented over a 20-year period, the establishment of a central database and the use of Knowledge Management (KM) are essential tools for achieving continuous performance improvement for future SDM projects. They recommended that the database must be updated based on the continuous feedback provided from the running and completed projects, and should be accessible via the Intranet to all SDM project managements.

7.4.1.5 Dissemination of LL

Interviewees were asked how captured LL are disseminated to on-going and future SDM projects. All the 12 interviewees emphasised that an effective dissemination of LL depends on the existence of a central database and the level of use of effective communications. Accordingly, as no database was established either in the project or in the H.O, there was ineffective dissemination of LL to SDM projects. The researcher probed whether there were observed mistakes that recurred during the on-going projects. The majority of interviewees stated that past mistakes that had occurred in completed projects recurred again in later projects, and further, improvements made in completed projects were restricted to these projects, and little improvement was achieved in SDM projects' performance.

The majority of interviewees in all four cases highlighted the importance of using IT, such as web-based tools, in facilitating the sharing of knowledge between all SDM projects, where currently there was no use of advanced technology, such as Intranet access. The researcher probed the level of dissemination of LL within the four case studies. In CS1 and CS2, all the interviewees confirmed that the level of dissemination was rather satisfactory. In contrast, in CS3 and CS4, all the interviewees stated the level of the dissemination of LL was unsatisfactory, where only a few circulations were disseminated to the contractor through the consultant and client in the form of hard copies or in an informal way. The researcher asked regarding the reasons behind this difference. Half of the interviewees linked this problem to an ineffective client commitment to LL and the consultant, while the others linked that to the shortage of skilled and experienced contractors who are implementing the current projects in contrast to the level of skilled and experienced contractors in CS1 and CS2. In CS4, all the interviewees indicated that none of the LL that had been captured in completed projects had been disseminated to this project, despite CS4 starting from scratch. They added that very few circulations were disseminated by using hard copies or verbal information through the consultant and the client, sometimes after holding a meeting. This was illustrated by stating that *"LL must be disseminated to all projects rather that the current individual situation, the search for any needed LL captured from completed projects requires a couple of months, although it is missed due to non-documentation"* (CLR4).

7.4.2 Contract-Management-Related CSFs

The analysis of interviews across the four case studies revealed four CSFs associated with Contract Management, where they significantly influence the improvement of SDM project performance. The identified CSFs are: invitation to tender; tendering criteria for selection of contractor; the payment process and contract documents for future SDM projects. The CSFs are discussed below and illustrated in Table 7.5.

Table 7.5: Cross-Case Synthesis of Contract-Management-Related CSFs

Identified CSFs	CS 1	CS2	CS 3	CS4
Invitation to tender	- Open invitation system - Time, cost, quality and client satisfaction used as performance criteria. - Project was successful and captured LL due to experienced and skilled contractor. - A call made by all clients and consultants for "closed invitation"/long term contract.	- Open invitation system - Time, cost, quality and client satisfaction used as performance criteria. - Project was successful and captured LL due to experienced and skilled contractor. - A call made by all clients and consultants for "closed invitation"/long term contract.	- Open invitation system - Time, cost, quality and client satisfaction used as performance criteria. - Underachievement in project performance and a few LL due to inexperienced and unskilled contractor. - A call made by all clients and consultants for "closed invitation"/long term contract.	- Open invitation system - Time, cost, quality and client satisfaction used as performance criteria. - Underachievement in project performance and a few due to inexperienced and unskilled contractor. - A call made by all clients and consultants for "closed invitation"/long term contract.
Tendering criteria for selection of contractor	- Project was awarded based on the lowest price regardless of other measures. - A call made by all clients and consultants for comprehensive measures. - The current procurement system used was criticised by all clients and consultants.	- Project was awarded based on the lowest price regardless of other measures. - A call made by all clients and consultants for comprehensive measures. - The current procurement system used was criticised by all clients and consultants.	- Project was awarded based on the lowest price regardless of other measures. - A call made by all clients and consultants for comprehensive measures. - The current procurement system used was criticised by all clients and consultants.	- Project was awarded based on the lowest price regardless of other measures. - A call made by all clients and consultants for comprehensive measures. - The current procurement system used was criticised by all clients and consultants.
Payment process	-A very long process used for accepting and granting the payments. - Major cause of delays in payment process was the H.O. - There were outstanding bills for the contractor not	-A very long process used for accepting and granting the payments. - Major cause of delays in payment process was the H.O. - There were outstanding bills for the contractor not	-A very long process is still being used for accepting and granting the payments. - Major cause of delays in payment process was the H.O. - Consultant and contractor shared in the payment delays.	-A very long process is still being used for accepting and granting the payments. - Major cause of delays in payment process was the H.O. - Major cause of delays in payment process was the

	paid by the client. - Consultant and contractor shared in the payment delays. -A call made for standardising and computerising the payment process.	paid by the client. - Consultant and contractor shared in the payment delays. -A call made for standardising and computerising the payment process.	-A call made for standardising and computerising the payment process.	H.O. - Consultant and contractor shared in the payment delays. -A call made for standardising and computerising the payment process.
Contract documents for future SDM projects	-A call made by all 12 interviewees for updating allocated project budget. - Bill of quantity was subject to some changes due to the difference between estimated and practical quantities. - Identification of LL was not included in the project contract. -Terms and conditions of contractor not updated.	-A call made by all 12 interviewees for updating allocated project budget. - Detection of mistakes was made in the BoQ and other documents. - The same allocated budget - Identification of LL was not included in the project contract. -Terms and conditions of contractor not updated.	-A call made by all 12 interviewees for updating allocated project budget. - Allocated budget not reassessed and the same budget as cases 1 & 2. - Identification of LL was not included in the project contract. -Terms and conditions of contractor not updated.	-A call made by all 12 interviewees for updating allocated project budget. - Past mistakes in BoQ were detected and not avoided. - Allocated budget not reassessed and the same budget as cases 1 & 2. - Identification of LL was not included in the project contract. -Terms and conditions of contractor not updated.

7.4.2.1 Invitation to tender

The 12 interviewees were asked to identify the procurement method used in the SDM projects. As they stated that the invitation to tender system used in the SDM projects was an “open invitation” which depends on advertisements in newspapers, contractors therefore rely on winning work through competitive tendering, which often depends on the lowest price to the exclusion of other factors. The majority of clients and consultants in all four case studies indicated that this creates an opportunity for all contractors to compete for the project although some of them may not have sufficient financial, manpower and logistical resources, due to the main criterion for winning the project being the lowest price.

According to all clients and consultants in CS1 and CS2, contractors who implemented these projects delivered them successfully as well as providing a number of LL that contributed to the improvement of the two projects. The researcher probed how all interviewees in CS1 and CS2 measured the success of projects. They sated that project performance is measured based on four criteria: time, cost, quality and client satisfaction, and these were achieved in CS1 and CS2. On the other hand, all clients and consultants indicated that CS3 and CS4 are suffering from breakdowns and slow progress and it is expected that the two projects would not be delivered on time, therefore, these contractors have demanded an extension for finishing the projects. However**,** all interviewees in CS3 and CS4 delivered the aforementioned measures used in CS1 and CS2.

In all four cases, clients and consultants called for the adoption of a “closed invitation” system to invite only contractors who had relevant and satisfactory past performance. They advocated this approach to submitting a bid based on the familiarity gained with the SDM projects and the relevant experience and skills gained in their implementation. Additionally, they suggested that, based on the relevant and satisfactory past performance of a contractor, the use of long-term contracts would be significant due to their influence on improving the performance of SDM projects through creating an effective learning environment. This has been confirmed by CLR4 “the *H.O is now studying the use of long-term contracts with selective contactors who made* a *satisfactory past performance in completed projects to ensure transferring the experiences* and *skills obtained from the completed projects to the new projects to ensure achieving a continuous project performance improvement”*.

7.4.2.2 Tendering criteria

Interviewees were asked to discuss the criteria used for selecting the contractors in the SDM projects. All 12 interviewees indicated that tendering criteria were based on the lowest price regardless of other measures for selecting the contractor. The researcher asked whether there was a relationship between the invitation stage and the tendering process. All the interviewees agreed that tendering criteria are concerned with the invitation stage; therefore, they are affected by the type of contractors invited to enter the competition.

As established by all clients and consultants in all four case studies, there is a need to adopt more comprehensive tendering criteria to take into account the measures of financial soundness, skilled staff, relevant experience and contractor’s past performance rather than relying solely on the lowest price. The researcher questioned all 12 interviewees to identify the impact of including these measures among the current criteria. They agreed that the financial soundness of the contractor, their skills, relevant experience and satisfactory past performance have a significant impact on project performance in terms of the client failing to make regular payments on time and meeting the technical requirements of a project respectively.

As stated by all clients and consultants in CS3 and CS4, although the contractors in those cases have an unsatisfactory past performance, those contractors are still awarded new SDM projects. The researcher probed for an explanation of the reasons behind this decision. They indicated that this was due to the current procurement method used in governmental sectors, which is based on the lowest price regardless of the aforementioned measures.

7.4.2.3 Payment process

Interviewees were asked to what extent the payment processes in the SDM projects are standardised. All 12 interviewees agreed that little improvement had been made in the payment process since the beginning of the SDM programme, which started in 2003. The researcher sought to identify the reasons behind this issue. All consultants and contractors in the four case studies highlighted that the H.O failed in paying regular payments to the contractors due to the use of a very long process for accepting and granting the payments. As acknowledged by 12 interviewees, the payment process in governmental sectors passes through many departments before acceptance. They suggested that payment process should be standardised and computerised across all the SDM projects.

In all four cases, all the contractors stated that on some occasions, claims needed more than one request before being accepted and granted by the client as well as consultants. The majority of clients and contractors indicated that another reason behind the delay was caused by the consultant who should first receive a claim to verify and confirm that it is in accordance with the project activities and BoQ before submitting them to the client. However, the majority of clients and consultants stated that the contractor was partially responsible due to the delay in submitting the claims. This was mainly due to delays in achieving the planned activities according to the time schedule or delays in preparing and reviewing the claim documents in line with the BoQ.

The researcher probed whether delays in payments influenced the performance of projects. All interviewees in CS3 and CS4 reported that contractors suffered from this delay in receiving payments from the client, which particularly led to their shortage of liquidity, and thus affected the performance of projects. On the other hand, in CS1 and CS2, all interviewees stated that contractors were able to cope with this situation and tried to maintain the progress of their projects successfully by using their strong financial position.

7.4.2.4 Contract documents for future SDM projects

Interviewees were asked to describe the improvement achieved in contract documents as a result of captured LL. All 12 interviewees stressed that, in general, the costs of SDM projects were estimated a long time ago. They went further to argue that prices in the market are not stable, therefore, there should be a continuous assessment for estimated costs, or even time, to avoid any financial problems leading to failed projects. The researcher asked whether interviewees observed recurring mistakes in contract documents. In all four cases, the majority of interviewees highlighted that mistakes were repeated in the project contract documents with respect to allocated cost, BoQ and terms and conditions. In CS1 and CS2, contractors and consultants stated that there were a number of different mistakes detected in the BoQ of the project through the project management reviewing the documents. On the other hand, all the interviewees in CS4 noted that mistakes had been detected in completed projects and they caused cost overrun due to the increases in new quantities as well as the time delays caused by getting approval from the H.O. They emphasised that this gives a significant indicator of these documents not being subject to review and assessment as well as the non-reuse of the LL from completed projects.

As reported by the majority of interviewees in all four case studies, although there have been rapid changes, usually increases, in prices of materials, the cost allocated for implementing CS1 and CS2 (executed in 2003) is the same as for CS3 and CS4 (executed in 2006 and 2007) which contributed to processing the tendering of massive projects due to the difference between estimated cost and offered bids. All the interviewees across the four case studies stressed that achieving a continuous project performance on SDM projects could partially be achieved through the continuous assessment and review of contract documents by focusing on learning from mistakes or improvements obtained from completed projects.

7.4.3 Construction-Management-Related CSFs

Five CSFs were identified from the interviews analysis which are concerned with the effect of the Construction Management process on improving SDM project performance. These CSFs include: SDM projects procedures; the decision-making process; communication and cooperation; the methodology for identifying, capturing, documenting and reusing LL; and the SDM project close-out report. These CSFs related to construction management are discussed below and illustrated in Table 7.6.

Table 7.6: Cross-Case Synthesis of Construction Management – Related CSFs

Identified CSFs	CS1	CS2	CS3	CS4
SDM project procedures	-Inspection requests; material submission requests; approval of shop drawings and prequalification submittal for subcontractors were standardised. -A lack of full standardised procedures between all SDM projects. -Standardised procedures were made by regional administration.	-Inspection requests; material submission requests; approval of shop drawings and prequalification submittal for subcontractors were standardised. - A lack of full standardised procedures between all SDM projects. -Standardised procedures were made by regional administration.	-Inspection requests; material submission requests; approval of shop drawings and prequalification submittal for subcontractors are standardised. -A lack of full standardised procedures between all SDM projects. -Following the same standardised procedures used in CS1 and CS2.	-Inspection requests; material submission requests; approval of shop drawings and prequalification submittal for subcontractors are standardised. -A lack of full standardised procedures between all SDM projects. -Standardised procedures were made by regional administration. - Procedures for handing the project to the contractor were standardised.
Decision-making process	- Limited authority given to project management. -Project performance was affected by delay in decision-making process -Identifying and capturing LL and innovation were affected by long and delay in decision-making process. - A call made for the need to grant greater authority to the project management.	- Limited authority given to project management. -Project performance affected by delay in decision-making process -Identifying and capturing LL and innovation were affected by long and delay in decision-making process. - A call made for the need to grant greater authority to the project management.	- Limited authority given to project management. -Project performance affected by delay in decision-making process -Identifying and capturing LL and innovation were affected by long and delay in decision-making process. - Informal procedures used in this project to avoid delay. - Client project manager was not able to take decisions. - A call made for the need to grant greater authority to the project management.	- Limited authority given to project management. -Project performance affected by delay in decision-making process -Identifying and capturing LL and innovation were affected by long and delay in decision-making process. - Informal action took place due to absence of authorisation. - There is no clear authorisation given to project manager. - A call made for the need to grant greater authority to the project management.
Communication and coordination	- Effective informal communications between typical projects through visits or meetings. - Mutual experiences and site visits have direct impact on project performance. -Effective tool for exchanging skills and experience in the light of documentation and dissemination of LL. - A call made for using Intranet-based for more quickly and easily communication.	- Effective informal communications and project visits conducted by contractors or consultant. - This project delivered early due to learning gained from another project. -Effective tool for exchanging skills and experience in the light of documentation and dissemination of LL. - A call made for using Intranet-based for more quickly and easily communication.	-Less effective communication and coordination made by contractor. - Informal communication and interaction between projects. -Effective tool for exchanging skills and experience in the light of documentation and dissemination of LL. - A call made for using Intranet-based for more quickly and easily communication.	- Miscommunications between SDM projects caused repetition of past mistakes. - Informal communication took place with typical projects to know some ideas, even mistakes. -Effective tool for exchanging skills and experience in the light of documentation and dissemination of LL. - A call made for using Intranet-based for more quickly and easily communication.

Methodology for identifying, capturing, documenting and reusing LL	- There was no clear methodology guiding LL. -Major problems were identified, studied, analysed, solved and action taken by H.O. - Less commitment to learning by H.O. -Skilled and experienced contractor positively affected the captured LL. - Two learning styles: SLL and DLL. - Learning mechanism (contractor-consultant-client, collective learning, benchmarking with other typical SDM projects). -No clear policies or strategies adopted for learning. - Contractor documented the list of suppliers and subcontractors. - Client and consultant must inform contractor about saving the LL. - Documentation of LL was a part of project files (No special document). - Documentation was only a part of 'as built' stage.	- There was no clear methodology guiding LL -Major problems were identified, studied, analysed, solved and action taken by H.O. - Less commitment to learning by H.O. -Skilled and experienced contractor positively affected the captured LL. - Two learning styles: SLL and DLL. - Learning mechanism (contractor-consultant-client, collective learning, benchmarking with other typical SDM projects). -No clear policies or strategies adopted for learning. - Documentation was only a part of 'as built' stage. - Appointing a coordinator for organising the LL. - No special document was delivered to client at the end of project. -Lack of a systematic document process.	- There was no clear methodology guiding LL -Major problems were identified, studied, analysed, solved and action taken by H.O. -Unskilled and inexperienced contractor negatively affected the captured LL. - Two learning styles: SLL and DLL. - Learning mechanism (contractor-consultant-client, collective learning, benchmarking with other typical SDM projects). -No clear policies or strategies adopted for learning. - Lack of project history. - Appointing a coordinator for organising the LL. - No special document was delivered to client at the end of project.	- There was no clear methodology guiding LL -Major problems were identified, studied, analysed, solved and action taken by H.O. - Less commitment to learning by H.O. -Unskilled and inexperienced contractor negatively affected the captured LL. - Two learning styles: SLL and DLL. - Learning mechanism (contractor-consultant-client, collective learning, benchmarking with other typical SDM projects). -No clear policies or strategies adopted for learning. -Currently, distinguished contractors are being appointed for collecting the LL.
SDM projects close-out report	- No organised instructions were provided to contractor and consultant for project close-out report. - No assessment was performed at the end of the project. - No project close-out report was delivered to the client at the end of project. - A call made for a comprehensive assessment of project.	- No organised instructions were provided to contractor and consultant for project close-out report. - No assessment was performed at the end of the project. - No project close-out report was delivered to client at the end of project. - A call made for a comprehensive assessment of project.	- No organised instructions were provided to contractor and consultant for project close-out report. - Documents related to maintenance operations only will be submitted to client. - A call made for a comprehensive assessment of project.	- No organised instructions were provided to contractor and consultant for project close-out report. - Documents related to maintenance operations only will be submitted to client. - A call made for a comprehensive assessment of project.

7.4.3.1 SDM project procedures

Interviewees were asked to what extent SDM project procedures are standardised. 12 interviewees acknowledged that the characteristics of SDM projects provide a good opportunity for standardising project procedures. The majority of interviewees agreed that the standardised procedures of the SDMs, such as submittal requests and change order requests, facilitate and accelerate the flow of work in a project and prevent mistakes resulting from individual efforts and unorganised work, thereby achieving continuous improvement in performance. Indeed, CLR4 commented that *"the SDM projects have many advantages that should lead to* the delivery of *successful projects, among these is the great ability to standardise procedures used to manage projects through the reuse of the work done during previous projects. This should be done to avoid the long and complicated procedures which contribute towards bleeding into the time of the contractor as well as costs. Moreover, it was surprising that each project was dealt with separately through using different approaches, although they are the same design, i.e. Police Department*".

The researcher probed all interviewees to describe the level of application of standardised procedures. The 12 interviewees indicated that there were some standardised procedures that were used in project management, which include: inspection requests; material submission requests; approval of shop drawings and prequalification submittal for subcontractors. CLR4 highlighted that procedures for handing the project to the contractor were standardised to help reduce the time spent by what was estimated to be two months. However, all the interviewees in the four case studies argued that, although a form of standardised procedures are used, there is a lack of full standardised procedures within all the SDM projects, which has led to varied project procedures for each region. Therefore, they went further to report that the current standardised procedures were established by the regional administration and contributed to achieving a considerable improvement in project performance, particularly in terms of time. CLR3 and CONSR3 indicated that CS3 is located in the same region as CS1 and CS2 and was managed by the regional administration and, as such, the same standardised procedures were followed in all three projects. The majority of interviewees in all the four case studies pointed out that the "Vendors list" is a good example of standardisation, where contractors were directed to deal with specified vendors (materials, equipments, etc.) to save time and ensure good quality.

7.4.3.2 Decision-making process

Interviewees were asked to discuss the level of the decision-making process entrusted to project management. The majority of interviewees across the four case studies criticised the current decision-making process made by the H.O (see Chapter Five) due to the limited authority given to project management. The researcher asked the 12 interviewees about the influence of these limitations to the authority given to project management on project performance. The majority of interviewees within the four case studies stated that, by and large, projects suffered from delays in the decision-making process used by the client, therefore, the regional administration tried to solve some problems in-house to avoid the delay in projects. This has been confirmed by CLR3 "*the contractor could not take action for solving problems or applying new ideas without getting approval from the H.O. This indeed caused a delay in completing some tasks, disencouraging the contractor to capture LL and therefore affected project performance".*

As stressed by the 12 interviewees, there is a need to grant greater authority to the project management, particularly the client's representative, or the regional administration. They argued that this helps to build trust in the project management, promote the offering of innovation and, therefore, the capture of valuable LL that could be re-used for on-going and future projects. In all four cases, the majority of interviewees highlighted that the long decision-making process impeded the improvement trajectory.

7.4.3.3 Communication and coordination

Interviewees were asked to identify suitable and effective methods to exchange skills and experiences between the SDM projects. As established by the majority of interviewees in all four case studies, communication and coordination are considered as an effective tool for transferring the information, skills and experience between stakeholders, either inside the project or between all SDM projects, particularly in the current situation, where there is no documentation and dissemination of LL. They went further to argue that SDM projects provide a suitable environment for establishing effective internal communication and coordination.

In CS1 and CS2, consultants and contractors stated that effective communication and coordination initiated by contractors contributed to improvements in project performance through mutual visits, including direct observation and holding meetings if necessary, where many faults were avoided due to capturing LL from other typical SDM projects. In all four cases, all the interviewees established that it was necessary to learn from other stakeholders who may have better experience and the skills needed to execute some items that created difficulties for staff working in other projects. Thus, it was not necessary that all needed information should be obtained from the H.O.

The majority of interviewees indicated that communication and coordination took place verbally when there was no need for direct observation, which was restricted on the boundary of the region. The researcher probed whether the 12 interviewees practise this method as a significant method in project performance improvement. In CS1 and CS2, all the interviewees stated that communication and coordination between all stakeholders were very effective due to the establishment of an effective project network. However, in CS3, the consultant and contractor highlighted that the communication and coordination between other typical SDM projects were less effective. This was attributed to the fact that only one SDM project was being built in this region as well as a lack of communication with other typical projects located in other regions.

In CS4, all the interviewees stated that the focus was on communication and coordination between stakeholders through regular meetings. CLR4 and CONTR4 stated that there was some communication with other typical SDM projects through field visits and making empirical observations. These resulted in tangible benefits in terms of avoiding previously detected mistakes, understanding specifications and for quality improvement purposes.

However, in all four cases, the majority of interviewees acknowledged that communication and coordination could be more effective via an Internet-based network to facilitate and accelerate transferring the required information. In all the case studies, the majority of clients and consultants confirmed that communication and coordination with other typical SDM projects should be initiated by the contractor and also promoted by the client and consultant.

7.4.3.4 Methodology for identifying, capturing, documenting and re-using LL

Interviewees were asked to describe the current methodology used for organising LL in SDM projects. The 12 interviewees stated that the LL situation was fuzzy, unorganised and fragmented with no learning being performed in an effective and operational way, but only some individual attempts made by stakeholders in every project by using traditional methods. This was confirmed by CLR4 *"the situation in LL right now is considered* [to be] *individual efforts because we had no source for LL, no clear methodology for identifying, capturing, documenting and re-using LL, so all attempts made to improve this situation were done within the boundary of this region".*

The researcher asked about who is responsible for this ambiguous situation. In all four case studies, the majority of interviewees highlighted that there was less commitment to learning by the H.O so the language and culture of learning were ambiguous, which negatively influenced the value of any LL that could be achieved in such a project environment. This has led to emerging suggestions being dealt with in a traditional style with no LL being captured for re-use in on-going and future SDM projects. As argued by all clients, consultants and half of the contractors, the level of qualifications of the contractor played an important role in identifying, capturing and reusing LL in line with client commitment. As reported by all clients and consultants, contractors who executed CS1 and CS2 are good examples in terms of their initiative which contributed towards the identification and capture of valuable LL, including design faults or suggested improvements. The direct impact of these lessons on project performance improvement was recognised where they could be delivered successfully. However, in CS3 and CS4, clients and consultants stated that the contractors in those cases had insufficient relevant experience and skilled staff and also lacked initiative; this contributed to poor project performance and, as a result, few valuable lessons were learned.

The researcher investigated the learning styles used in the SDM projects. Two levels of learning styles were identified by the 12 interviewees: simple problems/single-loop learning (SLL), which were treated immediately by the project management (client, consultant and contractor) without the need to inform the H.O, and major problems/double-loop learning (DLL) (design fault, change of material specification) which needed to be studied by the H.O to identify the major causes of the problem, prevent any repetition, provide the solution and allow action to be taken. In the case of making suggestions or ideas for improvement purposes, the situation was correlated with the impact of these suggestions/ideas on cost, quality and time, where it should be executed within the allocated cost of the project or the limited increase which is identified in the contract (about 10 per cent). However, in CS1 and CS2, all the interviewees agreed that, despite the lack of a clear methodology for organising the LL, the range of learning styles was considerable and better results were achieved. In CS3, CONSR3 stated that there were a few examples of learning, but the contractor was directed by the consultant based on the LL from previous projects. In CS4, CLR4 highlighted that there is a desire and commitment to spreading the culture of learning, but these attempts were limited to the regional administration.

The researcher probed whether there is a learning mechanism used by stakeholders in the SDM projects. All interviewees in the four case studies stated that it was started by the contractor or consultant and discussed together to be provided to the client in the form of collective learning to finally make an informed decision, or through benchmarking with other typical SDM projects. This was achieved using two forms of communication: an informal style, which was often used when a simple problem emerged, and a formal style, which involved holding meetings to discuss the problem and then reporting the outcome to the H.O. Nevertheless, in CS1 and CS2, clients and consultants stated that the contractors were the major forces behind activating the learning process. As a result, many lessons were captured by the contractor and presented to the consultant and thus provided to the client to contribute to the improvement of the project's performance, which was recognised through delivering successful projects. In contrast, CLR3 and CONSR3 indicated that in CS3 there were few attempts to produce new lessons, but the contractor was not the initiator in terms of capturing LL. CLR4 stated that, although there were serious attempts made by the client, there were few lessons identified and captured by the client and then provided to the consultant and contractor.

The researcher went further to extract more information about polices and strategies that are formulated by the H.O and adopted by stakeholders in the SDM projects. The 12 interviewees agreed that there were no clear policies or strategies adopted for learning, either written in the contract for the SDM projects or by oral instructions. Such strategies should focus on 'day-to-day' learning in order to obtain very effective learning, which could lead to a continuous performance improvement for SDM projects.

The researcher probed the aspects covered by the LL. As established by all 12 interviewees, LL covered every aspect of a project (e.g. design faults, material specifications, electrical and mechanical works and new improvements, etc.). The researcher went further to explore the learning sources. In all four cases, the majority of interviewees indicated that a number of learning sources were identified, such as dealing with suppliers, subcontractors, project documents. Additionally, they noted other factors that have an impact on learning sources, such as the staff's technical experience being sufficient to identify and capture the technical aspects (e.g. study of shop drawings and specifications) or managerial aspects (e.g. project procedures, procurement) of the LL. The researcher asked the 12 interviewees to identify the factors affecting the learning process. A majority of interviewees indicated that training of staff, a clear methodology for learning, commitment to the time schedule, employing the right people, the organisational structure, the learning climate, mutual trust and dialogue between stakeholders, focus on the adaptation stage of the SDM to the site, determining “what next”, benchmarking, a high level of response by the client and monitoring project progress to identify mistakes and understand the need for improvement were all important.

The researcher asked the 12 interviewees to describe the current document process used in the SDM projects. They highlighted that the documentation process was unsatisfactory, and made by a traditional method through saved LL, including project documents. All the interviewees in all four case studies stated that there were no special documents specified for LL. To address this loophole, they suggested appointing a coordinator/facilitator, designing special forms for recording LL, including details of lessons, and launching special files for storing LL for every project.

7.4.3.5 SDM project close-out report

In CS1 and CS2, all the interviewees stated that project close-out reports were not prepared at the end of the projects. The majority of interviewees highlighted that, even within the contract of the project, there were no organised instructions issued by the client and provided to the contractors and consultants. As a result, none of indicators of SDM project performance were identified and recorded.

In CS3 and CS4, all the interviewees indicated that the situation *vis-à-vis* the project close-out report is similar in all the SDM projects, where there were no organised instructions provided to the contractors and consultants by the client, even within the terms and conditions of the project contracts. The researcher probed this to secure more information from the 12 interviewees about the type of documents that are submitted at the end of a project. The 12 interviewees argued that the instructions written in the project contract document emphasise only the project documents related to maintenance operations, which must be submitted at the end of the project to the end-user.

All the interviewees in all the four cases emphasised the importance of the project close-out report, where a comprehensive assessment of a project must take place in every project to involve every aspect of the project in order to identify its strengths and weaknesses. They concluded that this assessment must include: contractor and consultant performance, suppliers, subcontractors, end-user demands, design quality and further comments delivered by the receiving committee and the problems related to relationships with other public sector organisations. Additionally, this should be followed by final meetings at the end of the project to discuss and finalise the report and then to submit it to the H.O.

7.5 CONTINUOUS IMPROVEMENT IN SDM PROJECTS

Interviewees were asked how they would assess the impact of using LL on achieving continuous improvement (CI) in SDM projects. As highlighted by all the 12 interviewees, the adaptation of SDM projects is a suitable environment for achieving CI. The majority of interviewees indicated that CI is strongly correlated to the quantity and quality of LL from the completed projects and re-used in on-going and future SDM projects. The researcher enquired whether CI is practised by all interviewees in SDM projects. They stated that in practice, the concept of CI is known, but its implementation is usually not investigated. Therefore, all the interviewees focused on promoting CI through identifying past mistakes, encouraging suggestions leading to innovation, providing a methodology for identifying, capturing, documenting and reusing the LL, staff training, removing barriers between all stakeholders and establishing a learning climate. As quoted in CONTR3 "*Significantly, the adoption of SDM projects promotes and facilitates the achievement of CI, for example, it can avoid the majority of previous mistakes that occurred in completed projects in terms of design faults, submissions of materials and specifications, and also providing new improvements"*. CLR4 went further to argue that the use of long-term contracts emerges as an essential approach to achieving CI, particularly when SDM projects are to be implemented over a 20-year period. Table 7.7 summarises the 14 identified CSFs.

Table 7.7: CSFs Identified from Four Cases Studies

Adaptability of SDMs to Context	Contract Management	Construction Management
● Collaboration between the Design and Supervision departments	● Invitation to tender	● SDM' project procedures
● Design modification	● Tendering criteria	● Decision-making process
● Material specifications amendment	● Payment process	● Communication and cooperation
● Central database	● Contract documents for future SDM projects	● Methodology for identifying, capturing, documenting and re-using LL
● Dissemination of LL		● SDM project closeout report

7.6 SUMMARY

The findings from the analysis of the interviews and the SMoI-SDM documents from the four case studies revealed that there are 14 CSFs that affect the process improvement of SDM project performance. These are broadly clustered under three main themes: Adaptability of SDMs to Context, Contract Management and Construction Management.

Regarding the adaptability of the SDMs to context-related CSFs, the findings revealed that the collaboration between the design and supervision departments in the H.O is one of the CSFs affecting the improvement of SDM project performance due to poor collaboration and communication between those two departments, which contributed to the repetition of known faults in future SDM projects. Design modification and materials specifications amendments have a significant influence on achieving the continuous performance improvement of SDM projects as a result of the need to avoid faults or for improvement purposes. The existence of a central database is another CSF affecting the process of improvement for SDM projects due to its role in storing the LL related to the SDM project. The findings highlighted the crucial role of the dissemination of LL in maintaining the continuous performance improvement within all the on-going and future SDM projects. However, in practice, very few lessons were disseminated.

With regard to contract-management-related CSFs, the invitation to tender that was used in all four cases was based on an "open invitation" approach, which gave an opportunity for all contractors to provide their bids regardless of the focus on the prequalification measures. However, in all four cases, the lowest price was the tendering criterion used by the client in awarding a project to a contractor. The findings from the case studies demonstrated the importance of financial power, skilled staff, relevant experience and the past performance of the contractor as major measures that must be considered in the selection of a contractor. The payment process emerged as a CSF affecting the improvement of SDM project performance due to its direct impact made on maintaining the progress of the project as well as ensuring that the due amounts are paid to the contractor on time**.** In all four case studies, the payment process suffered from being both long and complicated. The nature of SDM projects underlines the importance of reviewing contractor documents based on the LL in completed projects. These documents include the BoQ, the terms and conditions of the contract as well as those that monitor the allocated budget for every project with the aim of aligning it with the rapid changes occurring in the markets.

With regard to the construction-management-related CSFs, SDM project procedures suffered from the lack of an organised project management system which focuses on standardising procedures to facilitate and speed up the progress of the project in terms of the approval of materials, inspection requests, etc. The decision-making process also suffered from difficulties in taking informed decisions due to the ambiguity of responsibilities granted to the project management. The findings revealed that communication and coordination between all stakeholders, either inside the project or with other typical SDM projects, are CSFs for the exchange of information and skills to generalize the benefits of LL and therefore for the achievement of common, continuous, performance improvement for SDM projects. The interviewees argued that LL were fragmented, unorganised and missed due to the lack of a clear methodology that could guide their successful identification, capture, documentation and re-use. The SDM project close-out report was not a common practice in all four case studies; therefore, it emerged as a CSF affecting the process of improvement for SDM project performance due to its important role in providing a comprehensive assessment of every aspect of a project.

Finally, the findings revealed that the concept of CI was known by the interviewees. However, practically, this concept was not effectively used due to the lack of a clear strategy that could guide the staff in its adoption. Addressing this shortcoming would provide the opportunity to achieve CI for the SDM projects to be fully grasped.

The three themes and associated CSFs emanating for the four case studies are the structural pillars for the development of a framework for improving the performance of SDM projects. The following chapter presents the development and validation of the improvement framework.

CHAPTER 8

8 FRAMEWORK DEVELOPMENT AND VALIDATION

8.1 INTRODUCTION

A framework for improving the performance of SDM projects is necessary if the SMoI is to plan effectively to achieve continuous project performance improvement over a long-term plan. This requires a very organised and systematic framework that could be achieved by utilising the characteristics of SDM projects and the concept of learning. The literature review and the analysis of data collected from the preliminary interviews and four case studies formed a concrete basis for developing the improvement framework for SDM projects performance. This chapter presents the development and validation of a framework process for improving SDM projects performance. It discusses the need for the framework and presents an overview of its components. The validation of the framework is also covered and the chapter concludes with a discussion of how the framework can be implemented and the implications for its usage.

8.2 FRAMEWORK DESIGN AND DEVELOPMENT

The extant literature revealed that there are many definitions of framework. Two common definitions of framework have been provided by Fayad et al. (1999) as “a reusable design of all or part of a system that is represented by a set of abstract classes and the way their instances interact”, and “the skeleton of an application that can be customised by an application developer”. The former definition describes the structure of a framework; and the latter describes its purpose. Frameworks are becoming more important and they are targeted by many fields, such as Advanced Computing Environment (ACE) and Microsoft Foundation Classes (MFCs), and they play an increasingly important role in contemporary software development. Frameworks are principally implemented to reduce cost and improve quality. A framework describes both the component objects and how these objects interact, illustrates the interface of each object and the flow of control between them; and explains how the responsibilities of a system are mapped into its objects (Johnson and Foote 1988; Wirfs-Brock et al. 1990). The most important part of a framework is the way that a system is divided into its components (Deutsh 1989). Accordingly, this research aims to develop an improvement framework for SDM projects that is based on three main components (Adaptability of the SDMs to Context; Contract Management; and Construction Management) as shown in Figure 8.2, which each have CSFs identified through a data analysis of the four case studies as illustrated in Table 7.7.

8.2.1 Framework Purpose

The framework is proposed to address the key research questions related to SDM project performance improvement in order to achieve the aim of the research. Consequently, the CSFs identified in the research were classified under three main themes. The framework objectives are:

1. highlight the CSFs that affect the improvement of SDM project performance. It provides an opportunity for stakeholders to identify improvement areas that should have a significant influence on the SDM project performance through LL to achieve sustainable improvement;
2. provide architectural guidance that describes interface design by using abstract classes and that describes functional factoring by specifying the responsibilities and collaborations between these;
3. provide a systematic and organised method for capturing, sharing and reusing knowledge between all SDM projects;
4. provide a set of guides that describe CSFs to improve the SDM projects performance and how they are interrelated in an organised and integrated system; and
5. provide a basis to enable leaders or managers to implement and assess the improvement process.

8.2.2 Framework Structure and Contents

The framework presents a holistic picture of the components that influence the process of improvement of SDM project performance as well as the expected performance improvement curve that results from the cumulative learning and experience. The framework was developed based mainly on the findings of the four case studies which are summarised in Table 7.7. Some guidelines were derived from the preliminary study which suggested a number of factors that should be involved in the improvement framework. Additionally, through the literature reviews in Chapters Three, Four and Five, a number of CSFs were reviewed (e.g. Sanvido et al. 1992; Belassi, and Tukel 1996; Takim 2005; Cheng and Shiu 2008). Also a number of learning frameworks were examined (e.g. Gieskes and ten Broeke 2000; Law and Chuah 2004; Tan et al. 2007). These provided some guidelines that help in developing the proposed framework for improving the performance of SDM projects. The framework, as shown in Figure 8.1, comprises four phases that are in the form of chronological sequences, these are: design modification phase (Adaptability of SDMs to Context), the pre-construction phase (Contract Management), the construction phase (Construction Management) and the post-project audit (LL, Database and LC). These are explained below.

a. ***Design Modification Phase*** – This phase comprises input factors, which are in the form of CSFs related to the adaptability of the SDMs to the context. In this phase, there are processes in which design modification as well as material specification amendments are performed; in addition, there is a need to collaborate between the design and supervision departments, which can be achieved based on the LL from the on-going and completed SDM projects. Accordingly, the integration between the design and construction activities could lead to a better outcome based on LL from previous experiences. Scott and Harris (1998) demonstrated that, when a design's faults are identified, recognised and presented in an accessible way to designers of future projects, improvements can be achieved. Moreover, forward and backward feed loops were provided by headed arrows that were linked to the next phase - the pre-construction phase - and to the same phase for other typical SDM projects.

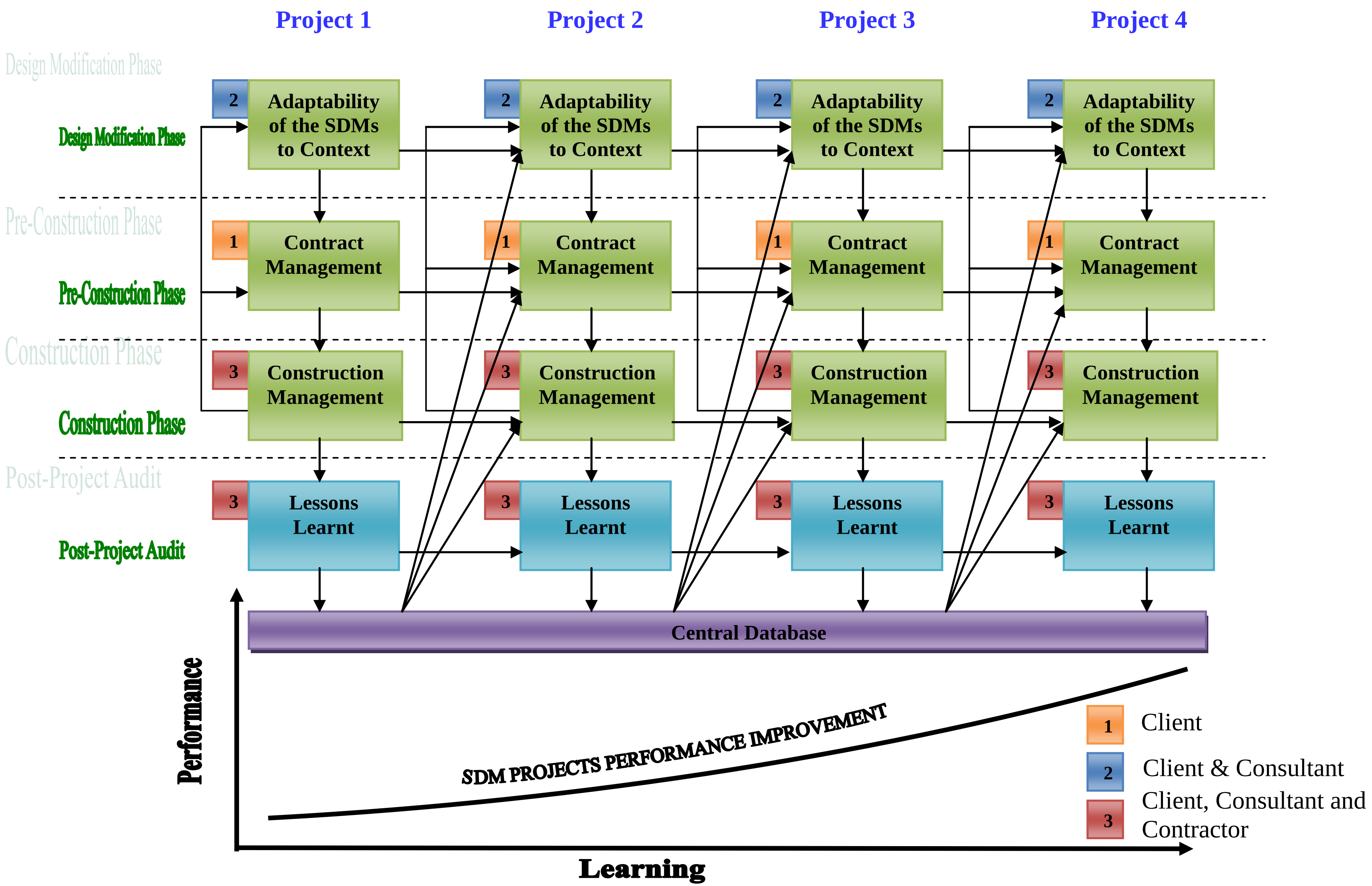

Figure 8.1: SDM projects Performance Improvement Framework

The responsibilities that were allocated to the stakeholders were determined through the number given on the corner of each phase, where this phase is performed by teamwork is formed from a client and a consultant.

b. ***Pre-Construction phase*** – This phase comprises input factors in the form of CSFs, which are related to the management of contracts; and includes processes in which the invitation to tender, tendering process, payment process and the contract document are involved. These processes can be based on the LL from on-going and completed SDM projects because the changes that are made during the construction phase affect the quantities involved in the BoQ and, therefore, the cost of the project and the requests for payment. Additionally, future SDM projects will take these changes into consideration during the preparation stage. Moreover, forward and backward feed loops were provided by headed arrows linked to the next phase, which is the construction phase, as well as the same phase for other typical SDM projects. The responsibilities that were assigned to the stakeholders were determined through the number given on the corner of each phase, where this phase is performed by the client.

c. ***Construction Phase*** – This phase comprises input factors in the form of CSFs related to: the construction management component; the SDM project's procedures where the standardised SDM project's procedures facilitate the flow of work and avoid bureaucratic procedures; and the speed of the decision-making process, which encourages the capture of LL and innovation to circulate the captured knowledge between the SDM projects. This phase also includes communication and cooperation between all of the stakeholders either inter- or intra-SDM projects, which is one of the best tools for promoting the exchange of knowledge; the methodology for identifying, capturing, documenting and reusing LL from the SDM projects, which creates an environment for continuous performance improvement; and the focus of issuing closeout reports, which provide a comprehensive assessment of all the project's features.

This can be based on the LL from on-going and completed SDM projects. Moreover, this phase is linked with the next phase which is the post-project audit phase (LL) through forward and backward feed loops that were provided by headed arrow. Tan et al. (2007) stated that the efforts of sharing and reusing knowledge created on construction projects tend to be ineffective mainly through the lack of important insights concerned with the time lapse involved in capturing the knowledge, staff turnover and people's reluctance to share knowledge. They subsequently proposed a methodology for "live" capture and reuse of project knowledge in construction. Weiser and Morrison (1998) noted that systematic methods of identifying, capturing and transferring lessons learnt for future projects are still to be found in very few firms. Additionally, to produce a shared knowledge based on the LL that are captured during the construction phase to other SDM projects, forward feed loops were provided by the headed arrows linked to the design modification and pre-construction phases. Simultaneously, forward feed loops were provided by the headed arrows linked to the construction phase of other SDM projects. Accordingly, the need for a methodology for "live" capture and reuse of project knowledge during the execution of a project is crucial to enable this knowledge to be presented in a timely manner and in a format that can be reused for ongoing and future projects. The responsibilities of key decision makers (i.e., the client, the consultant and the contractor) are identified by the number on the corner of each phase.

d. ***Post-Project Audit Phase*** – This phase comprises the outputs from the construction phase, which are mainly the LL and the SDM project's closeout report. Newell et al. (2006) criticised the rare use of databases that are built by transferring the lessons from one project to another. Kamara et al. (2003) indicated that, in current practice, the reuse of captured knowledge is often associated with persons rather than projects; thus, this knowledge can be reused in projects that are executed by those people and, therefore, in the post-project reviews (PPR) that are used by each participating organisation. Accordingly, a significant reduction in the time spent on problem solving and an increase in the quality of work can be achieved through the reuse of existing organisational knowledge, which is gained through experience (Dave and Koskela 2009). The central database is linked with the three phases to be fed by the LL that were captured from completed SDM projects to improve future SDM projects. Tan et al. (2007) stated that the main strength of web-based KM technologies (e.g., group-wave, expert directories and knowledge bases) is their capability to connect distant project offices together, to provide fast access to captured knowledge, to facilitate the sharing of knowledge and to provide a huge knowledge storage space. This could be followed by measuring the improvement of the SDM projects performance by using the learning curve (LC), which employs the accumulative learning *versus* project performance criteria in terms of time, cost, quality and client satisfaction. The preliminary study suggested that client satisfaction, cost, time and quality should be included as project performance criteria for the SDM project performance improvement framework. Zangwill and Kantor (1998) stated that the LC could be used for almost any performance measure, such as cycle-time, defects, customer satisfaction and costs. They noted that the LC which is also called the *experience curve* or the *progress curve,* allows the value of continuous performance improvement for SDM projects to be achieved through the implementation of the SMoI long-term plan, which will be assessed.

8.2.3 Framework Process Map

The development of a framework shown in Figure 8.1 was followed by developing a process map for applying the improvement framework as illustrated in Figure 8.2. This map aimed to describe how the three components involved in the framework are working. The map clarifies each component in terms of the teams charged in the implementation of this component of the framework and how simultaneously projects are being implemented and learning from others. Additionally, it also shows the flow of information between projects through the three components and central database, the relationship between all relevant teams, responsibilities granted to those teams, and finally how learning could be achieved. Crucially, this process is used in every new package of SDM projects. Further details of process map are explained as follows.

1) ***SDM Knowledge Management Team* (SDMKMT):** this team works under the umbrella of Information Technology Department (ITD). The role of SDMKMT is to manage and organise the knowledge base (i.e. the development of a Project Knowledge File for a project (PKF)) as well as to create all required communications between all teams over the three components.

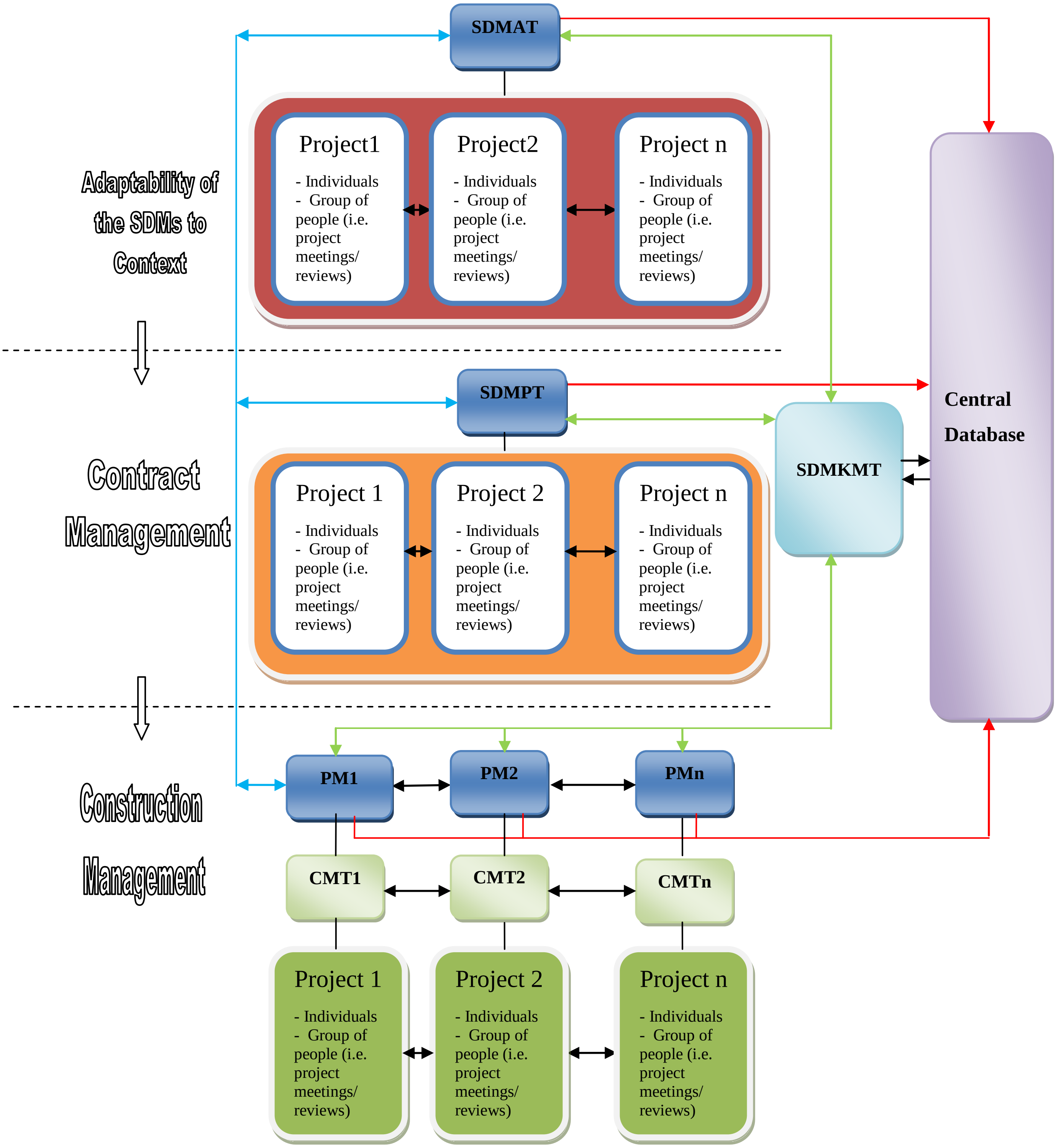

Figure 8.2: Framework Process Map

Legends

Access to Central Database

Communication between SDMKMT and other Teams

=========== between the Three Components

Shared Learning between SDM Projects

This team receives LL which are unstructured, so that team adds value to the knowledge through processing information. This process involves organisation, classification, codification and arrangement. This is followed by sending this information to be stored and then reused for on-going and future SDM projects. LL will be formulated into different types of files such as PDF, Word File, Spread Sheet, etc. The ITD creates accounts for various users, which includes specifying the level of access of different users.

2) Adaptability of SDMs to Context:

The nature of current work in the adaptability of SDMs to context is that there is a package of projects must be adapted simultaneously, and therefore, there is a determined team is responsible for performing this task. Similarly, as such, the same procedures are followed to adapt the future package of projects.

- *Standard Design Model Adaptation Team (SDMAT)*: the nature of adaptation requires a number of engineers working together to adapt the SDM to context. Therefore, the SDMAT comprise a number of client and consultant engineers such as architectural engineer, civil engineer, electrical engineer, etc.

- *Responsibilities*: SDMAT is responsible for performing adaptation requirements in terms of required changes based on the requirements of each site which are affected by geographical factors, soil investigation results, surveying results, etc. This is followed by reviewing electrical, mechanical and civil works, etc.

- *Process*: during the adaptation works, SDMAT is charged to identifying, capturing LL from project meetings/reviews, individuals and from making changes to project documents (such as engineering drawings). The validation process is important task for the LL identified and captured in the system. The LL identified and captured from a group (i.e. meetings and reviews) is deemed to have been validated in the meetings or reviews, whereas the LL submitted by individuals may need to be validated prior to reuse. The identified and captured LL can simultaneously be shared within the package of projects. Finally, to protect LL from missing due to the time lapse, they are sent “live” to SDMKMT via electronic file designed by SDMKMT to be processed in order to be stored into a central database to be reused for on-going and future SDM projects.

- *Communication:* SDMAT has communications with SDMKM as mentioned above, Standard Design Model Pre-construction Team (SDMPT) and Project Managers (PMs). The communication with SDMPT comes according to two levels: first is a communication in relation to providing the adapted SDM projects to be processed into the pr-construction phase, and second is a communication for discussing arisen issues which often create new lessons. The communication with PMs is to address the problems/suggestions related to adaptation phase which arising during SDM projects implementation and almost producing new lessons. SDMAT has an access into a database to only get the needed information via a web-based system.

3) Contract management

The style of work in this component is similar to what is done in the adaptability of SDMs to context. This is because the same package of projects which were adapted are provided to the SDMPT to be prepared for tendering process and awarding projects to contractors.

- *SDMPT:* in this component, there is a need to team working together comprising a number of members of client such as quantity engineer, contract engineer, financial specialist, etc.

- *Responsibilities*: SDMPT is responsible for producing project contract documents, project cost estimation, performing tendering and awarding process.

- *Process*: in this component, SDMAT follows the same process identified in the adaptability phase except the difference in type of works which focuses on preparation of project to be tendered and awarded to contractor.

- *Communication:* SDMPT has communications with SDMKM as mentioned above, SDMAT and PMs. The communication with SDMAT was described above. The communication with PMs is to address the problems/suggestions related to contract management which arising during SDM projects implementation and almost producing new lessons. SDMPT has an access into a database to only get the needed information via a web-based system.

4) Construction Management

In this component, the nature of work is different completely than previous components, where every project is managed separately in terms of contractor, consultant and client as well as different location and region.

- *Project Manager (PM) and Construction Management Team (CMT):* in the execution of project there is a team involving contractor, consultant and client. This team is engaged with project manager who is assigned by client's head office and is linked with regional administration.

- *Responsibilities*: CMT is responsible for following the implementation of project according to determined schedule and holding regular meetings/reviews to assess the project performance. This comes with a full cooperation with project manager who can be a member in every meeting/review. Responsibilities are similar in every SDM project implemented in different location.

- *Process*: CMT follows the same process identified through the aforementioned components in terms of identification and capture and validation the LL. However, in such case, every project is being implemented separately under one PM and CMT which is different than the previous components, where package of project are adapted and prepared under one team. Consequently, project-to project learning can be achieved through two ways. First, the SDM projects which are being implemented can learn from others through having an access into central database via a web-based system. Second, they can learn through communication with other SDM projects located in the same area via regular visits and meetings. At the end of project, CMTs are charged to provide close-out report to PMs in order to be sent to SDMKMT.

- *Communication:* PM has communications with SDMAT, SDMPT and SDMKMT as explained above. However, in this component and in particular if there are a number of SDM projects implemented simultaneously in the same area, there are communications between Projects Managers as well as CMTs to discuss the hot issues and then exchange needed information, skills, experiences, and therefore, these information could be formed as LL and provided to SDMKMT through PMs. Additionally, learning could be created through regular meetings between all teams in the three components to discuss the important issues.

8.3 FRAMEWORK VALIDATION

A more comprehensive framework for improving the performance of SDM projects in the SMoI projects has been developed as shown in Figure 8.2. The aim of this section is to explain and discuss the framework validation process, which was achieved through stakeholders' feedback on various issues pertaining to the framework. These issues include validation of the concept, SDM' life-cycle project performance and LL (details and feedback) and framework implementation strategy. The following sections discuss the approach to validation, the validation results and a discussion of the framework, which includes comments and suggestions for improvement, a framework implementation strategy, any implications and a summary.

8.3.1 Framework Validation: Aims and Objectives

The aim of the validation exercise was to test the framework's practicality, clarity and appropriateness. The following objectives of the framework validation were proposed:

1. To discuss and seek agreement about the findings and major issues which are presented in the framework and their effects on the improvement of SDM' project performance.

2. To discuss and validate the framework's critical success factors (CSFs) and their influence on SDM' project performance improvement.

3. To discuss and validate the CSFs by reference to good practice.

4. To discuss and validate the framework implementation strategy to provide a practical guide.

8.3.2 Validation Approach

The concept of validation is dependent on the view that the framework is a representation of the real world, or part of it (Pidd 2009). Furthermore, validation is to check if the model/framework behaves as the real world under the same conditions (Miser 1993; Pidd 2009). Nevertheless, this was described as only suitable for quantitative models/frameworks and not necessarily appropriate for interpretive models/frameworks such as in this case where various perspectives of the epistemology of science can play a crucial role. Pidd (2009) indicated that the historical and social perspectives suggest that a model becomes valid when it obtains acceptance by the surrounding expert and scientific community. Moreover, there are no unanimous criteria for validation, hence, any validity judgement depends on the situation in which the proposed model/framework is adopted and the phenomenon being modelled (Miser 1993). Qualitative models/frameworks could be validated using a qualitative approach through interviews and survey techniques while highlighting the advantages and disadvantages of the model in the validation process (Smith 1993). However, Oberkampf and Trucano (2008) have reviewed a number of definitions for validation and stated that this can be defined as "*a process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended uses of the model*".

The term 'validation' implies that the judgement is made by a competent person or body (Church 1983). The validation phase of the scientific method could be defined as deciding if the objective of the research task has been achieved (Bock 2001). In this research, the developed framework was validated through a workshop, and therefore, the validation approach was pursued through seeking stakeholders' judgement and feedback. The validation workshop was attended by the stakeholders who participated in the data collection stage in the four case studies, thereby providing guests with a clear picture of the framework and then seeking their insights about its applicability in the field. Miser (1993) and Pidd (2009) argued that useful and realistic views of validation emphasise the possible utilisation of models as the means of validation, which finds some authors considering validation with regard to the use of framework practicality. The design of the validation workshop and the choice of stakeholders involved in making judgements play a vital role in obtaining utilitarian and pragmatic views.

It is important to distinguish between 'verification' and 'validation', where verification means ensuring the model/framework is the one intended to be built, i.e. "building the model right", whereas validation ensures the degree to which input and output of the model/framework relate to the real system, i.e. "building the right model" (Miser 1993; Pidd 2009; Ng and Smith 1998). It should be noticed that this differentiation is valid in the quantitative models/frameworks, particularly computerised/simulation models; nevertheless, verification issues are weak in their present form in many other situations (Miser 1993; Pidd 2009).

8.3.3 Validation Process

Four processes have been used to conduct the validation, where nine of the stakeholders involved in the data collection stage were invited to attend the validation workshop. This workshop aimed to seek stakeholders' feedback/judgement about the research results. At this type of workshop shared discussions between participants are important in capturing valued feedback in order to ensure that a practical and appropriate framework was developed. Ritchie and Lewis (2009) indicated that focus group discussion allows participants to present their own views and experiences as well as hearing those of other people. Similarly, Kreuger and Casey (2000) stated that the focus group provides a more natural environment for sharing discussion and views rather than that of an individual interview. This is due to participants influencing and being influenced by others – just as they are in real life. The workshop focused on validating three major issues: the framework concept, SDM life cycle project performance, and LL (details & feedback), and the framework implementation strategy. The validation workshop comprised the four phases described below, and the stakeholders were given Post-it-Note to write their comments/views on, which were then posted on a board for discussion in groups. The validation employed a 5-point Likert-scale because it is less negative and ensures that all items measure the same thing (Oppenheim 2003). The attitude instrument took two forms to rate the results of research: agreement and importance. In the first form, the 5-point Likert scale ranges from 1 (strongly disagree) to 5 (strongly agree) while the 5-point Likert scale for the second form ranges from 1 (very weak) to 5 (very strong).

Phase 1

The researcher provided a PowerPoint presentation for 20 minutes, in which the background of the research, including its aim and objectives, were presented to the audience to provide a clear picture of the research methodology and findings and the process used to develop the improvement framework.

Phase 2

The proposed framework for SDM performance improvement framework was presented to the stakeholders in order to review its concept; capture participants' feedback on the robustness of its structure and content; and agree on any modifications and/or corrections that needed to be addressed before it could be finalised. There was an open discussion and debate resulting in valuable feedback with open-ended questions being used to give the respondents the freedom to express their views. Participants were asked to indicate their level of agreement with the whole framework, the clarity of the framework, the cycle of improvement from stage to stage, the use of LL for each aspect of future projects, the potential for learning and the measures of SDM project performance.

The participants reviewed and commented on the framework developed in the research to assess:

- the completeness of the framework in dealing with all the issues which impede;
- the achievement of SDM' project performance improvements;
- the suitability of the framework and the ease with which it can be implemented; and
- the willingness of management to implement the framework concept in future SDM projects.

Phase 3

This phase examined the framework in depth, where the critical success factors (CSFs) identified from the case studies that affect SDM project performance were presented. Open discussion led to acquisition of useful feedback and good judgement depending on well-known. Participants were asked to rate their level of agreement of the proposed CSFs as affecting SDM' project performance in terms of the adaptability of SDMs to context, contract management and construction management. Furthermore, they were asked to rate their level of agreement identification of CSFs through good practice that leads to the improvement in SDM project performance. This was to enable them to assess the extent of any improvement within the SDM' project performance according to what the stakeholders see as good practice.

Phase 4

As mentioned above, there was an open discussion at the beginning of each phase. The last phase of the validation process focused on the framework implementation strategy where stakeholders were asked to rate their level of agreement with the identified implementation strategy. Furthermore, a statement was distributed to stakeholders to record their views about the implementation strategy that could be suitable for adopting this framework.

8.3.4 Scope and Limitations

In this research the workshop used allows for validating the results within the original sample that was used to identify the key issues affecting the improvement of SDM project performance. Therefore, the results are immediately pertinent to the context in terms of SDM projects. Furthermore, the target people were those stakeholders who were involved in the four case studies, and this was justified in Chapter Two. This was a focused effort to sustain consistency between the results of the research and the source of data and might help tackle the existence of any gap between results and their source.

8.3.5 Participants Information

The nine participants represented the client, consultant and contractor and were divided into three clusters as show in Table 8.1. For easy identification and systemic presentation for validation results through tables, prefix codes were used for participants. Following the plenary discussion, the participants used quantitative feedback (Likert–scale ratings) to provide their views regarding the level of agreement as well as importance. Although the use of arithmetical means suggests treating Likert-scale-based data at an interval level of measurement, the mean scores should not be deemed as "quantities" to show how much more important each factor is than the other, but as "indicators" to establish a rank order of importance for a factor (Idrus and Newman 2002). The validation questions covered the following four main points.

1. Developed improvement framework assessment.
2. SDM project performance improvement critical success factors assessment.
3. Assessment of CSFs through good practice.
4. Framework implementation strategy.

Table 8.1: Type and Number of Participants Involved in Validation Workshop

Participants	Group A	Group B	Group C
Client representative	A1	B1	C1
Consultant representative	A2	B2	C2
Contractor representative	A3	B3	C3

8.3.6 Validation Results and Discussion

The stakeholders' views and feedback on the developed framework were obtained by using the validation sheet completed within the workshop by all the participants. The general outcome of the validation was very positive, and participants provided tangible benefits during the workshop regarding the developed framework, which are discussed in the next sections. A summary of stakeholder's quantitative ratings and feedback are illustrated in Tables E1, E2, E3 and E4 respectively (see Appendix E), where the respondents' mean ratings were all close to the high rating. The results show that a high percentage of the stakeholders believe that the improvement framework components are adoptable and workable.

8.3.7 Validation of Framework Components

The assessment of the improvement framework achieved a high percentage of agreement from the participants. The framework was subjected to overall assessment covering eight aspects to ensure that it is a workable and appropriate framework. The concept of the framework was collectively accepted by the stakeholders. This is because the framework highlights the major stages that play a vital role in the improvement process. These stages were discussed in terms of the right order, sharing knowledge, achieving continuous performance improvement for SDM projects and as a whole process for the learning cycle and received the full agreement of the stakeholders.

The debate covered whether LL were the best tool for improving SDM project performance since they receive insufficient attention in the current situation. Furthermore, in the light of using the SDM projects, LL can easily be captured in accordance with a clear methodology for all participants. The learning curve had a great acceptance by stakeholders due to its significant role as an indicator for SDM project performance improvement as a result of accumulative learning. Stakeholders agreed that SDM project performance can be measured based on the overall measures of time, quality, cost and client satisfaction. Stakeholders were asked to rate their level of agreement with the framework aspects. The framework was assessed in terms of its practicality, appropriateness and clarity; it gained an average score of 4.0, 4.7, and 4.8 respectively as shown in Figure 8.3 (also see Table E1 in Appendix E). The validation results revealed that the clarity of the framework was highly rated by the participants, where it achieved a score 4.8; the appropriateness of the framework also achieved a score 4.7. In the opinion of the participants, the practicality of the framework achieved the lowest score 4.00 because of the long time required until practical implementation. Additionally, the framework was assessed in terms of its components, such as comprehensive coverage CSFs that are based on lessons learnt (LL) and the provision of stages needed. All of the aspects received high ratings, which showed that the framework addressed these aspects. There were some differences among the mean ratings of the aspects, but these were mainly very small, with a highest mean rating of 4.8 and a lowest of 4.3 as shown in Figure 8.4 (also see Table E1 in Appendix E). Indeed, it can be seen that *supporting performance improvement for future SDM projects, LL needed as a tool for improvement process and providing potential learning* received the highest levels of agreement, with a mean of 4.78. Moreover, Figure 8.4 clarifies that the distribution of overall assessment of components based on a scale (strongly disagree to strongly agree) as well as average of score achieved for these items.

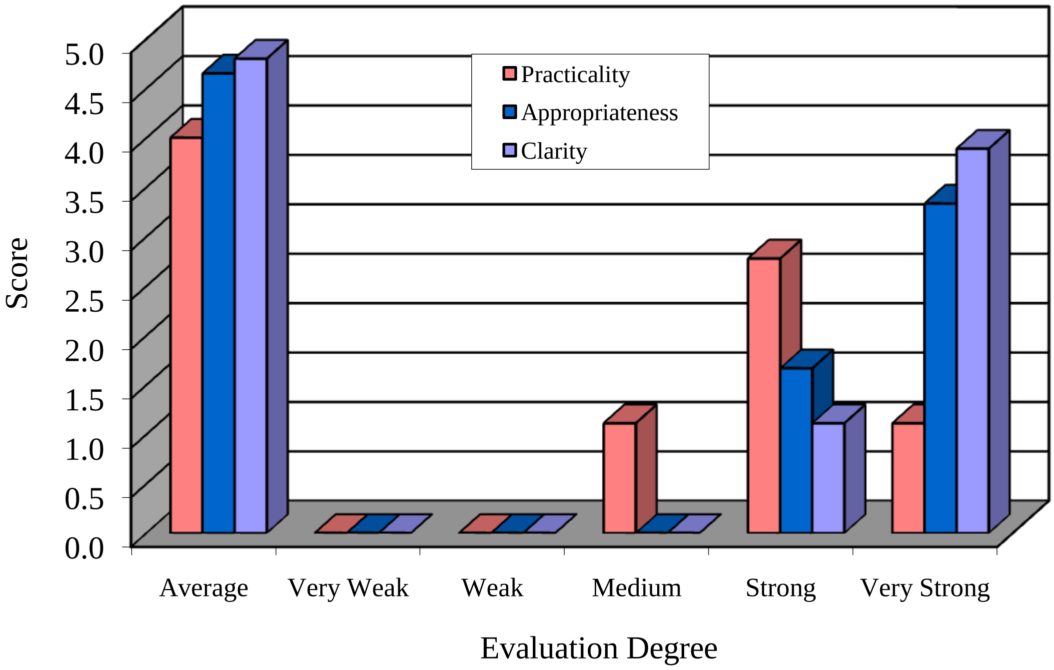

Figure 8.3: Validation of the Improvement Framework

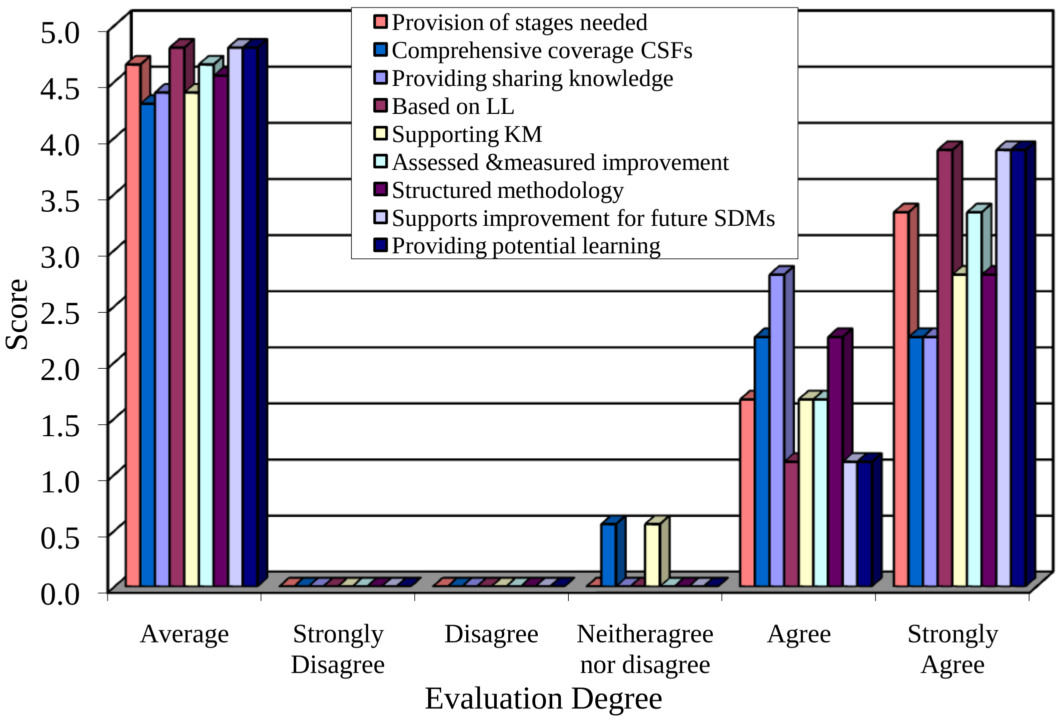

Figure 8.4: Validation of the Improvement Framework Component

8.3.7.1 Validation of SDMs-related CSFs

One of the objectives of validation is testing the CSFs identified from the four case studies. These factors have been presented to stakeholders to be validated as CSFs in the process of improving SDM project performance. CSFs were validated under the three components: adaptability of the SDMs to context; contract management; and construction management. For easy identification and systemic presentation of CSFs through figures, prefix codes were used as illustrated and listed-in Tables E5 and E6 (see Appendix E). The overall assessment of identified CSFs that affect the performance improvement process of the SDM projects are illustrated in Figures 8.5, 8.6 and 8.7. These received a high rating in terms of the level of agreement; thus, the participants believed that these factors had a significant impact on the improvement process. The CSFs were assessed under three components: adaptability of the SDMs to the context, contract management, and construction management. As shown in Figure 8.5, the CSFs related to the adaptability of the SDMs to the context received a high score in terms of the level of agreement, which ranged between 4.8 and 4.3, with a significant impact on the improvement process. *AA1* gained the highest mean rating, while *AA3* gained the lowest mean rating (also see Table E2 in Appendix E). Figure 8.5 shows the distribution of overall assessment of adaptability- related CSFs based on a scale (strongly disagree to strongly agree) and average score achieved by these items. The CSFs that are related to contract management achieved a high average score in terms of the level of agreement with a significant impact on the improvement process, which ranged between 4.8 and 4.4; *CMB2* gained the highest mean rating, while *CMB1* gained the lowest mean rating as clarified in Figure 8.6 .(also see Table E2 in Appendix E). Figure 8.6 clarifies that the distribution of overall assessment of contract management-related CSFs based on a scale (strongly disagree to strongly agree) as well as the average score achieved by these items.

The CSF related to construction management, received a high average score of 4.9 in terms of the level of agreement, while *CMC1* received the lowest average score of 4.2, (also see Table E2 in Appendix A). However, the differences between all of the CSF's mean ratings were mostly very small, with a highest mean rating of 4.9 and a lowest of 4.2. Nevertheless, there was a general consensus on the importance of these factors and their role in the improvement process. Based on the validation of all of the CSFs, the factor with the highest score (level of agreement) was *CMC4* (mean 4.9). Although *CMC1* received the lowest score, it was still high (mean 4.2), which suggests the importance of all of the identified CSFs.

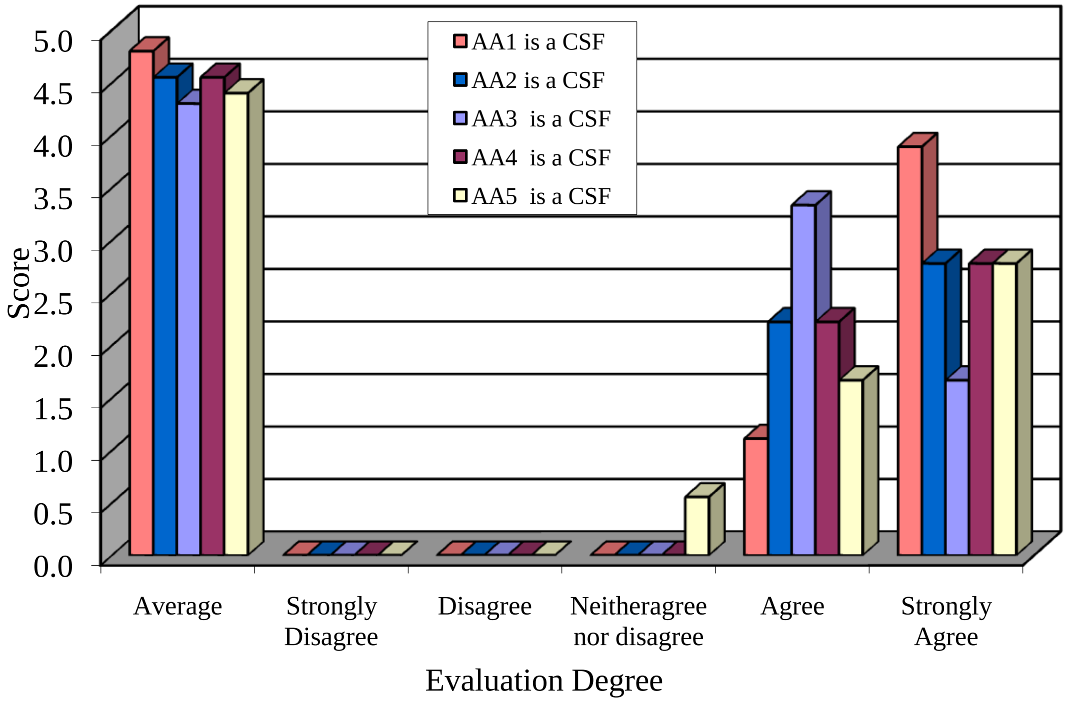

Figure 8.5: Validation of CSFs of Improvement on SDM Project Performance (Adaptability of SDMs to Context –Related CSFs)

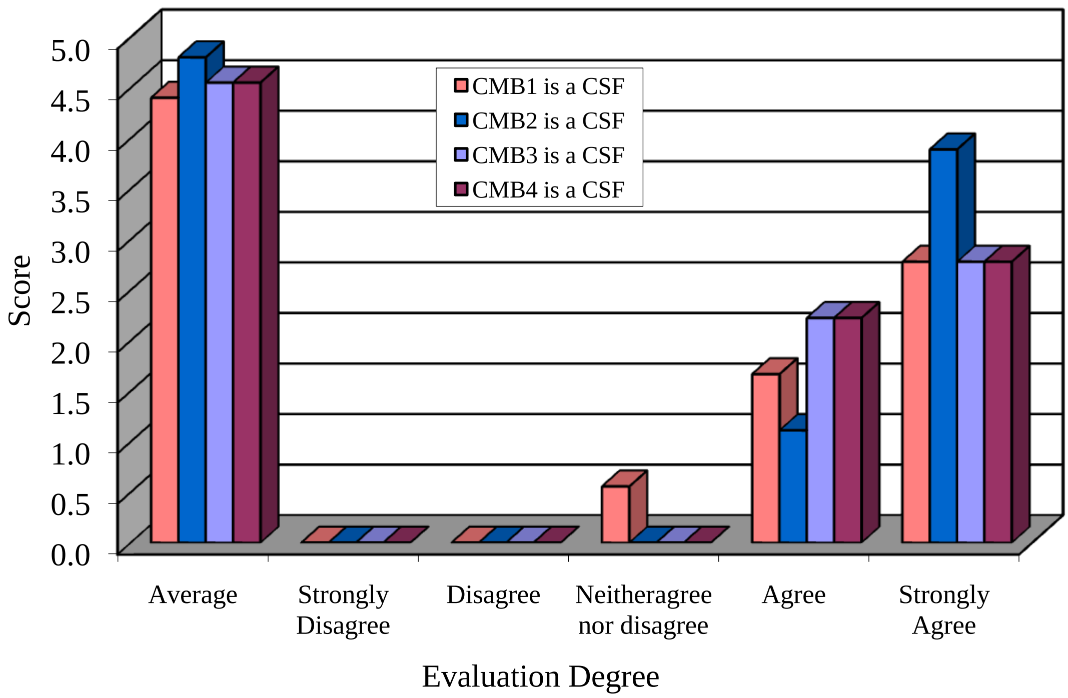

Figure 8.6: Validation of CSFs of Improvement on SDM Project Performance (Contract Management-Related CSFs)

Figure 8.7 clarifies that the distribution of overall assessment of construction management-related CSFs based on a scale (strongly disagree to strongly agree) as well as average score achieved by these items.

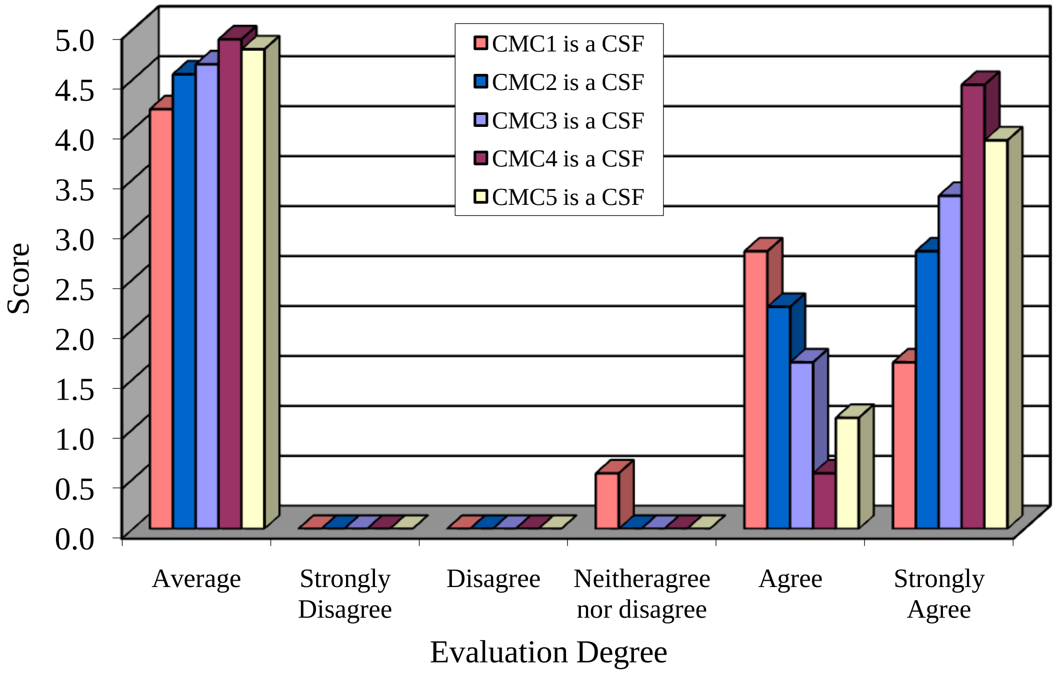

Figure 8.7: Validation of CSFs of Improvement on SDM' Project Performance (Construction Management-Related CSFs)

8.3.7.2 Validation of SDMs related-CSFs as identified through good practice

Validation of the identified CSFs that affect the performance improvement process of the SDM projects, as illustrated in Figures. 8.8, 8.9 and 8.10, received a high average score in terms of the level of agreement, which showed that these factors can be identified through good practice. The debate covered the CSFs, which had been identified from the research; and their relationship to good practice. Moreover, the discussion highlighted whether these factors are evident and identifiable in practice. The stakeholders agreed that sustainable assessment of the LL is required to identify the CSFs needed to maintain continuous performance improvement. In the next step, the stakeholders were asked to rate their level of agreement about the identification of the CSFs through good practice.

The average agreement with regards to identifying the CSFs related to the adaptability of the SDMs to the context through good practice ranged between 4.2 and 4.65 as shown in Figure

8.8, (also see Table E3 in Appendix E). Figure 8.8 also illustrates the distribution of overall assessment of the identification of the adaptability-related CSFs through good practice based on a scale (strongly disagree to strongly agree) and average score achieved by these items. With regards to CSFs that are related to contract management, the average agreement in terms of identifying them through good practice ranged between 4.4 and 4.65 as shown in Figure 8.8 (also see Table E3 in Appendix E). Figure 8.9 illustrates the distribution of overall assessment of the identification of the contract management-related CSFs through good practice based on a scale (strongly disagree to strongly agree) and average score achieved by these items. As clarified in Figure 8.10 the CSFs related to construction management achieved an average score reneged between 4.2 and 4.8 (also see Table E3 in Appendix E). However, the validation of the identified CSFs that are related to good practice (see Figures 8.8, 8.9 and 8.10) received a high score in terms of the overall assessment of level of agreement, which showed that these factors are feasible and can be identified by stakeholders. The differences between the CSF's mean ratings were mostly very small, with a highest mean rating of 4.8 and a lowest of 4.2. However, *CMC5GP* received the highest rating of agreement with a mean of 4.8, while *AA5GP* and *CMC2GP* received the lowest rating of agreement with means of 4.2, which are still quite high.

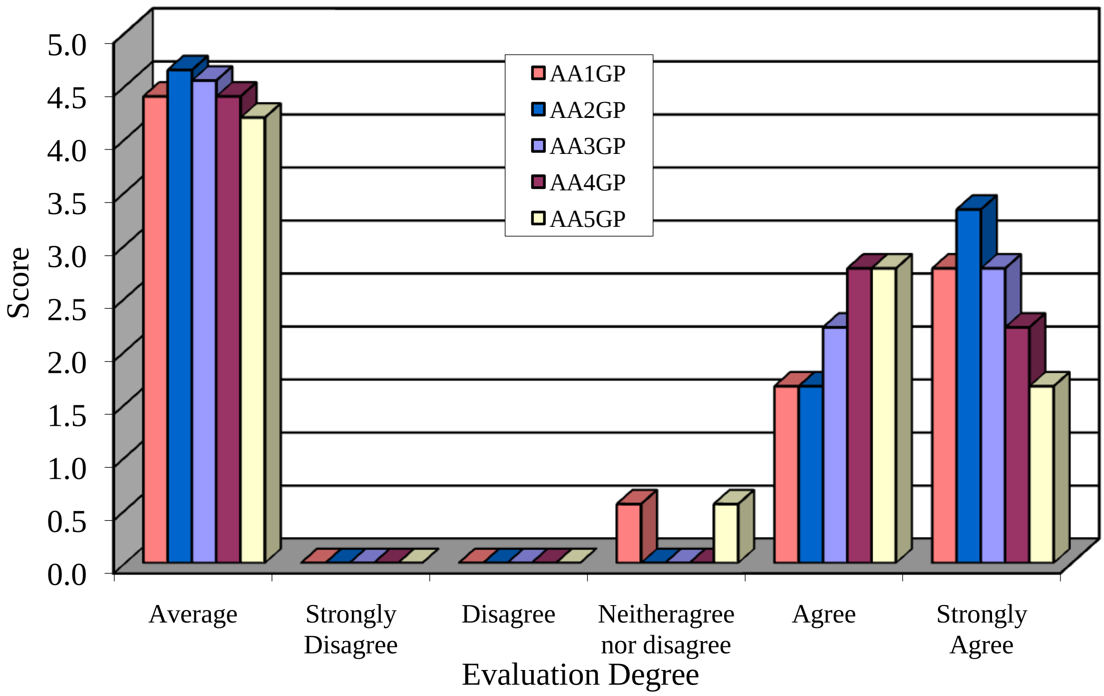

Figure 8.8: Identification of CSFs through Good Practice (Adaptability of SDMs to Context –Related CSFs)

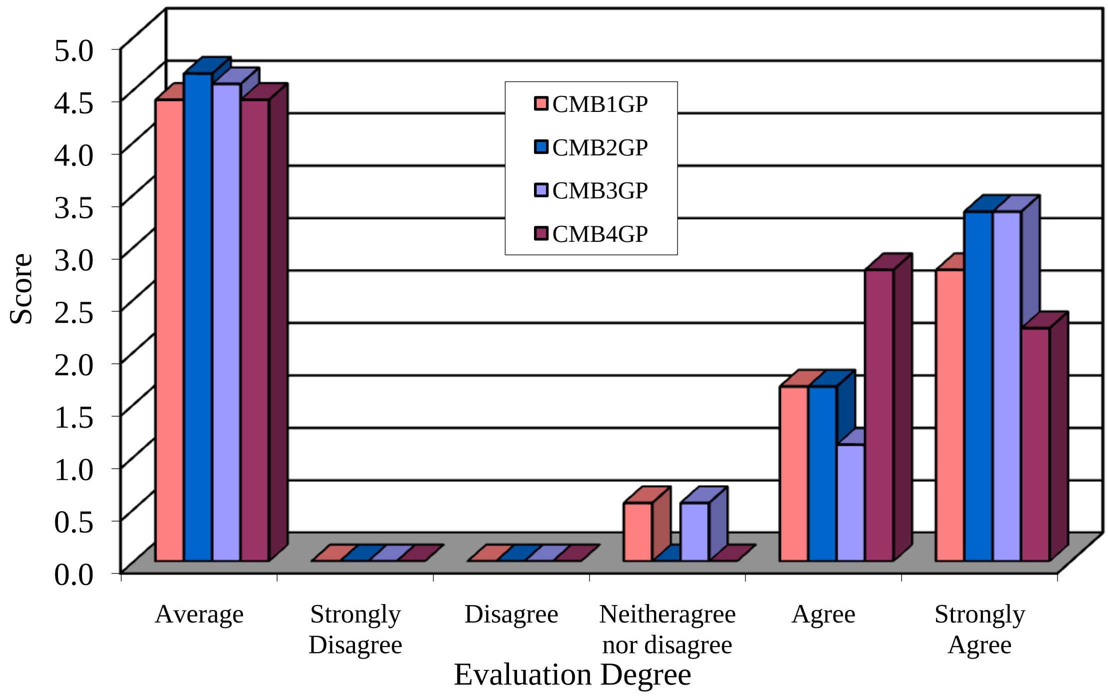

Figure 8.9: Identification of CSFs through Good Practice (Contract Management-Related CSFs)

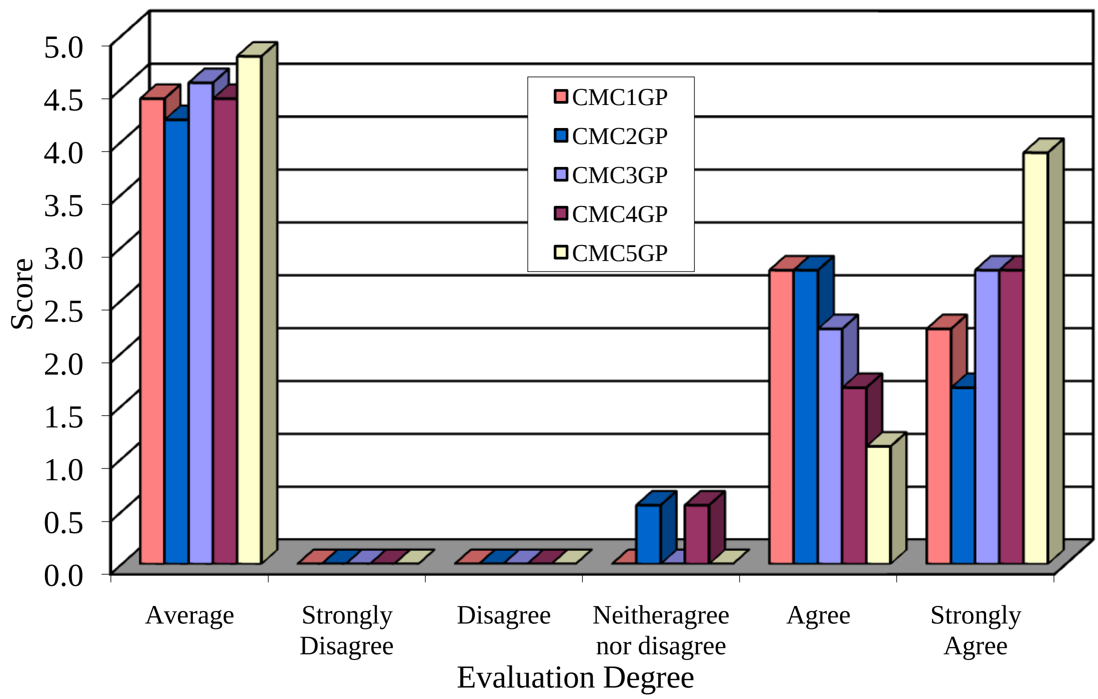

Figure 8.10: Identification of CSFs through Good Practice (Construction Management-Related CSFs)

8.3.7.3 Suggested changes/improvements to the framework

The results of the validation workshop provided extensive feedback on the framework. Stakeholders forwarded some comments, of which one focused on the concept of the post-project audit phase. It was suggested that this should include the period between the first handover and the final handover rather than the current concentration on the construction phase. This is because during that period, faults and mistakes will surface and therefore they must be included within the project audit. In addition to the fact that the project is still under the guarantee period provided by the contractor as well as the project management team still being in existence. Another suggestion focused on modifying the feedback from LL so that it came directly from a central database to the three phases (design modification phase, pre-construction phase and construction phase) to ensure saving all LL captured from the different projects as knowledge that could be managed to be reused for on-going and future projects. One of the stakeholders suggested that when a project is underway, there should be a feedback from the construction phase to avoid the expected faults or mistakes which might appear, or also to allow necessary improvements to be made. This is because these faults/mistakes or improvements should not be made before getting permission from the client and consultant, and at the same time they will be avoided in the models which are being subjected to the adaptation process for future projects. Next, the participants commented on the second component of a framework which is contract management.

Contract management should receive feedback about the new changes to be taken into consideration for adapted future projects. Another comment was made by one of the stakeholders regarding the limited period that should be allowed for feeding the information to other projects. However, in the light of using the SDM projects, there is no limited period for exchanging the information due to the need to maintain continuous improvement. Another stakeholder called for direct feedback between the construction phases for each project. This could possibly be done through effective communication between the same typical projects in order to exchange experience and knowledge. This is due to variety existing between skills involved in SDM projects in the respective organisations and also to avoid the bureaucratic procedures which sometimes cause long delays in a project. Another comment focused on the number of LL which will be captured from each project and whether this is constant or variable from one project to another. Another stakeholder linked the improvement curve to the aforementioned number of LL and whether it will finally be affected by the total number produced from all the projects. There are many variables that determine the average number of LL, such as the professionalism of the designer, client, consultant or contractor staff, and their abilities to detect the faults/mistakes or the needed improvements. With regard to SDM projects, the number of lessons could depend on the repetition of using the SDM because it is reasonable to expect there to be fewer faults/mistakes as the opportunities for improvement decrease. However, besides the aforementioned reasons, there are external factors that determine the average number of LL, such as the rapid changes in markets, or even the construction industry, as well as unforeseen circumstances. One of the stakeholders mentioned the relevance of the TQM concept, that focuses on achieving continuous and never-ending improvement, and which is particularly relevant in environments such as SDM projects. All stakeholders agreed that there is no constant average number of LL.

8.3.7.4 Validation of the framework’s implementation strategy

The final task of the validation workshop focused on getting feedback about a suitable method for implementing the improvement framework. Plenary discussion was held to reach an effective and practical strategy for implementing the framework. A designed statement for framework implementation guide (see Appendix E) was distributed to stakeholders in order to write their views about the suggested implementation strategy. The debate focused on identifying an overview of each issue of improvement, the objective in tackling each issue, tools/procedures, requirements and strategies for implementation, the expected outcome of the improvement process and the necessary assessment of the improvement process. Stakeholders emphasized that the client should have a clear vision of the targets to be achieved in the long term. Furthermore, LL must be used to produce an improved, high-quality model with fewer mistakes. Simultaneously, the invitation and tendering process must be improved to attract a good contractor to deliver a successful project, also the payment process and documents must be reviewed. The construction management environment must be improved to be ready to implement this framework through strong project management and a clear strategy. Stakeholders proposed a number of fundamental tools that must be used: effective teamwork, effective communication, flexible rather than bureaucratic processes, qualified staff in terms of skills and relevant experience, web communication and advanced technology. Stakeholders stressed that continuous assessment should be carried out to ensure that the expected outcome of continuous performance improvement for SDM projects is achieved. Stakeholders were asked to rate their level of agreement with the use of advanced technology as a part of the implementation strategy, as clarified in Table 8.2 and Figure 8.11.

Web-based tools and knowledge management (KM), as illustrated in Figure 8.11, received high ratings of agreement as a whole assessment of all items and are thus crucial factors in the implementation strategy, where, Web-based tools met with the strongest levels of agreement with average of 4.9 followed by KM 4.8. The differences between the mean ratings of these two factors were very small, with a highest mean rating of 4.9 and a lowest of 4.8, (see Table E4 in Appendix A). On the other hand, the stakeholders commented that there is currently no KM used in the SDM projects. A manual project file does exist; unfortunately, it is not activated in its full form. Web-based tools, knowledge management (KM) and existing KM were not in use where participants voted to adopt them, and they received the highest rating of agreement with means of 4.9, 4.8 and 4.8, respectively; however, the *manual project file* received the lowest rating of agreement, with a mean of 2.4.

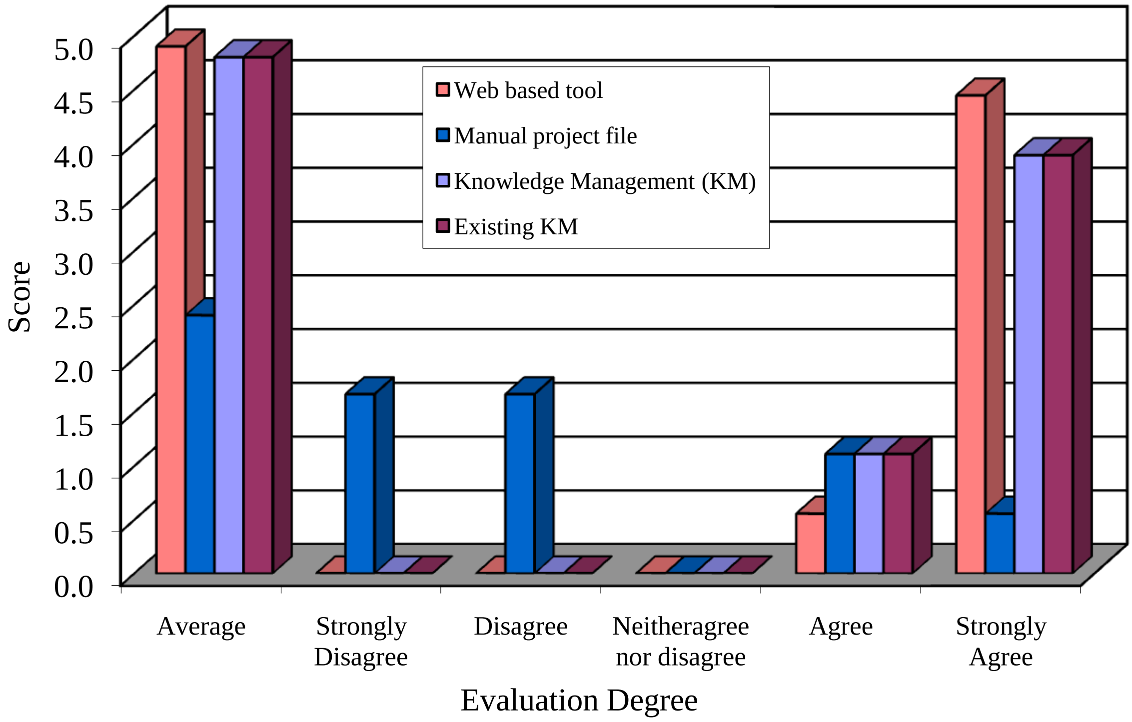

Figure 8.11: Validation of the Framework Implementation Strategy

The workshop participants described the framework as very interesting and expressed their expectation regarding the great benefits that this framework for SDM projects could provide. Finally, the implementation of the framework needs a guide in order to be effectively implemented. There should be a practical and reliable guide for adopting this framework. Stakeholders' views on an implementation strategy were provided as clarified in Table 8.2.

8.4 IMPLICATIONS

The use of the framework through the implementation guide would not instantly transform SDM project performance into one which was fully improved. It would, nevertheless, provide a significant step towards improving the performance of SDM projects if the guide is followed carefully, in particular by the client, and in general by all the stakeholders involved in the implementation of SDM projects. There are some contextual conditions within which the framework operation would be taken into consideration. A change in such conditions is expected to influence the manner in which the guide is to be implemented.

The guide has been designed in a very simplified format for easy implementation and monitoring. It is expected that the stakeholders who will implement the improvement framework would appreciate the complex nature of the relationships between the three components of improvement when they are organising the improvement process. Additionally, a training workshop for staff involved in the SDM projects is suggested in order to introduce the learning concept, its importance, tools, process and to improve the learning skills of staff as well as the tasks assigned to every participant in the learning process.

The guide is more suggestive than descriptive to make it more adaptable. The results of this research were contextual to SDM projects, therefore the guide sets out pointers to what must be done depending on the current conditions at the time of application.

Table 8.2: Framework Implementation Guide

	Adaptability of SDMs to Context	Contract Management	Construction Management	Assessment of SDM' project Performance Improvement
Phase	**Design modification**	**Pre-construction**	**Construction**	
Overview	Developing an improved models	Developing the process of invitation, bid evaluation, award of contract, payment, contract documents and contractor evaluation	Setting up of mental processes and strategies for project management to effectively organise its role in the site	Assessment of SDM' project performance improvement
Objective	To adapt design models to context and developing quality and material specifications for future projects to achieve client and end-user needs	To regularly develop processes of contract management to find a good contractor as well as effective processes and improved contracts	To encourage project management to achieve an excellent progress of the project and then deliver a successful project	To assess the extent of SDM' project performance improvement and achieving continuous improvement
Details of processes, procedures, tools checks and strategies	● An integrated teamwork system in the H.O ● Design modification & development ● Material specification amendment ● Storing all design changes in database software ● Availability of easy access for the use of information ● The use of advanced technology ● Qualified staff ● Effective communication ● Simple and flexible system ● Training workshop for staff	● Invitation to tender ● Developing tendering criteria ● Improving payment process ● Reviewing estimation for future projects ● Reviewing contract documents (terms & conditions, BoQ) ● Qualified staff ● Simple and flexible system ● Package contract ● The use of advanced technology ● Training workshop for staff	● Standardised project procedures ● Delegation of authorities to project management ● Encouragement and motivation for effective communication between all typical projects ● Setting up of clear processes and strategies for documentation ● Assessment of contractor abilities ● Producing project closeout report involving LL ● The use of advanced technology ● Learning ● Qualified staff ● Simple and flexible system ● Relevant experience ● Training workshop for staff	● Regular assessment of tools, processes and strategies used ● Selective committee to assess the overall performance improvement
Improvement target/anticipated outcome	● Less faults and mistakes in design ● Developing designs ● Developing material specifications ● High quality and functionality ● Avoiding change order	● Developing technical and contractual contracts ● Contracting with good contractors ● Updated cost estimation ● Modern and systematic process	● Successful project management ● Excellent progress of project ● Better overall performance ● Qualified contractor ● Systematic approach ● Valuable LL ● Successful project	● High and considerable progress ● Sustainable performance improvement in terms of cost, quality, time and client satisfaction ● Achieving continuous improvement ● Effective learning ● Effective knowledge management

8.5 SUMMARY

In this chapter the framework development processes were presented to show the stages of developing the framework. Four major reasons were highlighted to justify the need for developing such a framework, and findings of four case studies were the main structural core of the framework development. The literature review and preliminary study findings provided some guidelines during the stages of developing the framework. A framework overview was explained through presenting the four phases involved in the framework development. Additionally, these phases were explained and discussed to show the CSFs involved in each component of the framework and its structure. Forward- and backward-fed loops with their headed arrows are linked to other phases as well as to the assembly of the framework.

The feedback from selected stakeholders was used to validate the improvement framework through a validation workshop involving nine participants conducted within the context of the SDM projects in Saudi Arabia. The framework was found to be practical, appropriate and relatively clear. The validation of SDMs-related CSFs received a high score in terms of level of agreement with respect to their impact on the process of improvement on SDM project performance. Additionally, the validation of identification SDMs-related CSFs through good practice received a high score in terms of the level of agreement, which can be easily identified through good practice. Web-based tools and KM received high ratings of agreement and are thus crucial factors in the framework implementation strategy. The current manual project file which is used in SDM projects received the lowest rating of agreement. Overall feedback was mostly positive and participants forwarded some comments that support the implementation of a framework. All stakeholders expressed their intention to implement this framework in the field and expected that there will be tangible benefits from it. An implementation guide was presented to be followed for a better outcome and long-term success. The following chapter discusses the overall results of this research within the context of the literature.

CHAPTER 9

9 DISCUSSION

9.1 INTRODUCTION

This research aims to develop a framework for improving the performance of SDM (Standard Design Models) projects. The key methodology adopted in this research involved: review of an extensive literature; conducting a preliminary study in Saudi Arabia; conducting four case studies in Saudi Arabia; framework development; and conducting a validation workshop for the developed framework in Saudi Arabia. The extensive literature review involves construction project performance, learning, Knowledge Management (KM) and the SDM projects. The preliminary study emerged as a useful source for gathering information about SDMs' project performance and provided sufficient justification for the research. It was conducted to give details about the current performance of the SDMs and help in understanding the practical realities. Accordingly, the information related to project performance improvement gathered from the literature review and preliminary study identified the appropriate research method for this research. As a result, four case studies were carried out to explore and obtain deeper insights into the context of SDMs by identifying information relevant to the performance of SDM projects and the role of Lessons Learnt (LL) in improving the performance of these models due to their repetitive characteristics. Four projects were selected for the case studies: two completed projects and two ongoing projects. The collected data were analysed, and the findings were presented in Chapter Seven. This chapter provides a discussion of the research findings in the light of the literature and draws out the main achievements and their contribution to knowledge.

9.2 DISCUSSIONS OF THE RESEARCH FINDINGS

This section discusses the findings identified from the preliminary study as well as the four case studies, from which emerged 14 Critical Success Factors (CSFs) affecting the process of improvement for SDM project performance. These CSFs are classified under three main themes: adaptability of SDMs to context-related; contract-management-related; and construction-management-related.

9.2.1 Adaptability of the SDMs to Context – Related - CSFs

The findings revealed the following CSFs that affect the process of improving the performance of SDM projects, these include: collaboration between the design and supervision departments; design modification; material specifications amendment; central database; and dissemination of LL. These CSFs are classified under the above theme, and are discussed below.

9.2.1.1 Collaboration between the client's design and supervision departments

It was established that effective responsibility and input of Design and Supervision Departments in the context of SMoI are considered to be a CSFs in the process for the improvement of SDM projects performance. In the context of SMoI, there are critical roles made by those departments: the Design department in adapting models to sites and modifying and developing the design to ensure the continued provision of sophisticated models; and the Supervision department in managing the construction phase to deliver a successful SDM project. However, the findings show serious coordination issues between the two departments due to their failure to collaborate, which is undoubtedly having a negative impact on SDM projects performance. This lack of coordination has resulted in scores of the LL delivered by different SDM projects being missed. All the interviewees argued that past mistakes or the suggested improvements made in completed projects will be unavailable to future, or even on-going, projects. Egan (1988) stressed that design needs to be properly integrated with construction and performance. He emphasised the importance of integration between the design and construction phases, which means the designer and supervisor should work in close collaboration.

However, continuous collaboration disparities between the two departments may contribute towards an accumulation of repetitive mistakes rather than an accumulation of experiences and skills in the SDM projects, which will result in underachievement and/or discontinuous performance improvement. Accordingly, in order to achieve a continuous performance improvement for SDM projects, there is a need to bridge the gap existing between the two crucial departments through establishing close collaboration aimed at organising the work within an integrated system. This can be incorporated with other CSFs to develop the improvement framework for SDM projects performance.

9.2.1.2 Design modification

All the interviewees stated that the non-collaboration between the Design and Supervision Departments significantly influenced the level of design modification. This is due to the shortage of information that must be provided to the Design Department by the Supervision Department. Therefore, teamwork is disorganised and fragmented because the majority of the LL provided to both departments were not circulated and then reused in future SDM projects. Scott and Harris (1998) demonstrated that when a design fault is identified and recognised and then presented in an accessible way to designers for future projects, improvement could be achieved. They criticised the unstructured and informal way of using learning and experience to improve future projects. Accordingly, the integration between the design and construction teams could lead to a better outcome based on the LL from past experience.

Additionally, two forms of design modification have emerged from the findings: one was based on the detection of design mistakes which must be modified, and the other was based on the need for improvement offered by stakeholders. Davis et al. (2009) argued that design errors made by the designers are affected by the client’s demands for the design and documents to be completed within a limited time. Pitman (1991) emphasised the importance of the valuable LL when avoiding past mistakes.

9.2.1.3 Materials specifications amendments

The findings addressed the need to amend the material specifications to be a CSF in the process of improvement for SDM project performance. Furthermore, the findings revealed that reasons for amendment were threefold: existing mistakes in material specifications; improvement purposes; and validity and availability of materials. As mentioned in the design modification, the frequent emergence of specification mistakes is considered as a serious problem due to lacking learning from past mistakes. The second type of materials specification amendment is the availability of such specifications, the validity of these materials and sustainability. This can be performed through improving the quality of material specifications to align with their rapid changes and improvements. In this regard, Egan (1988) emphasised that material improvements should be included within the scope of improvement in construction projects. He indicated that innovation is required for the benefit of the client and the stripping out of waste, whether in design, materials or on-site construction.

Significantly, development of material specifications has a significant impact on SDM project performance as well as on the construction of a sustainable building through choosing materials that achieve a social, economic and environmental balance. Ortiz et al. (2009) indicated that the construction industry is concerned with improving the social, economic and environmental indicators of sustainability. This improvement can be achieved through applying Life Cycle Assessment (LCA), which possibly helps in optimising the above aspects from the extraction of raw materials to the final disposal of waste building materials. However, the focus on the development of material specifications is crucial for achieving continuous performance improvement for SDM projects, as well as client and end-user satisfaction, rather than wasting project time in solving the mistakes that are being repeated from project to project.

9.2.1.4 Central database

The findings of this research revealed the need for a central database for storing the LL within the SMoI due to it being the main centre, critical in the process of improving the performance of SDM projects. It was established that easy accessibility to this database via the Internet by all SDM projects management is very important. Additionally, all the interviewees stated that the lack of a central database in the H.O was one of the reasons for the underachievement of improvement on SDM' project performance. This is because most of the LL captured from completed projects remained within the boundary of that completed project or were missed due to these lessons not being stored in a central database to be reused for on-going and future projects. All the interviewees stated that future SDM projects might suffer from repeated mistakes as well as lack the improvements made in completed projects, except those located within the same region as the completed projects, due to the LL being provided through the consultant (e.g. CS3). This is in line with Newell et al. (2006) who criticised the rare use of databases to transfer the LL from one project to another.

A further issue addressed by interviewees was the continual updating of the central database based on information coming from completed and on-going projects. This is in line with Pakes and Schankerman (1979) who acknowledged that knowledge may become obsolete over time. This could occur due to the development of a discipline and the employment of new information, rules and theories (Bhatt 2001). Maintaining knowledge encompasses reviewing, correcting, updating and refining it to keep it up-to-date by preserving knowledge in the archive whilst removing that which is obsolete (Rollett 2003). Accordingly, the need to establish and monitor a knowledge base is essential in storing information provided by the different SDM projects to ensure that it will be available for all to be reused in on-going and future SDM projects.

9.2.1.5 Dissemination of LL

According to the research findings, the dissemination of LL was significantly affected by the existence of a central database. Similar conclusions were drawn by Balthazor (1994) and Holtshouse (1999) suggested the possibility of achieving effective dissemination by using databases of LL, rotating personnel and circulating written reports. A few circulations were disseminated to SDM projects across the country. Additionally, the level of dissemination was initially satisfactory in CS1 and CS2, although it was based on a traditional method that made use of hard copies, but was worse in CS3 and CS4. As a result, past mistakes were repeated in the later projects (e.g. CS4), improvements made in completed projects were restricted to those projects and the process of improvement was carried out at the lowest level (e.g. CS3 and CS4). Garon (2006) stressed the dissemination and reuse of knowledge in future projects to support planning and decision-making at both project and corporate levels. Similarly, Ayas (1996) stressed the crucial role of disseminating the LL across an organisation.

Snider et al. (2000) stated that, although the idea of learning from experience is timeless, recently there has been considerable attention given to formalising systems for capturing and disseminating LL within an organisation. He argued that LL are regarded as a driver for an organisation to improve its performance by encouraging staff to learn from their past experience when executing previous projects in order to improve performance in future projects. Additionally, the improvement of learning will be increasing over time by improving staff skills and thus will strongly reflect the value of the LL.

Additionally, in this research, findings highlighted the importance of using Information Technology (IT) in facilitating the share of knowledge between all the SDM projects. This step involves the provision of the right knowledge to the right person at the right time (Mertins et al. 2001; Robinson et al., 2002) or within the shortest time (Tan et al. 2007).

Markus (2001) claimed that this process can be passive (e.g. publishing a newsletter or populating a knowledge repository for users to browse), or active (e.g. passing knowledge by an electronic alert to those who need to know). Significantly, there are necessary tools and methods used to activate the knowledge, these include: information and communication technology (ICT) applications (Mertins et al. 2001).

9.2.2 Contracts Management – Related - CSFs

It was established that part of the identified CSFs that affecting the process of improvement on SDM project performance. These CSFs include: invitation to tender; tendering criteria for selection of contractor; payment process; contract documents for future SDM projects. These CSFs are discussed below.

9.2.2.1 Invitation to tender

In all the four case studies, it was established that the invitation to tender used in all four cases for inviting contractors was an “open invitation” process. This resulted in noticed differences in the qualifications of invited contractors, where those were not selective. To avoid the problems resulting from these differences, Aje et al. (2009) stated that there was a need for a prequalification process for contractors prior to the invitation to tender. However, it was established that all the interviewees across all the cases suggested the adoption of the “closed invitation” approach rather than the “open invitation” one which was seen to attract unqualified contractors. This is in line with Harris et al. (2006), who argued that the more preferable invitation-to-tender approach is “selective tendering” which focuses on inviting a contractor selected from a shortlist of candidates for whom the project was deemed to be suitable.

Additionally, the findings revealed that there are some attempts being made by clients to adopt a long-term contract to implement typical SDM projects with selected contractors based on their past experience and past performance in SDM projects. In this regard, partnering has emerged as one of the important tools used to improve project performance, and so has gained major popularity. Different studies have been performed by several researchers (Gransberg et al. 1999; Black et al. 2000; Chan et al. 2004; Beach et al. 2005; Tang et al. 2006) on monitoring the performance of building industry projects. Egan (1998) indicated that the industry must replace competitive tendering with long-term relationships based on clear measurement of performance and sustained improvement in quality and efficiency.

Accordingly, the findings show that there is a need to improve the system of invitation to tender in order to attract good contractors who are able to implement successful projects, contribute to identifying and capturing valuable LL and who can also transfer their experiences, skills and familiarity to future projects rather than starting with a new contractor who might be less qualified than his predecessor.

The findings of this research revealed that the performance criteria used in the SDM project were limited to cost, quality, time and client satisfaction, while the contractors added that profitability criteria were used by the majority of contractors. Similarly, the preliminary study revealed time, cost, quality and client satisfaction as criteria for measuring the performance of SDM projects. The contractors considered profitability as an additional criterion for measuring performance. However, it is widely accepted that the objectives of any construction project are expressed in the ‘golden triangle’ of cost, quality, and time. Pheng and Chuan (2006) assumed that project performance was a function of quality, time and budget: “*Project performance = f (quality, time, budget)*”**.** Ashley (1987) identified a number of project performance criteria, these include: budget performance, schedule performance, client satisfaction, functionality, contractor satisfaction and project and team satisfaction.

Nevertheless, the extant literature in regard to construction project performance identified two approaches regarding project performance criteria: one suggests adding more dimensions to the basic criteria of time, cost, and quality, while the other focuses on the reduction of the dimensions describing project success. This approach sees the “Golden Triangle” of time, cost and quality as both inordinate and partial.

9.2.2.2 Tendering criteria

The findings revealed that in all the four case studies the tendering criteria used to select the contractor was the lowest price regardless of the other measures such as relevant experience, skilled staff, financial power and the contractor’s past performance. In turn, this contributed to long delays and underachievement in performance of the majority of SDM projects, and case studies CS3 and CS4 (on-going projects) were a good example. Additionally, the findings highlighted the need to adopt besides the lowest price the aforementioned measures.

Similarly, the findings of the preliminary study addressed the insufficient capabilities of selected contractors due to the use of the lowest price as a major measure for awarding the SDM project. This agrees with Egan (1988) and Holt (1988) who stressed the importance of targeting the best value rather than the lowest price for selecting the appropriate contractor. Similarly, in 1999, the Hong Kong Housing Authority (HKHA) (2002) developed a Preferential Bid Award System (PTAS) and a Performance Assessment Scoring System (PASS) to help in assessing contractors' bids. PTAS aims to formalise a holistic approach for assessing contractors' bids so that awarding the contract is based on both price and non-price factors. This agrees with Hatush and Skitmore (1997), the common criteria used for selecting the contractors are limited to their financial soundness, technical ability, management capability, health and safety performance and past performance.

However, considering the lowest price as a major measure in accepting the contractor's bid has been criticised by many authors (e.g. Hatush and Skitmore 1998; Stein et al. 2003; Al-Reshaid and Kartam 2005). They argued that the serious problems which arise within the construction phase as a result of accepting the lowest bid can lead to serious overruns of time and cost, serious quality problems and eventually to increased litigation. Furthermore, they criticized the selection procedures that depend on the lowest bid rather than on technical issues, although a particular bid may have the lowest pre-qualification score. Inevitably, the bid price has been used as the sole criteria for contract award decisions (Cheung et al. 2008).

Accordingly, tendering criteria are considered to be a CSF for the improvement of SDM project performance and one which requires the adoption of comprehensive criteria in the selection of the contractor to ensure that the project will be implemented according to cost, time and quality and, therefore, to maintain a continuous project performance improvement for SDM projects through the rich LL provided by a good contractor.

9.2.2.3 Payment process

In all the four case studies, all the interviewees argued that the major reason behind the delay of payment is due to the client's complicated procedures used to grant the requested amount. This is in line with Ahmed et al. (2003) and Alaghbari (2005) who argued that the success of a project is affected by the client's financial problems in terms of delayed payments, financial difficulties, and economic problems. Furthermore, Bageis and Fortune (2009) identified that project cash flow and the nature of the client (private, public) affected the bid/no-bid decisions of Saudi construction contractors. Therefore, as such, there was a negative impact on SDM projects performance, particularly in the case of contractors with less financial power. This was highlighted by Al-Kharashi and Skitmore (2009), who argued that Saudi public construction projects suffered from delays due to the problems resulted from a contractor's difficulty in financing projects.

Additionally, the findings highlighted that not only was the client a reason for the delayed payment process, but also the contractor and consultant shared in the problem. The contractor is responsible for this problem because of the delay in providing the request for payment, while the consultant delays in giving the approval for processing the payment request before providing it to the client. Similarly, Assaf and Al-Hejji (2006) addressed the delay in performing inspection and testing as approving major changes in the scope of work by the consultant and inadequate contractors' work are causes of delays in the Saudi construction projects.

9.2.2.4 Contract documents for future SDM projects

According to all the interviewees in all the four case studies, it was established that despite the prospect to avoid all past mistakes being provided by adopting SDM projects, a catalogue of errors related to contract documents was repeated from project to project. These include: mistakes in Bill of Quantity (BoQ), terms and conditions and the estimated cost of projects. Similarly, Al-Reshaid et al. (2005) argued that reviews of BoQ should be checked and assessed. Furthermore, Davis et al. (2009) discussed the situation of BoQ in Australian construction projects in which concern over the quality of the contract documentation produced was mentioned.

The reoccurrence of such mistakes in BoQ contributed to the increased project costs due to the changes in the quantities of works in addition to further cost increases based on the modified quantities. Additionally, the request for changes in these quantities must be approved by the H.O, which causes extensive time delays for both contractor and project. Odeh and Battaineh (2002) identified a number of factors affecting project performance improvement which are related to the client, among which are discrepancies in contract documents.

In addition, the findings identified the failure to re-estimate the cost of SDM projects according to the present prices in the market has led to many problems that have affected SDM project performance. Similar conclusions were drawn by Al-Reshaid et al. (2005) who stressed the importance of checking and assessing the project cost estimation.

Accordingly, there was apparent consensus between the issues addressed through the findings of the four case studies of this research and the literature review. The latter revealed the importance of these issues in the success of construction projects as the research findings identified these issues as CSFs in the process of improvement of SDM projects performance. Additionally, the role of tendering criteria in the success of SDM projects was confirmed by the preliminary study which was conducted in the context of SDM projects.

9.2.3 Construction Management – Related - CSFs

In this research, some CSFs were found relate to Construction Management. These CSFs include: SDM project procedures; decision-making process; communication and coordination; methodology for identifying, capturing, documenting and re-using LL; and SDM project closeout report. These CSFs are discussed below.

9.2.3.1 SDM project procedures

The findings of this research reveal that there were some standardised procedures that were used in project management. These procedures include: inspection requests; material submission requests; approval of shop drawings and prequalification submittal for subcontractors. Additionally it was established that SDMs can provide valuable insights by focusing on three procedures: avoiding repetitive mistakes; unifying the project management process and encouraging creativity and innovation. Similarly, Kerzner (2006) called for a striving for innovation and learning in order to achieve successful project management by using standardised project processes. The standardisation of processes contributes to expected levels of performance improvement in the construction industry, such as those that are often demonstrated in the manufacturing sectors (Griffith et al. 2000; Kondo 2000).

Additionally, research findings highlighted that although the use of standardised procedures is limited within the boundary of regional administration, there were unorganised procedures used by all the SDM projects. This agrees with the preliminary study which revealed that the project procedures adopted in the SDM projects are disorganised, fragmented, inappropriate and inflexible, despite them offering a suitable opportunity for standardising the procedures of typical models. Accordingly, this creates problems for stakeholders, particularly new contractors, who will spend a part of the project time learning how to deal with the project and finding out the formal procedures that should be followed.

According to Alotaibi et al. (2008) SDMs is regarded as an enabler for project management through gained knowledge and using unique processes for project management and standardised specifications and materials. These standardised procedures will contribute to achieving a considerable improvement in project performance, particularly in terms of time. However, the importance of standardised procedures of projects identified through findings has also been argued through literature review. Toney and Powers (1997) argued that a standardised process (approach and procedure) is a key success factor in project management. Furthermore, Standardised Project Management (SPM) tools and skillsets for project leadership were identified as critical success factors in a case study of Toyota projects (Sobek et al. 1998), which helped with minimising duplication of effort and waste (Avery 1996).

9.2.3.2 Decision-making process

It was established that the majority of SDM projects suffered from delays in the decision-making process; therefore, the regional administration tried to solve in-house all the problems that required the H.O to take a decision, to avoid following bureaucratic procedures. Fortune and White (2006) reported that decision-makers have a significant influence on project success. Furthermore, decision-making is necessary and is a significant characteristic that occurs in each phase of a project; therefore, often, such decisions may influence the other tasks that will take place (Arain and Pheng 2007).

In all four case studies, the focus was on the importance of granting greater authority to the project management, particularly the client’s project management, or the regional administration. This helped to build trust in the project management, promote the offering of new ideas and, therefore, the capture of valuable LL that could be re-used for on-going and future projects. Similar conclusions were drawn by Steiner and Ryan (1986), who argued that there are some important authorities that should be given to project management which influence the success of a project. These include: managerial and technical actions, where ‘managerial’ involves the control of funds, schedule and quality of product and ‘technical’ involves appropriate authority in design and in making technical decisions in development. Similarly, Brown and Eisenhardt (1997) demonstrated that giving an authorisation to project management is crucial to the building of leadership confidence, the speeding up of work processes and, ultimately, the achieving of a successful outcome.

In all the four case studies, the barriers used in the decision-making process reduced the improvement scope, particularly for the contractor who was concerned about the expected delay that might result from providing a new idea or suggestion due to the need to involve the H.O, which he could expect to cause a delay that would cost a contractor time and money. Additionally, improvement and innovation are affected by the flexibility and speed of the decision-making process, which contributes to the achievement of a continuous performance improvement for SDM projects. This is in line with Mudrak et al. (2005) who argued that the innovation could be incremental due to the day-to-day nature of decision-making in projects and fast changing demands and needs of the client organizations. Zehir and Özsahin (2008) argued for the significant role of speed of decision making and innovation performance.

9.2.3.3 Communication and coordination

Findings revealed communication and coordination, either intra-project or between other typical SDM projects, to be a CSF for improving project performance through the exchanging of LL, experiences and skills between the stakeholders. Noticeably, the findings derived from the preliminary study confirmed that communication and coordination contributed to the exchange of experience and skills as well as many of the LL between the SDM projects. This is in line with Jha and Iyer (2006) who identified that the feedback and interaction between project participants are CSFs affecting the quality of construction project performance. Additionally, research findings established that an effective use of communication and coordination through these repetitive SDM projects contributes towards generalising tangible benefits for stakeholders and SDM projects leading to the sharing of improvements within these projects. Studies identified communication to be a critical factor in improving learning processes (Love et al. 2000), and the corporate feedback cycle (Disterer 2002).

However, research findings established that the level of communication and coordination in the two completed projects were effective due to their skilled staff who were initiators and had a desire to learn from others, either to cope with the problems encountered or to improve performance. In CS3, there was little communication and coordination with other typical

SDM projects due to the shortage of the available typical SDM projects in the same region. In CS4, the client was making a considerable effort to activate the communication and coordination by directing the contractor to learn from other typical projects**.** Similar conclusions were drawn by other studies related to effective communication, for example, construction contractor experience (Kuluanga and Kuotcha 2008) and commitment to learning involving leadership (Chiva et al. 2007).

Additionally, it was established that in all the case studies, communication and coordination took place through mutual visits, including direct observation and holding meetings if necessary, where many faults were avoided due to obtaining beneficial information from other typical SDM projects. Accordingly, open communication between stakeholders has a significant influence on project performance improvement. Similar conclusions were drawn by Chua et al. (1999) and Jha and Iyer (2006) who argued that communication and coordination – an interactive process involving formal and informal communication - are CSFs for a project. This was confirmed by Nguyen et al. (2004) and Fortune and White (2006). In addition, the importance of communication and coordination through regular meetings and revisiting the project processes were seen to be CSFs by Carrillo (2005).

9.2.3.4 Methodology for identifying, capturing, documenting and re-using LL

In all the case studies, the situation in LL was unsatisfactory, being fuzzy, unorganised and fragmented with no learning being performed in the right way, but only some individual attempts made by stakeholders in every project by using traditional methods. Similarly, findings were identified through the preliminary study conducted in the context of SDM projects. This is in line with Weiser and Morrison (1998) who noted that systematic methods of identifying, capturing and transferring LL for future projects are still found only in very few firms. Kamara et al. (2003) indicated that in the current practice, the reuse of captured knowledge is often associated with persons rather than projects, which means this knowledge can be reused in the projects executed by those people, and therefore, in the post-project reviews (PPR) used within each participating organisation. Accordingly, this captured knowledge needs to be organized and managed through a systematic approach. This can be achieved through Knowledge Management (KM), in which there is a systematic and organized attempt to use this knowledge for improving future project performance (KPMG 1998).

In general, the situation of learning in the two completed projects was better than in the two on-going projects due to the contractors' awareness of the importance of learning, which was a result of their having well-qualified, skilled and experienced staff. However, a few LL transferred from completed projects to on-going projects. Additionally, research findings established that LL should be transferred as a form of sharing knowledge, where they need to be managed and made available for all the SDM projects. Similarly, Garon (2006) indicated that LL are the best key element of knowledge management since they help to improve the planning/management of future projects in order to accomplish corporate missions by acting as a communication tool between projects. Kamara et al. (2003) set out the challenges related to the loss of knowledge due to the time lapse in capturing the knowledge, high staff turnover and reassignment of people. Nonaka and Takeuchi (1995) stated that explicit knowledge refers to documented information, this includes: design drawings and specifications, cost reports, risk analysis results and other information being collected, stored, and archived in paper or electronic formats. On the other hand, tacit knowledge can be defined as the way of storing experience, LL and other valuable information in the construction professional's mind without transferring them to another person or storage system (Lin et al. 2005). However, the serious problem is that this knowledge is mostly not used effectively and sufficiently due to its remaining stored in the minds of project team members. Therefore, it will be unavailable for transfer across the organisation to be used in future projects (Kazi and Koivuniemi 2006).

Additionally, the findings show that there were no clear policies or strategies adopted for learning, either written in the SDM project contract or by oral instructions. Tan et al. (2007) stated that the efforts of sharing and reusing knowledge created from construction projects are ineffective mainly through the lack of important insights concerning the knowledge caused by the time lapse between capturing the knowledge, staff turnover and people's reluctance to share knowledge. Dimitriades (2005) demonstrated that to achieve learning more quickly and effectively, it requires the development of strategic learning capabilities by linking learning with knowledge management within the context of the organisation.

The findings of this research revealed that the documentation process was unsatisfactory, since it was conducted through a traditional method without recognising the LL that could be re-used in on-going and future SDM projects through the normal project documents. Therefore, there were no special files delivered at the end of projects CS1 and CS2. As a result, the LL which were captured in cases 1 and 2 were not re-used in cases CS3 and CS4, except for a few lessons saved by the consultant from the completed projects and re-used in CS3. Carrillo (2005) claimed that the LL must be documented in a systematic way by using a structured format with a number of key attributes and levels of detail in terms of project participants, contact details, recommendations, responsibilities, etc.

Additionally, research findings established that in the light of adopting repetitive SDM projects, there is a need for a methodology for identifying, capturing and reusing LL based on 'day-to-day' learning in order to be sharing knowledge particularly for on-going SDM projects. This is in line with Whetherill et al. (2002) who argued that whether a construction organisation is able to be in a competitive position is linked to its capability to learn faster than its competitors and that this is reinforced by the external environment, so it needs to embrace effective learning based on day-to-day work processes.

9.2.3.5 SDM project closeout report

The findings demonstrated the problematic situation regarding SDM project closeout reports, where in the two completed cases (CS1 and CS2) no closeout reports were issued and delivered to the client at the end of the projects. Additionally, there were no instructions provided to contractors in the two on-going projects (CS3 and CS4) regarding preparation for the closeout report, even within the terms and conditions of the project contracts. Studies discussed the importance of post-project review on the success of future projects through issuing project close out reports. Anbari et al. (2008) indicated that a post-project review is a crucial factor affecting the success of future projects, the improvement of the overall performance, the development of the learning process and the provision of a historical database, on which future project teams can base the development of meaningful project plans. Furthermore, Disterer (2002) identified that a project must be subjected to post-project reviews, post-project appraisals, a project post-mortem, debriefing, reuse planning, reflection, the corporate feedback cycle and experience in order to capture the lessons that can be learnt and used in future projects. von Zedtwitz (2002) stated that project improvement for future projects can be achieved through conducting a post-project review.

However, the interviewees suggested that a SDM project close out report should include: assessment of the consultant's and contractor's performance, end-user demands, design quality and further comments delivered by the receiving committee. This assessment must include: contractor and consultant performance, suppliers, subcontractors and problems related to relationships with other public sector organisations. Kendric (2009) stressed that reviewing the technical aspects of project records helps stakeholders to avoid some fatal mistakes to which many construction projects repeatedly fall victim. He added that the closing report reveals many issues related to a project such as inadequate staffing, low levels of commitment, inadequate project management and many other issues, all of which will be listed in the project's database after completing the project. Huemann and Anbari (2007) assert that a post-project review is an evaluation of a project involving project management performance, technical processes and performance criteria. As a result, CSFs and critical failure factors can be identified, thereby highlighting the areas for improvement.

9.2.4 Continuous Improvement in SDM Project

The findings of this research reveal that the adoption of Continuous Improvement (CI) in the right form did not take place. However, the adaptation of SDM projects as a suitable environment for achieving CI was welcomed. Accordingly, CI was strongly correlated with the quantity and quality of LL from the completed projects and re-used in on-going and future SDM projects. Similarly, the preliminary study revealed that a failure to reuse LL in practice, except within a few limited situations, made it difficult to identify the impact of LL on the improvement of SDM' project performance. Moreover, there was a focus on using the characteristics of SDM projects to achieve "zero defects" which are considered to be a scale for assessing continuous performance improvement. This means stakeholders should show commitment to avoid repeating faults in future projects. However, improving the quality of LL could help to minimise the size of any defects. The findings also indicated that Total Quality Management (TQM) and Benchmarking were not used for achieving the CI of SDM projects.

Research findings emerged that the concept of CI was known by all the interviewees, but the requirements for its adoption were missing. However, in the public sector, particularly the construction industry, the adoption of CI suffered from slow progress compared with other industries, where the culture of CI could be created and spread. The situation in the public sector is different from that in the private sector, where the motivation for improvement is not multi-dimensional with demographic and societal changes, diminishing funds and political drivers for achieving quality (Fryer et al. 2007).

In this research, the findings focused on promoting CI through identifying past mistakes; encouraging suggestions leading to innovation; providing a methodology for identifying, capturing, documenting and reusing the LL; providing training, removing barriers; establishing a learning climate, taking account of the quality of the contractor and securing an integrated system for LL in terms of identification, design improvement, process management, the availability of a database and dissemination and the use of long-term contracts. Gilbreath (1986) enumerates a number of CSFs that should be included in the agenda of LL, among these factors are ‘learn failure, but do not practise it; understand it and then avoid it’ and know your project, assessing its weaknesses, both generic and specific. The failure to achieve CI means the failure to capture and reuse the LL. In CS4, the use of long-term contracts was suggested as an essential approach to achieve CI, particularly when they are to be implemented over a 20-year period. Similar conclusions were drawn regarding partnering that emerged as one of the important tools used to improve project performance, and so has gained major popularity (Tang et al. 2006, Beach et al. 2005; Chan et al. 2004; Gransberg et al. 1999).

There are many benefits gained from adopting CI. The research findings revealed that the use of CI can help maintain a sustainable improvement of quality in line with the rapid changes, reduce the waste of time and deliver sophisticated SDM projects. Similarly, the preliminary study showed that it was focused on ensuring client and end-user satisfaction, meeting the needs of the project, quality improvement, reducing wasted time, saving costs, modernising project methods and ensuring contractor profitability as well as the productivity of the workers. Therefore, performance improvement never stops at a certain level; it is always a subjective assessment. The literature review revealed that CI brings many benefits, including: improved performance/quality (Chassin 1997; Goh 2000); reduction of waste (Gallagher et al. 1997); reduced costs (Gallagher et al. 1997) and improved client satisfaction (Gallagher et al. 1997; Taylor and Hirst 2001).

9.2.5 Development of a Framework for Improving the Performance of SDM Projects

The findings of this research revealed the key ingredients for developing a framework for improving the performance of the SDM projects. These findings revealed fourteen CSFs affected in the process of improving the performance of SDM projects, and these CSFs are discussed throughout this chapter. Some guidelines were derived from the preliminary study which suggested a number of factors that should be involved in the improvement framework. Additionally, through a literature review in Chapters Three, Four and Five, a number of frameworks of the CSFs were reviewed (e.g. Sanvido et al.1992; Belassi, and Tukel, 1996; Takim 2005; Cheng and Shiu 2008), also a number of learning frameworks were reviewed (e.g. Gieskes and ten Broeke 2000; Law and Chuah 2004; Tan et al. 2007). These provided some guidelines that help in developing the proposed framework for improving the performance of SDM project. The framework consists of four phases that are in the form of chronological sequences, each phase comprises one component, these phases are: the design modification phase (Adaptability of SDMs to context), the pre-construction phase (Contracts management), the construction phase (Construction management) and the post-project audit (LL, Database and LC). The framework is explained in detail through Chapter Eight.

Validation of the developed framework is an important stage in this research to ensure the workability and practicality of the framework. The feedback from selected stakeholders was used to validate the improvement framework through a validation workshop conducted within the context of the SDM projects in Saudi Arabia. The concept of validation is dependent on the view that the model is a representation of the real world, or part of it (Pidd 2009). The validation workshop passed through four phases which covered giving the stakeholders the background to the research, the validation of the framework concept, the validation of CSFs, the validation of CSFs through good practice and the framework implementation strategy. The workshop depended on open discussion to enrich the validation and then the answering of questions based on a Likert scale. The framework was found to be practical, useful and have relative clarity. The overall feedback was mostly positive and a few comments were delivered to be taken into consideration.

9.3 SUMMARY

This chapter provided the discussion of the overall results including the literature review, preliminary study and final findings. Examining the research findings in the light of the literature review and preliminary interviews. The CSFs were discussed under their main themes: Adaptability of SDMs to Context; Contracts Management; and Construction Management.

The chapter discussed the CSFs related to the adaptability of the SDMs to context in the light of the literature. These CSFs include: collaboration between the Design and Supervision departments; design modification; material specification amendments; a central database and the dissemination of LL. In turn, research findings and literature are in the same line in terms of the importance of collaboration between the design stage and the construction stage to achieve an improved performance. Design modification was affected by serious coordination issues between the two departments due to their failure to collaborate, which undoubtedly is having a negative impact on SDM project performance, and this was confirmed through the findings of the preliminary study. Similarly, the literature argued the need to identify the design's faults and then present these in an accessible way to designers for future projects. Material specification amendments are similar to the design modification in terms of amending past /new mistakes or for improved quality. The chapter discussed the lack of a central database and the need to establish a central database for storing the LL captured from completed SDM projects to be reused for future projects. This agrees with the literature review, where the rare use of databases built for transferring the LL from one project to another was criticised. Additionally, the dissemination of LL was significantly affected by the existence of a central database, where there is a need for a knowledge base that should be accessible through the Internet. This is in line with the literature which argued the significant role of disseminating the LL in project performance improvement and suggested the possibility of achieving effective dissemination by using databases of LL.

The CSFs related to contract management were discussed in the light of literature review. These include: invitation to tender; tendering criteria; the payment process and contract documents for future SDM projects. Invitation-to-tender is categorised into two approaches: "open invitation" and "closed invitation". It was realised that the common, widely-used approach was "open invitation," in particular in the public sectors. Similarly, this agrees with the literature review, however, in recent years partnering has emerged as the best tool for improving project performance through strategic sharing. The chapter discussed that the performance criteria used in the SDM projects were limited to cost, quality, time and client satisfaction, while the contractor added profitability. Similarly, the preliminary study revealed time, cost, quality and client satisfaction as criteria for measuring the performance of SDM projects. This is in line with the common project performance criteria discussed in the literature which are cost, time and quality.

Tendering criteria also still depend on the lowest price regardless of other measures such as the financial power of contractors, their employment of sufficiently skilled staff and the contractor's past performance. This was highlighted through the preliminary study. There have been some attempts made to develop tendering criteria. For example, the Hong Kong Housing Authority (HKHA) (2002) developed a Preferential Bid Award System (PTAS) and a Performance Assessment Scoring System (PASS) to help in assessing contractors' bids. PTAS aims to formalise a holistic approach for assessing contractors' bids so that awarding the contract is based on both price and non-price factors. The payment process concerns all stakeholders, while a large part of the responsibility was associated with the client. This is due to the bureaucratic procedures used for processing the contractor's payments. Similarly, this agrees with the literature, where clients' financial problems affect the success of a project. Additionally, there was agreement between the research findings and the literature regarding contract documents which should be checked and assessed.

The chapter also discussed the CSFs related to construction management including: SDM project procedures; the decision-making process; communication and cooperation; the methodology for identifying, capturing, documenting and reusing LL, and the SDM project closeout report. With regard to SDM project procedures, the case studies as well as the preliminary study highlighted that there were some standardised procedures that were used in project management. However, there is a need for common standardised project procedures for SDM projects. The literature revealed that standardised processes (approach and procedure) are a key success factor in project management. Furthermore, the decision-making process was discussed in the light of the literature, where flexibility and the speed of the decision making process have a significant influence on project success as well as innovation value. The chapter also discussed the agreement between the research findings of the case studies and the preliminary study regarding the role of communication and coordination, either within or between typical SDM projects in the success of the project on hand, and this agrees with the literature on the other hand.

Additionally, the need for a methodology for identifying, capturing, documenting and re-using LL for SDM projects was clear. This is due to the situation in LL being unsatisfactory, fuzzy, unorganised and fragmented with no learning being performed in the right way, but only some individual attempts made by stakeholders in every project by using traditional methods. This was confirmed by the preliminary study. Similarly conclusions were drawn from the literature regarding systematic methods of identifying, capturing and transferring LL for future projects which are still found only in very few firms. The SDM project close-out report was discussed within the chapter where there is consensus within the literature on the role of this report in improving future projects through post-project reviews.

Furthermore, the adoption of CI in the right form did not take place, where LL are considered to be the best tool for achieving CI in SDM projects. Similarly, the preliminary study revealed that a failure to reuse LL in practice, except within a few limited situations, made it difficult to identify the impact of LL on the improvement of SDM project performance. The literature review highlighted the importance of LL in achieving CI.

A development of a framework for improving the performance of the SDM projects is the outcome of this research. This framework was developed based on the findings of four case studies besides some guidelines derived from the preliminary study and literature review. The findings of four case studies revealed fourteen CSFs affecting the process of improving the performance of SDM projects. A number of relevant frameworks to CSFs and learning have been reviewed to help in the development of a framework. Validation of a framework has been conducted in the context of SDM projects in Saudi Arabia. A workshop validation was conducted with the stakeholders who were involved in the case studies. This was found to be practical, useful and have relative clarity based on workshop results. The overall feedback was mostly positive and a few comments were delivered to be taken into consideration. The following chapter presents the conclusions, recommendations and further research.

CHAPTER 10

10 CONCLUSIONS, RECOMMENDATIONS AND FURTHER RESEARCH

10.1 INTRODUCTION

The main introduction to the research was presented in Chapter One, where the research aims to develop a framework for improving the performance of SDMs in the SMoI projects. Methodological issues were considered and appropriate research approaches were selected and justified in Chapter Two. The research process consisted of three main phases: preliminary interviews, case studies and a validation workshop. The theoretical aspects and the context within which the research was conducted were examined in Chapters Three, Four and Five.

Chapter Six presented results and analysis from the first phase of the research process. Findings from case studies conducted to further investigate the prevalence of issues in the preliminary study of the research were presented in Chapter Seven. Chapter Eight presented the development and validation of a framework for improving the performance of SDM projects. Chapter Nine presented the discussions on research findings in the light of the literature review.

This chapter presents the conclusions of the study and recommendations for future research in the context of SDMs. The chapter discusses the achievement of the research objectives in order to highlight the contributions of the research and presents the main limitations of the research. The chapter concludes with recommendations for further research that can be conducted, based on the conclusions and limitations of the study.

10.2 ACHIEVEMENT OF RESEARCH OBJECTIVES

In order to achieve the aim of the research, research objectives were developed in Chapter One. Table 10.1 summaries the methods used to achieve the research objectives.

Table 10.1: Methods used to achieve the research objectives

	Details of objective.	Method of achievement.	Chapter
1	Review the relevant literature related to project performance, learning, knowledge management (KM) and continuous improvement (CI).	Literature review of previous research and industry references.	**3** **4**
2	Examine the Saudi construction and SDM projects in Saudi Arabia in terms of production process, current status of performance and categorisation.	Literature review of previous research and the SDMs (documents, reports) in Saudi Arabia.	**5**
3	Explore the current practice of SDM projects in relation to methods of planning, control, project performance criteria and key issues affecting improvement of SDM project performance.	Preliminary interviews involving 12 semi-structured interviews with stakeholders involved in SDM projects in Saudi Arabia.	**6**
4	Identify the key Critical Success Factors (CSFs) that affect the improvement of SDM project performance.	Use of 4 case studies including Semi-structured interviews with 12 key stakeholders and documentation to investigate the Critical Success Factors (CSFs) within case studies in Saudi Arabia.	**7**
5	Develop a framework for performance improvement of the SDM projects for the SMoI.	Findings from case studies and development of themes as well as literature review and preliminary study	**8**
6	Validate the proposed framework for improving the performance of SDM projects.	Testing of developed framework through a validation workshop conducted in Saudi Arabia involving the key stakeholders who had participated in the case studies.	**8**

10.2.1 Literature Review Findings

This section discusses the literature review findings which were achieved through Objective 1 in relation to project performance, learning, KM and CI which were discussed in Chapters Three and Four. It also discusses the findings identified through Objective 2, which are concerned with SDMs.

Objective 1: Review the relevant literature related to project performance, learning, KM and CI.

This objective aimed to identify the trend of construction performance improvement in terms of tools or learning. It discussed the issues that are related to project performance improvement tools in terms of benchmarking, partnering and LL, in addition to project success criteria and identification of CSFs under three umbrellas: design development-related CSFs; contract management-related CSFs and construction-related CSFs.

The review highlighted the increasing adoption of benchmarking in many industrial sectors as a tool for improving performance, while the construction industry is still reluctant to fully adopt this tool. Partnering was highlighted as a suitable tool to be used for improving quality and efficiency rather than competitive tendering, particularly in the light of increasing the disputes among the contracting parties, and there is an urgent need to develop an appropriate procurement protocol for constructive partnerships. At this time, the construction industry, known for its fragmentation and traditional culture, lags behind other industries in terms of using LL as one of the best tools for achieving sustained continuous performance improvement. This requires creating a suitable environment within which the LL of a project will be systematically identified, captured immediately, documented, authorized, disseminated and re-used in future projects to achieve sustained project performance improvement. The review highlighted attempts over the years to improve the performance of construction projects. These attempts were necessary to address the gap between the construction industry and other industries, particularly manufacturing. This gap had been caused by the industry’s fragmentation due to ineffective processes and product development. Consequently, a call was made for standard processes and components for sustained improvement.

When reviewing the concept of project success, the literature findings revealed that there was no full agreement as to its meaning since the term comprises a wide spectrum of multi-factors. However, it is generally accepted that project success criteria can be objectively measured in terms of time, cost and quality, although arguments have been made in favour of adding to or detracting from these dimensions. Furthermore, two groups of success factors were identified based on the macro and the micro viewpoints: date of completion and client satisfaction as a macro viewpoint of project success, and the micro viewpoint of project success can be determined by the completion criterion alone. The use of Key Performance Indicators (KPIs) for measuring project success based on objective and subjective methods was also examined.

The review highlighted numerous CSFs related to different construction industry projects, such as general construction projects, design & build projects, large-scale construction projects. These CSFs were classified under three umbrellas: design-development-related; contract-management-related and construction-management-related. The design-development-related CSFs include: identification of design faults; design standardization; and communication and coordination between design and construction. The contract-management-related CSFs include: tendering-related processes and the review of contract documents. The construction-management-related CSFs include: collaborative relationships; project management; standardized project procedures; post-project review and contractor capabilities.

Through this objective the issues related to learning in terms of identifying the two common types of learning: organisation learning (OL) and learning organisation (OL), learning styles: single-loop learning (SLL); double-loop learning (DLL) and deutero-learning (DeuL) were discussed. A number of learning mechanisms were also highlighted, for instance, learning through collaborative arrangements, learning through non-collaborative arrangements and learning through networks. Learning frameworks were reviewed, such as learning in a projects-based organisation framework, which is based on three stages of learning: intra-project learning, inter-project learning, and a learning process; and project action-learning framework. It was identified that there are two broad categories of learning situations: formal and *ad hoc*. The review highlighted the role of LC as an effective tool for measuring time, cost and defects and therefore achieving performance improvement. It also examined factors affecting LC and its limitations. The importance of KM in the construction industry, its role as a key factor in business thinking, and its recent adoption in the Architecture, Engineering and Construction (AEC) industry were also examined. The focus was also placed on the role of KM in the construction industry, by reviewing and discussing the KM process, the importance of 'live' capture and the reuse of construction project knowledge. Additionally, the review discussed the types of construction project knowledge as well as the representation of knowledge. CI was reviewed and discussed through highlighting its definition, stressing the importance of CI for every organisation and the benefits that should be gained from addressing the CI programmes as a major target for organisations. The CSFs of CI and the challenges and hindrances in implementing CI programmes were also addressed.

Objective 2: Examine Saudi construction industry and SDM projects in Saudi Arabia in terms of production process, current status of performance and categorisation.

Through this objective, the performance of Saudi construction projects was examined. Many problems were addressed, which include: underachievement in project performance; breakdowns and time and cost overruns. Additionally, these problems are concerned with clients and contractors, or designers. The findings revealed that there are inconsistencies between design and construction due to many factors, such as communication gaps between contractor and designer and insufficient details in project drawings and specifications, which contributed to increasing the change orders. Contractors' performance in Saudi Arabia was discussed, and the low performance of contractors due to insufficient experience, the lack of skilled staff, and financial problems highlighted. These problems were linked to the current procurement method used in Saudi Arabia, which is based on the lowest price regardless of other measures. The production process of SDMs was reviewed and discussed, and it was realised that this approach aims to reduce design changes and to save time thereby achieving a sustainable improvement for SDM project performance through LL. The SDM approach has six phases: a comprehensive inventory and requirements phase; feedback on the requirements approach; a design phase; adaptation of SDMs to site; a tendering phase and a construction phase. The current status of SDM project performance was highlighted and the situation where, by-and-large, SDMs projects suffered from long delays and breakdowns addressed. Additionally, despite the adoption of the SDM approach, the review revealed that by-and-large, SDM projects are suffering long delays, breakdowns and increased demand by the majority of contractors for extensions to project deadlines. The reasons behind this delay were addressed as follows:

- The delay of payments paid to contractors by the client;
- The contractor's lack of skilled staff;
- The inadequate and irrelevant experience of contractors;
- Delays in approving change orders, particularly with respect to contract extensions.

No considerable performance improvement was achieved although these SDM projects are repetitive, and further, LL were not effectively in place. This justified the need for this research to develop a framework for improving the performance of SDM projects.

10.2.2 Preliminary Interviews

Objective 3: Explore the current practice of SDM projects in relation to methods of planning, control, project performance criteria and key issues affecting the improvement of SDM project performance.

Indeed, not much has been published in the area of SDM project performance in the Saudi Construction Industry. Consequently, a preliminary investigation was conducted to address the literature gap on the one hand, and to act as a precursor for the in-depth case studies of this research. This objective was met through preliminary semi-structured interviews with 12 stakeholders involved in two completed and two on-going SDM projects. The preliminary interviews highlighted time, cost and quality as project performance criteria used in SDM projects. Primavera and MS Project were identified as common planning techniques used in SDM projects, while regular reports and meetings or visits, as well as variations in the number of workers allocated in projects were used as control methods.

Additionally, the preliminary interviews addressed a number of key issues affecting the performance of SDM projects. These key issues include: the shortage of skilled contractors and the use of inexperienced contractors; the need for effective communication and coordination; standardised project procedures; and the need for design modifications. Although the adoption of SDMs facilitates learning from past mistakes that occurred in completed projects and allows these to be reused as LL in order to improve the performance of on-going and future SDM projects, the learning was limited. Two reasons were identified for the poor implementation of LL. Firstly, the use of inexperienced and unskilled contractors resulted in repetitive mistakes. Secondly, no systematic method for capturing and documenting LL was found to be re-used.

The interviews highlighted the fact that Total Quality Management (TQM) and Benchmarking are not used in the SDM projects, while the LL were considered to be a suitable tool for achieving CI for SDM project performance due to their repetitive nature. Preliminary Interviews indicated that there are important key issues that should be part of the proposed improvement framework such as design modifications and development; development of material specifications; communication and coordination and the tendering process. Additionally, the findings highlighted the suitability of the Police Department (PD) as a case study for this research. This is because of the following reasons: the availability of completed projects of this category; the availability of on-going projects of this category which were underway during the data collection stage; and the existence of 200 PD-SDM among SMoI future projects planned to be implemented over the next twenty years.

10.2.3 Case Studies

Objective 4: Identify the key Critical Success Factors (CSFs) that affect the improvement of SDM project performance.

This objective aimed to identify the CSFs affecting the improvement of SDM project performance. This objective was achieved through conducting four case studies using two methods. Semi-structured interviews were held with 12 key stakeholders involved in the implementation of SDM projects. It also includes relevant documents including: tendering documents, the project contract document, financial requests, minutes of meetings, modification requests, disseminated documents and the project handover to end-user document. The case studies identified 14 CSFs that are classified into three main themes: Adaptability of the SDMs to context–related–CSFs; Contract management–related–CSFs; and Construction management–related–CSFs.

Adaptability of the SDMs to context–related–CSFs include: the need for an effective collaboration between the design and supervision departments to encourage collective learning; continuous design modification as well as material specifications amendments; the need to establish a central database to store the LL and dissemination of LL through Information Technology (IT) to maintain performance improvement for all SDM projects.

Contract management–related–CSFs include: invitations to tender based on closed invitations to attract selected contractors; comprehensive tendering criteria for selection of contractor rather than the currently-used lowest price criterion; the need for a more flexible payment process; a continuous assessment of contract documents based on LL for sustained improvement for future SDM projects.

Construction management–related–CSFs include: standardised procedures to facilitate the flow of work; improvements in the decision–making process to encourage learning and innovation; the need for more effective communication and coordination either intra-project or inter-SDM projects to facilitate transferring skills and experiences; the need for a methodology for identifying, capturing, documenting and reusing LL and the SDM project close-out report to assess every aspect of a project in order to improve future SDM projects. Additionally, the interviews highlighted the situation of CI in SDM projects and how it could be improved through focusing on the use of LL as an appropriate tool. The SDM project performance criteria were highlighted. However, the investigation highlighted the need to develop a comprehensive framework that comprises the three components involving CSFs to achieve improvements in the performance of SDM projects through learning.

10.2.4 Framework Development and Validation

Objective 5: Develop a framework for performance improvement of the SDM projects for the SMoI.

The achievement of objective 4 highlighted that improvement of SDM project performance was influenced by the identified CSFs. The development of the framework, set as objective 5, was principally based on the three key components of the CSFs. Additionally, some guidelines derived from the preliminary study and literature review were used in developing the framework.

The framework, presented in Chapter Eight, presents a holistic picture of the connected components that influence the SDM project performance improvement process. The framework, as shown in Figure 8.2, comprises four phases in the form of chronological sequences. Each phase comprises one component. These phases are: design modification (Adaptability of SDMs to context); the pre-construction (Contract Management); the construction (Construction Management); and the post-project audit (LL, Database and LC). The sharing of knowledge between the framework components is necessary to ensure maintaining improvement processes. This could be achieved through circulating the captured knowledge across the three connected components in order to achieve an integrated improvement of SDM project performance in both on-going and future projects over the long-term plan. It draws attention to the research target, presented in Chapter 1, on the need to be comprehensive in dealing with improving the performance of SDMs in the SMoI projects.

Objective 6: Validate the proposed framework for improving the performance of SDM projects.

This objective was achieved through testing the framework which was developed to address Objective 5. The aim of the validation process was to assess the appropriateness and workability of the improvement framework and ascertain whether the Framework developed captured all the CSFs affecting the improvement process of SDM project performance. The validation activity, presented in Chapter Eight, was conducted by means of a workshop held in the context of SDM projects in Saudi Arabia involving nine key stakeholders who participated in the case studies.

The validation workshop revealed that the framework adequately highlighted CSFs affecting the improvement of the performance of SDM projects, and identified a number of essential features, such as knowledge-sharing, provision of the stages needed to improve SDM project performance, support for performance improvement for future projects and assessment of the level of improvement achieved. The validation results showed that the practicality, appropriateness and clarity of the framework were highly adequate as shown by the high rating consensus from all participants (4.0, 4.7, and 4.8 respectively). The validation results also showed that there was a high level of agreement regarding the identified CSFs affecting the improvement of SDM project performance as well as identifying these factors through good practice. The workshop delegates concurred that the use of a web-based tool and KM would be the more appropriate implementation strategy/tool for the framework.

A framework implementation guide was also discussed and the key implementation stages were identified. It would, nevertheless, provide a significant step towards improving the performance of SDM projects if the guide is followed carefully, in particular by the client, and in general by all the stakeholders involved in the implementation of SDM projects. It is expected that the stakeholders who will implement the improvement Framework would appreciate the complex nature of the relationships between the 3 components of improvement when they are organising the improvement process. Additionally, a training workshop for staff involved in the SDM projects is suggested in order to introduce the learning concept, its importance, tools, process and improve the learning skills of staff as well the task assigned to every participant in the learning process.

10.3 CONTRIBUTIONS TO KNOWLEDGE

Overall, the major achievements of this research in terms of contribution to knowledge fall into two main categories: theory and industry.

10.3.1 Contributions to Theory

- The literature review revealed that there are increasing numbers of research findings on project performance improvement particularly through learning. This is in response to the call for the construction industry to move towards the need for design to be properly integrated with construction and performance in use, standardisation of products and processes, radical improvement in the process of construction to achieve sustained improvement and sharing learning, as emphasised in the UK government reviews by Egan (1988) and Latham (1994). Through the standardisation of products and process, there are many lessons to be learnt leading to sustained performance improvement in future projects. A further contribution has been the identification of the importance of knowledge management (KM) to produce shared and reused knowledge for future projects to stop the lessons learnt 'bleeding away'. The research stressed the relationship between effective learning and continuous improvement (CI) and underlined the importance of rooting the concept of CI. This research contributed to the body of knowledge by identifying the various CSFs related to repetitive construction projects which influence project performance improvement in the form of three phases: design, pre-construction and construction.

- The research highlighted the issues affecting the performance of the Saudi construction industry in terms of the use of current procurement methods as well as contractors' performance. This research provided a valuable insight into SDMs, in the light of the lack of publications in this field. Great efforts were made to provide a comprehensive review in relation to the SDM approach with respect to the expected benefits, the SDM production process, the adaptability of SDM designs to context, the tendering phase and the construction phase. This research explored the design adaptability of SDMs to context as a novel implement in Saudi Arabia in contrast to the traditional procurement action practice system. Additionally, the research explored the current performance of SDM projects to address the issues affecting the performance underachievement. Consequently, despite the adoption of the SDM approach, performance was still unsatisfactory. This provided a justification for conducting this research to develop a framework for improving the performance of SDMs.

- A further contribution was provided through analysis of preliminary semi-structured interviews held with 12 key stakeholders who are involved in the SDM projects. The preliminary investigation explored the criteria used in SDM projects, control and planning methods and addressed the serious issues related to LL in SDM. A further contribution took the form of a detailed analysis of stakeholders' views through an in-depth, twofold, qualitative investigation. The investigation identified the CSFs affecting the improvement process of SDM project performance. There was a limited number of publications on such types of projects compared with other studies that identified CSFs for different projects, such as general construction projects (Ashley et al. 1987; Pinto and Slevin 1988; Savindo et al. 1992; Chua et al. 1999; Egbu 1999; Phua and Rowlinson 2004; Fortune and White 2006) and design-build projects (Chan et al. 2001; Songer and Molenaar 1997; Ng and Mo 1997).

- The research proposed a framework for improving the performance of SDM projects based on learning, which was tested through a validation workshop conduced in the context of SDMs in Saudi Arabia. The use of the Learning Curve (LC) as a tool for measuring the improvement achieved was based on accumulative learning and performance over the implementation of the SDM approach as a novel implement in this framework. The research provided a comprehensive implementation strategy for using the improvement framework. This includes identifying an overview of each issue of improvement, the objective in tackling each issue, tools/procedures, requirements and strategies for implementation, the expected outcome of the improvement process and the necessary assessment of the improvement process. Web-based tools and KM are crucial factors in the implementation strategy.

10.3.2 Contributions to Industry and Practice

- The research showed that the SMoI experience of adopting the standardisation of design and processes through an SDM approach led to sustained performance improvement through learning from past mistakes.

- Modern methods of construction prefabrication could be adopted in the context of SDM projects to improve the programme in terms of reduction of costs, time, defects and consequently productivity. Additionally, the use of prefabrication provides potential benefits in relation to environment, economy and the social when compared to conventional construction methods.

- The research highlighted the inexperienced and unskilled contractor as a major reason behind the underachievement of Saudi construction performance. This could contribute towards the re-assessment of the contractor selection process which is based on the lowest price regardless of other measures such as experience, past performance and the availability of skilled staff.

- The research contributed towards the debate and efforts to encourage design of projects for ease of construction making maximum use of standardisation of design, material specifications and processes.

- A further contribution has been the identification of the tangible benefits of using the SDM approach for replacing competitive tendering with long-term relationships based on clear measurement of performance and sustained improvements in quality and efficiency through LL. Indeed, competitive tendering problems could be reduced by long-term relationships within the SDM approach.

- One of the key issues that this research sought to address was to explore how SDM project performance can be improved. The improvement trajectory was low despite the adoption of an SDM approach. A further contribution highlighted the occurrence of repetitive mistakes in design and specifications from project to project. The research also identified that there was less commitment to learning, consequently, the focus on learning was limited, unorganised and fragmented. Furthermore, the LL achieved through implementation of SDM projects were few and restricted to specific regions. This issue was addressed to attract the attention of the SMoI to re-assess their current practices and facilitate and encourage the learning concept and culture among stakeholders through benefiting from the opportunity of LL provided by the SDM approach for achieving sustained performance improvement. Therefore, a carefully planned engagement process should facilitate the process of building a clear methodology for identifying, capturing, documenting and reusing LL for on-going and future SDM projects. This process should be based on a common vision and mission and enhance the training and commitment to learning. It should promote better learning in order to share in the process of performance improvement.

- The research contributed to highlighting the need for an integrated improvement process through the three stages: design adaptation of SDMs to context, contract management and construction management in order to facilitate the application of learning in SDM projects. The research contributed to the debate on the importance of communication and coordination between stakeholders as a tool for exchanging experiences and skills - both intra-project and inter-project - in order to increase knowledge sharing. A further contribution highlighted the need for the SMoI to improve the procurement method for selecting the qualified contractors with the necessary skills, experiences and resources to deliver best value projects. The research contributed to the identification of the limitations of using advanced technology, such as an intranet, within the SDM projects. Additionally, the research highlighted the CSFs affecting the process of improving the performance of SDM projects through LL, and how these factors could be identified through good practice.

- The SDM approach provides a suitable environment for achieving continuous performance improvement for SDM projects through LL over time. Consequently, the framework developed in this research was tested through a workshop to ensure its practicality, clarity and appropriateness in practice. The research contributed to the proposal of an implementation strategy that helps in facilitating the application of the improvement framework. This could help the improvement of SDM project performance to be managed in a proactive rather than a reactive way, and will ensure that SDM projects are adequately managed to maintain a sustained performance improvement.

10.4 RESEARCH LIMITATIONS

This research has limitations in terms of its conduct and scope as briefly outlined below:

- Although there have been a number of publications in relation to project performance and project success, none has been written mainly about SDM projects and there is limited information on this topic;
- The research was limited to the SMoI projects (governmental sector) in Saudi Arabia due to the availability of such types of projects and the data sources needed;
- Preliminary study was limited to four different categories of SDMs;
- The investigation to identify CSFs related to SDM projects was limited to the perspectives of representatives of clients, consultants and contractors;
- The case studies were conducted within four SDM projects, two completed and two on-going, due to the availability of this category of SDM as well as the key stakeholders involved in these cases; and the case studies were limited to the category of the Police Department (PD); and
- The identification of the CSFs were limited to those affecting the improvement of SDM project performance, therefore, the findings are contextual and cannot apply to the construction industry as a whole.
- Because of the SDM projects are located in different regions over a wide area of Saudi Arabia, workshop validation was conducted in one region and was limited to nine participants.

10.5 RECOMMENDATIONS FOR FURTHER RESEARCH

Based on the limitations of this research outlined in Section 10.4 above, some of the key relevant issues that require further research are recommended below.

1. The operation and maintenance stage of SDM buildings is not included in this research. Further research is required to develop a framework for improving the operation and maintenance performance based on the end-user's view. This would serve as a feedback channel to be used in the design adaptation of the SDM stage in order to achieve more efficiency and quality for future SDM buildings.

2. Further research is required to assess the impact of the tendering system used in the Saudi construction industry on the performance of SDM projects. In addition, research using accumulative experiences, skills and familiarity with SDM projects captured over the long term should address the extent of adopting long-term relationships in order to achieve a sustainable performance improvement.

3. Further research is required to develop a learning strategy in the SDM projects including assessment of the impact of culture, skills and training of staff on implanting this strategy during the implementation of SDM projects in order to move towards becoming a learning organisation.

4. Using technology-based solutions for capturing, validating and storing the knowledge captured during the implementation of SDM projects facilitates the possible re-use on future SDM projects. The captured knowledge can cover process, cost, performance, lessons, contractors, consultants, suppliers, skills, experience and expertise.

5. This research identified the CSFs for improving SDM project performance. However, further research is required to identify the specific Key Performance Indicators (KPIs) for SDM projects used in the SMoI in Saudi Arabia.

6. This research was conducted within the context of the SMoI projects, and further research is required to investigate the applicability of adopting the SMoI experience by adopting the SDM approach in the Saudi governmental and private sectors.

7. The research findings revealed that, due to the nature of the SDM approach where there are number of repetitive SDM projects being implemented simultaneously, further research is required to develop a methodology for "live" capture and reuse of SDM project knowledge.

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APPENDICES

Appendix A: List of Publications Arising from the Research

Forthcoming Refereed Journal Publications

1. Al-Otaibi, S., Osmani, M., Price, A.D. A framework for Improving Project Performance of Standard Design Models in Saudi Arabia. *Journal of Construction Engineering and Management.*
2. Al-Otaibi, S., Osmani, M., Price, A.D. Critical Success Factors for Standard Design Model Projects in the Saudi Construction Projects. *Engineering, Construction and Architectural Management.*

Conference Proceedings

3. Al-Otaibi, S., Osmani, M., Price, A.D., 2007. Approach of standard design models in the Saudi Ministry of Interior projects. Egbu, C., Tong, M. Proceedings of The Third Scottish Conference for Post Graduate Researchers of the Built and Natural Environment - PRoBE, Glasgow, November 2007, 55-65, ISSN1905866178.

4. Al-Otaibi, S., Osmani, M., Price, A.D.F., 2008. A standard design model as an enabler for project management competency: the Saudi construction experience, ICoPM 2008 International Conference on Project Management, Faculty of the Built Environment, University of Malaya, Malaysia, 18 – 20 Nov 2008.
5. Al-Otaibi, S., Osmani, M., Price, A.D.F., 2008. An investigation into standard design project performance: the Saudi Ministry of Interior experience, SiiC 2008 Saudi International Innovation Conference, University of Leeds, 9 – 10 June 2008, ISBN: 978 0 9559241 0 1.
6. A working paper has been written, submitted and reviewed for potential publication in SiiC, 2010 Saudi International Innovation Conference, "The Impact of Contractors' Qualifications on Continuous Project Performance Improvement in the Standard Design Models in the Saudi Ministry of the Interior Projects" (Al-Otaibi, S., Osmani, M., Price, A.D.F., 2010).

Appendix B: List of SDMs

B - List of SDMs

Group 1 of Administrative Projects (9807)

Bldg. No	Bldg. Name	MOI Area	Qty
1-070	Police Department	3,084	300
1-090	Police Station	1,422	250
1-100	Police Check Point	490	60
1-130	High Way Patrol Dispatch Center	1,246	289
1-010	Regional Police Building	9,037	5
1-020	City Police Category A	14,132	2
1-030	City Police Category B	9,271	2
1-120	High Way Patrol Command	1,878	90
1-150	Drug Enforcement Administration	6.872	14
1-170	Drug Enforcement Section	2,500	12
1-040	City Police Category C	7,885	3
1-050	City Police Category D	6,713	3
1-060	City Police Category E	6,694	5
1-110	High Way Security Force Command	4,570	13
1-140	Facilities Security Task Force in Region Category B	2,630	2
1-160	Drug Enforcement Division	5,421	4
1-180	Drug Enforcement Unit	1,490	16
1-190	Tele- Communication Division	3,240	2
1-200	Tele- Communication Section	2,259	3
1-210	Tele- Communication Unit	1,590	5
1-220	Tele- Communication Head Quarters Branch	1,091	2
1-230	Ministry Communication Bureau Category A	2,645	3
1-240	Ministry Communication Bureau Category B	1,920	2

Group 2 of Administrative Projects (9808)

Bldg. No	Bldg. Name	MOI Areas	Qty
2-050	Civil Defense Center Category A	2,965	84
2-060	Civil Defense Center Category B	2,326	180
2-070	Civil Defense Squad in Cities and Provinces	1,786	230
2-010	Civil Defense Directorate for Region Category A	4,886	9
2-020	Civil Defense Directorate for Region Category B	3,596	6
2-030	Civil Defense Administration in Cities and Provinces Category A	4,325	25
2-040	Civil Defense Administration in Cities and Provinces Category B	3,618	76
2-130	Border Check Point (Directorate General of Border Guard)	768	45
2-180	Administrative Building -1 Category C	8,355	10
2-190	Administrative Building -1 Category D	6,187	31
2-160	Administrative Building -1 Category A	17,180	3
2170	Administrative Building-1 Category B	12,024	7
2-200	Administrative Building -1 Category E	820	18
2-210	Administrative Building -2 Category A	12,985	4
2-220	Department of Logistics and Supplies Building	9,330	5
2-230	Administrative Building -2 Category C	6,192	7
2-240	Communication Administration	1,541	5
2-080	Civil defense Communication Branches	3,631	10
2-090	Civil defense Communication Units		
2-100	Civil Defense Heliports	13,482	4
2-110	Regional Command (Directorate General of Border Guard)	25,432	6
2-120	Sector Command (Directorate General of Border Guard)	6,240	6
2-140	Security Unit (Directorate General of Border Guard)	2,660	4
2-150	Operation Room (Directorate General of Border Guard)	320	8
2-250	Administration Branch category A (Mojahedeen general Directorate)	1,645	2
2-260	Administration Branch category B (Mojahedeen general Directorate)	1,085	10
2-270	Guard station (Mojahedeen General Directorate)	305	43

Group 3 of Administrative Projects (9809)

Bldg. No	Bldg. Name	MOI Areas	Qty
3-020	Governorate Building Complex Category (A-1)	10,500	3
3-030	Governaorate Building Complex Category (A-2)	6,450	15
3-040	Governaorate Building Complex Category A-2, catg. B-1	3,650	40
3-050	Governaorate Building Complex Category B-2	3,030	30
3-060	Center Complex Category A-1	1.228	30
3-070	Center Complex Category A-2, Category B	880	776
3-080	Civil Affairs Category A	4,425	6
3-090	Civil Affairs Category B	3,344	7
3-110	Civil Affairs Category D	1,500	64
3-130	Regional Passport Bureau Category B	4,990	17
3-160	Deportation Administration Category A	7,835	3
3-180	Investigation Authority Branch in Region A	9,126	3
3-190	Investigation Authority Branch in Region B	5,291	13
3-010	Regional Principality Complex	18,301	5
3-100	Civil Affairs Category C	2,077	16
3-200	Investigation General Procecution Circuit Category A	3,075	13
3-210	Investigation General Procecution Circuit Category B	2,431	46
3-220	Investigation General Procecution Circuit Category C	1,547	41
3-120	Regional Passport Bureau Category A	24,225	2
3-140	Regional Passport Bureau and Deportation Administration Category C	2,900	20
3-150	Access Passport Control	640	2
3-170	Deportation Administration Category B	2,540	14
3-230	National Security Council Branch	2,600	2
3-240	Industrial Safety, High Commission Branch	950	2
3-250	Recruitment Affairs Bureau Branch	4,535	5
3-260	Projects General Administration Branch	1,160	4


01/01/2004

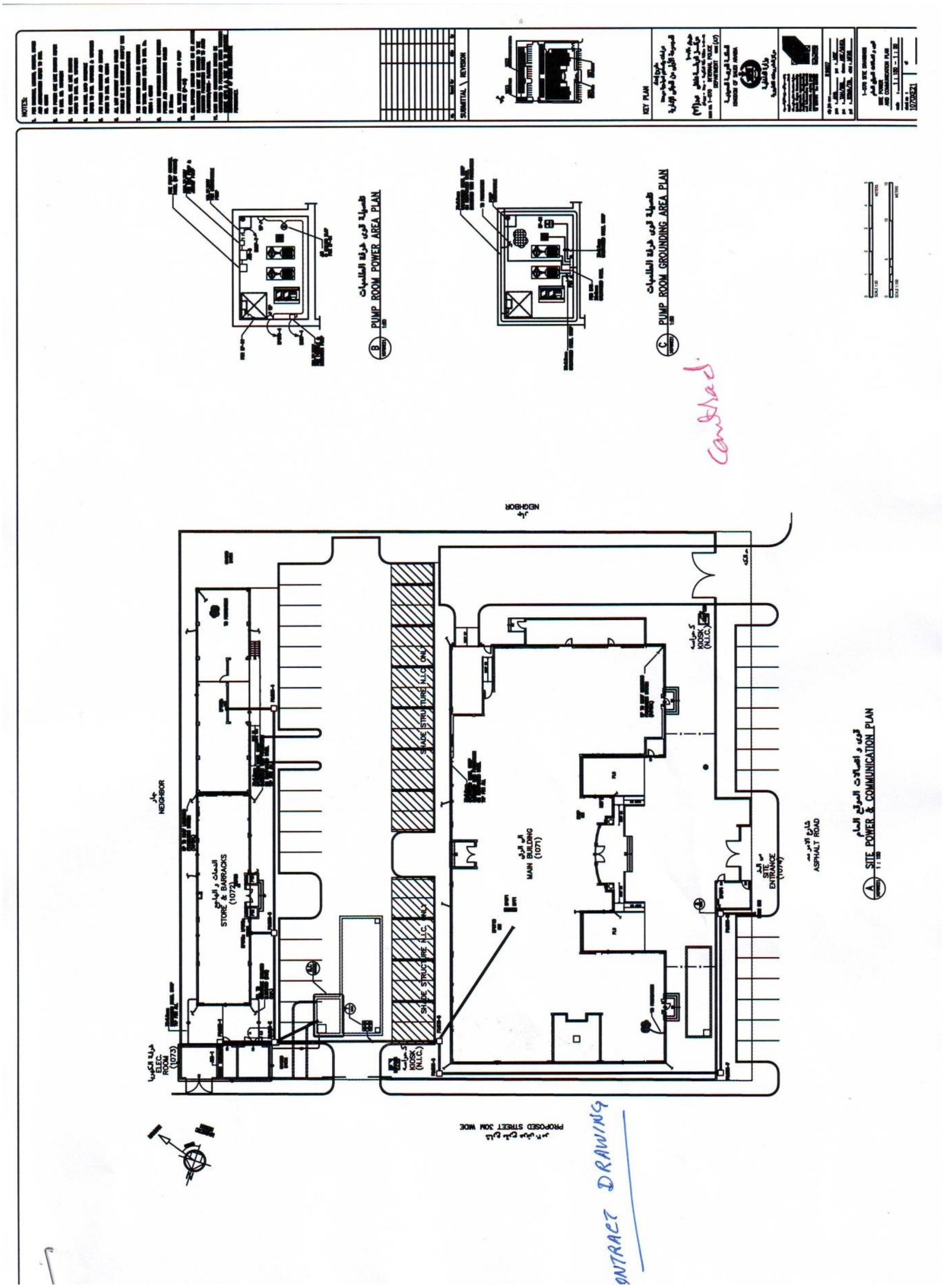
SDM Police Departments

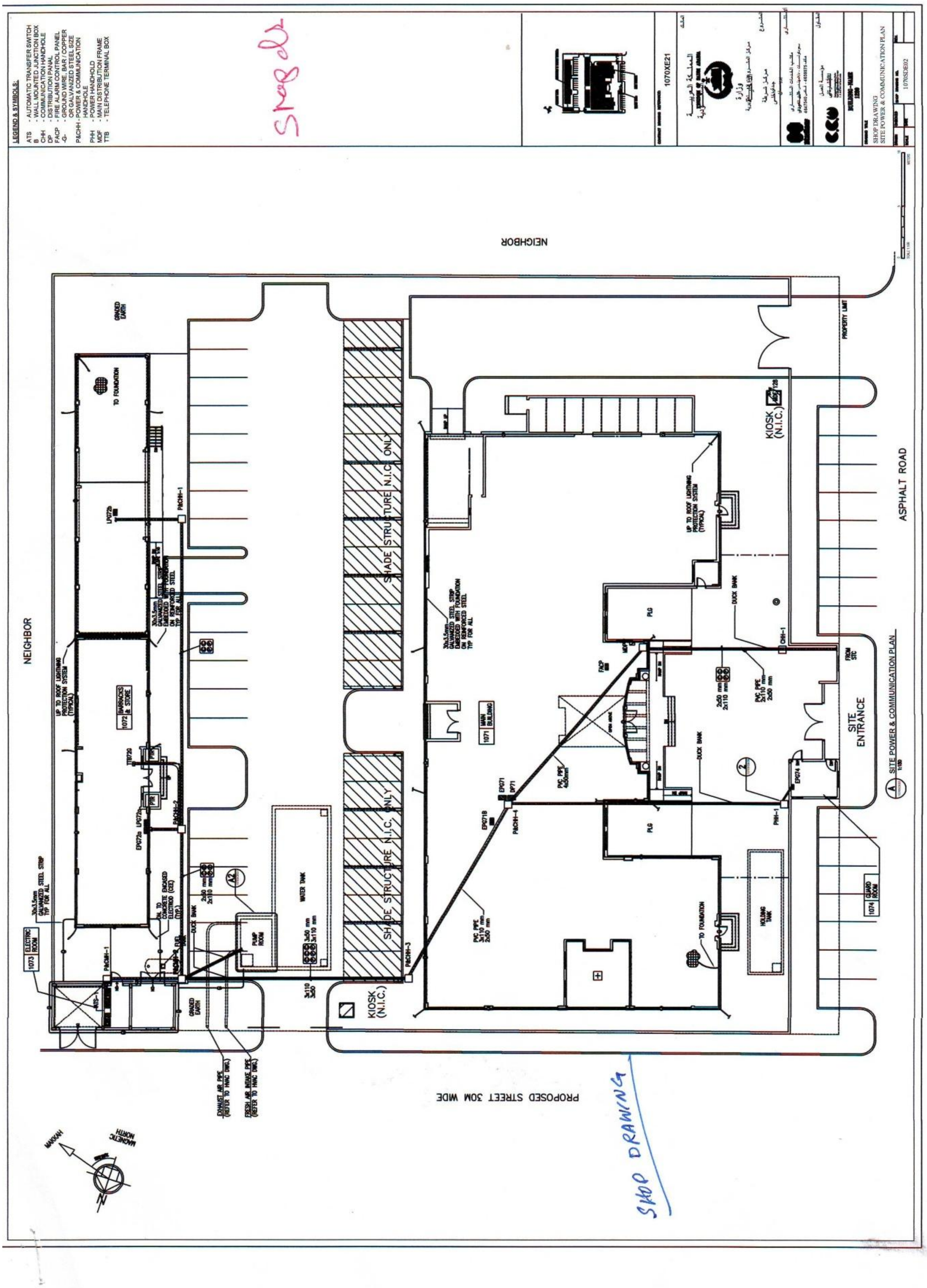
Civil Defence Centre Category A

SDM Hospital


مستوصف قوى الأمن الداخلي
- التكاليف المعتمدة لكل
مستوصف = ١٠ ٠٠٠ ٠٠٠ ريال.
عناصر المشروع
المبنى الرئيسي ويتكون من :
- مكتب مدير المركز ويشتمل(المكتب الرئيسي,سكرتارية,صالةاجتماعات)
- مكتب مساعد مدير المركز
- مكاتب ادارية متعددة المهام
- قسم العيادات الخارجية وتشتمل التخصصات التالية (عيادات العيون
الاسنان, أنف وأذن وحنجرة, جلدية, الباطنية,تقويم الاعضاء
أمراض القلب, النسائية, عيادة الأطفال, عيادة الطب المناعي)
- قسم الطوارئ ويشتمل على(غرفة الانعاش,استقبال طوارئ,عمليات صغرى)
انتظار رجال ونساء,غرفة التنفس الصناعي,غرفةمعاينة للرجال والنساء)
- قسم المختبر (المختبرالرئيسي,مختبرميكروبولوجي,غرفةتحضيرالعينات)
- بنك الدم ويشتمل(غرفة أخذ عينات الدم للرجال والنساء,غرفة التبرع)
- قسم الأشعة ويشتمل(غرفةأشعة X,غرفةالتطهير,غرفةاستقبال المريض)
- الخدمات الطبية(كاونتر المرضات,الصيدلية,مستودعات,الملفات الطبية)
- خدمات عامة(مصلى رجال ونساءالبهو الرئيسي,اماكن انتظار رجال ونساء)
الموقع العام
غرف الخدمات
البوابة و غرف الحراسة

SDM Clinic


PUMP ROOM POWER AREA PLAN
PUMP ROOM GROUNDING AREA PLAN
SITE POWER & COMMUNICATION PLAN
NEIGHBOR
STORE & BARRACKS (1072)
MAIN BUILDING (1071)
ELEC. ROOM (1073)
SITE ENTRANCE (1074)
ASPHALT ROAD
PROPOSED STREET 30M WIDE
SHADE STRUCTURE N.I.C. ONLY
KIOSK (N.I.C.)
KEY PLAN
NOTES:



SDM Police Department Drawings

Appendix C: Template of Semi-Structured Preliminary Interviews

Preliminary Interviews

1- Background of SDMs' projects

<table>
<tr><td>CITY:</td><td></td><td rowspan="2">REGION NAME:</td><td rowspan="2"></td></tr>
<tr><td>Project Title:</td><td></td></tr>
<tr><td>Date of inception:</td><td></td><td>Date of completion:</td><td></td></tr>
</table>

2- Background of Respondents:

Q1: What is your job title?

Q2: What organisation do you work for? (Client, Consultant, Contractor)?

Q3: How long have you been working in the construction industry?

Q4: How long have you been working for your current organisation?

3- Success Criteria for Project and Organisation

Q1: What are the main criteria used for determining performance of this project?

Q2: Define each of the criteria identified above?

Q3: On the basis of the criteria identified above, how would you assess the performance of this project?

Q4: What are the positive impacts of measuring project performance?

Q5: What are the barriers/hindrances that affect achievement of successful project performance?

Q6: What are the projects planning methods being used on this project?

Q7: What are the project control methods being used on this project?

Q8: What lessons you have learnt on this project and how can they be used in future projects?

Q9: What lessons did you learn from previous projects that can be reused in this and future projects?

4- Key ways : improving project performance

Q1: What are tools and techniques used for ensuring continuous performance improvement on this project?

Q2: What benefits do you expect from continuous improvement?

Q3: What would you expect to be in a continuous improvement framework? Are there components involved?

Q4: What SDMs' projects are available to be used for conducting as a case study?

Q5: Are there other issues/comments regarding SDMs' project performance that you would like to add?

Appendix D: Template for Semi-Structured Interviews for Case Studies

Interviews for Case Studies

Interview Meeting Form

Name:………………………………....... **Date:…………………….**

Company/Organisation:…………………………………………………………...

Position:…………………………………… **Telephone:……………….**

Address:……………………………………………………………………………….

Type of project:…………………………... **Status of project:……………….**

==

Personal Background:

Q1-1: Title of your current position

Q1-2: Years of experience:

Q1-3: State in which of the following capacities you are involved?

- Client
- Consultant
- Contractor

==

2- SDM Projects Performance Improvement

Q1: What is the procurement method used in the SDM projects?

Q2: To what extent is the payment process in the SDM projects standardised?

Q3: How could you describe the improvement achieved in contract documents as a result of LL?

Q4: How could you identify the role of H.O design and supervision departments in activating LL for the SDM projects?

Q5: To what extent was performance improvement achieved in the light of adopting SDM projects through LL?

Q6: How are LL documented and saved to be shared and reused for on-going and future SDM projects?

Q7: How are captured LL disseminated to on-going and future SDM projects?

Q8: To what extent are SDM project-procedures standardised?

Q9: How do you describe the level of decision-making process entrusted to project management?

Q10: How could you identify suitable and effective methods that could be used for exchanging skills and experiences between SDM projects?

Q11: How would you describe the current methodology used for organising LL in SDM projects?

===

(END OF INTERVIEW)

Appendix E: Validation Workshop

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING
LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

Validation Form

A FRAMEWORK FOR IMPROVING THE PERFORMANCE OF STANDARD DESIGN MODELS IN THE SAUDI MINISTRY OF INTERIOR PROJECTS

By

Shabbab Al-Otaibi

Under the Supervision of
Prof. A. Price and M. Osmani

2009

A FRAMEWORK FOR IMPROVING THE PERFORMANCE OF STANDARD DESIGN MODELS IN THE SAUDI MINISTRY OF INTERIOR PROJECTS

VALIDATION SHEET

Section A – Respondent Background

Organisation Type: Client/ Consultant/ Contractor/ University/ Others…………………………

Position: ………………………………………

Section B – Proposed Framework

Please read the accompanied attachment on **"SDM' project performance improvement framework"** and kindly answer the following questions. (Please circle the appropriate option)

PROPOSED FRAMEWORK Do you agree that the proposed framework is:	**Ranking** 1 = strongly disagree & 5 = strongly agree				
	1	2	3	4	5
1. having provision of stages needed to improve SDM' project performance					
2. a comprehensive coverage of SDM' project performance CSFs					
3. providing/sharing knowledge					
4.based on LL needed as a tool for improvement SDMs' projects performance					
5. supporting for knowledge management					
6. enabling the assessment and measurement of achieved improvement for SDMs' projects performance					
7. having a structured methodology for improving SDM' project performance					
8. supporting performance improvement for future SDMs' projects					
9. providing potential learning					

PROPOSED FRAMEWORK Please rate the following aspects of the improvement framework.	**Ranking** 1 = very weak & 5 = very strong				
	1	2	3	4	5
1. Practicality of the framework					
2. Appropriateness of the framework					
3. Clarity of the framework					

Q. Are there any changes/improvements you would suggest to the Improvement Framework for SDMs' Projects Performance?

<u>Section C – Validation of CSFs</u>

	Validation of CSFs **Q1. To what extent do you agree with the collar statement:**	**Ranking** 1 = strongly disagree 2 = disagree 3 = neither agree nor disagree 4 = agree 5 = strongly agree				
		1	2	3	4	5
Contextualise the Design Model to Context	1. developing the collaboration between the Design and Supervision departments in the H.O is a CSF					
	2. the need to design modification is CSF					
	3. the need to material specification amendment is CSF					
	4. establishing a central database and using KM are CSFs					
	5. the dissemination of LL to SDMs' projects through availability of easy access and the use of knowledge are CSFs					
Contracts Managemen t	6. developing invitation to tendering is CSF					
	7. developing tendering criteria is CSF					
	8. improving payment process is CSF					
	9. reviewing estimated cost for future projects, and reviewing contract documents (terms & conditions, BoQ) are CSFs					
Construction Management	10. standardised project procedures is CSF					
	11. improving the decision–making process is a CSF					
	12. encouragement and motivation for effective communication and coordination between all typical SDMs' projects is CSF					
	13. The need for a methodology for identifying, capturing, documenting and reusing LL is a CSF					
	14. producing project close out report involving LL is CSF					

Section D – Validation of CSFs as identified through good practice

	Do you agree that CSFs could be identified through a good practice: :	**Ranking** 1 = strongly disagree 2 = disagree 3 = neither agree nor disagree 4 = agree 5 = strongly agree				
		1	2	3	4	5
Contextualise the Design Model to Context	1. developing the collaboration between The Design and Supervision Departments at the H.O could be identified through good practice as a CSF					
	2. the need for design modification and development could be identified through good practice					
	3. the need for material specification amendments could be identified through good practice as a CSF					
	4. establishing a central database and using KM could be identified through good practice as a CSF					
	5. the dissemination of LL to SDMs' projects through the availability of easy access and the use of knowledge could be identified through good practice as a CSF					
Contracts Management	6. developing the invitation to tender could be identified through good practice as a CSF					
	7. developing tendering criteria could be identified through good practice as a CSF					
	8. improving the payment process could be identified through good practice as a CSF					
	9. reviewing the estimated cost for future projects, and reviewing contract documents (terms& conditions, BoQ) could be identified through good practice as a CSF					
Construction Management	10. standardised project procedures could be identified through good practice as a CSF					
	11. improving the decision–making process could be identified through good practice as a CSF					
	12. encouragement and motivation for effective communication between all typical projects could be identified through good practice as a CSF					
	13. the need for a methodology for identifying, capturing, documenting and reusing LL could be identified through good practice as a CSF					
	14. producing a project closeout report involving LL could be identified through good practice as a CSF					

Section F – Validation of the Framework Implementation Strategy

Do you agree that the framework can be implemented through:	**Ranking** 1 = strongly disagree & 5 = strongly agree				
	1	2	3	4	5
1. web based tool					
2. manual project file					
3. knowledge Management (KM)					
4. existing KM					

Framework Implementation Guide

► Task 1 (individual): 30 minutes

- Write down an overview of each identified issue
- Write down the objective of each identified issue
- Write down tools/requirements needed for implementing the improvement framework
- Write down the appropriate procedures that should be followed for distributing the responsibilities for implementation strategy
- Write down 3-4 major difficulties that might hinder generalising implementation of the improvement framework
- Write down improvement target/expected outcome and the way of assessment
- Write down any further suggestions associated with the implementation strategy
- Place your Post-it notes on your group notice board

Thank you for accepting this invitation and your effective cooperation

Framework Implementation Guide

	Adaptability of SDMs to Context	Contract Management	Construction Management	Assessment of SDM' project Performance Improvement
Phase	**Design modification**	**Pre-construction**	**Construction**	
Overview				
Objective				
Details of processes, procedures, tools checks and strategies				
Improvement target/anticipated outcome				

Table E1: Validation Results of the Improvement Framework

IMPROVEMENT FRAMEWORK ASSESSMENT										
	1 = strongly disagree & 5 = strongly agree									
Questions	**Participants' score**									**Average Score**
	A1	**A2**	**A3**	**B1**	**B2**	**B3**	**C1**	**C2**	**C3**	
1. Provision of stages needed to improve SDM' project performance	4	5	4	5	5	5	5	5	4	4.7
2. Comprehensive coverage of SDM' project performance CSFs	5	5	4	5	4	4	4	5	3	4.3
3. Providing/sharing knowledge	4	5	5	5	5	4	4	4	4	4.4
4. Lessons learnt needed as a tool for improvement process	5	5	4	4	5	5	5	5	5	4.8
5. Support for knowledge management	5	5	5	4	5	5	4	4	3	4.4
6. SDM' project performance improvement is assessed and measured	5	5	5	4	4	5	4	5	5	4.7
7. Structured methodology for improving SDM' project performance	4	5	4	5	5	5	4	4	5	4.6
8. Supports performance improvement for future projects	5	5	5	5	5	4	5	5	4	4.8
9. Providing potential learning	5	5	5	4	5	5	5	5	4	4.8
General aspects of framework	1 = very weak & 5 = very strong									
1. Practicality of the framework	3	4	4	5	4	5	4	4	3	4
2. appropriateness of the framework	4	5	4	5	5	5	5	5	4	4.7
3. Clarity of the framework	4	5	4	5	5	5	5	5	5	4.8

Table E2: Validation Results of CSFs of Improvement on SDM Project Performance

	Validation of CSFs 1 = strongly disagree & 5 = strongly agree										
	Questions	**Participants' score**									**Average Score**
		A1	**A2**	**A3**	**B1**	**B2**	**B3**	**C1**	**C2**	**C3**	
Adaptability of the SDMs to Context	1. Developing the collaboration between the Design and Supervision departments in the H.O is a CSF	4	5	5	5	5	4	5	5	5	4.8
	2. The need for design modification and development is a CSF	4	5	5	5	5	4	4	5	4	4.6
	3. The need for material specification amendments is a CSF	4	5	4	4	5	4	5	4	4	4.3
	4. Establishing a central database is a CSF	5	5	4	5	5	4	4	5	4	4.6
	5. The dissemination of LL is a CSF	5	5	5	5	5	4	3	4	4	4.4
Contract Management	6. Developing the invitation to tender is a CSF	5	5	4	5	5	4	4	5	3	4.4
	7. Developing tendering criteria is a CSF	5	5	5	5	5	4	5	5	4	4.8
	8. Improving payment process is a CSF	5	5	5	5	5	4	4	4	4	4.6
	9. Reviewing contract documents (cost estimation, review of BoQ and terms and conditions) for future SDM projects is a CSF	4	5	5	5	4	4	5	5	4	4.6
Construction Management	10. Standardised SDM' project procedures is a CSF	5	5	4	4	4	5	3	4	4	4.2
	11. Improving the decision–making process is a CSF	5	5	5	5	4	5	4	4	4	4.6
	12. Encouragement and motivation for effective communication between all typical projects is a CSF	5	5	5	5	4	5	4	5	4	4.7
	13.The need for a methodology for identifying, capturing, documenting and reusing LL is a CSF	5	5	5	5	4	5	5	5	5	4.9
	14. Producing a project closeout report involving LL is a CSF	4	5	5	5	4	5	5	5	5	4.8

Table E3: Identification of CSFs through a Good Practice

	Good practice 1 = strongly disagree & 5 = strongly agree										
Questions		**Participants' score**									**Average Score**
		A1	**A2**	**A3**	**B1**	**B2**	**B3**	**C1**	**C2**	**C3**	
Adaptability of the SDMs to Context	1. Developing the collaboration between The Design and Supervision Departments at the H.O could be identified through good practice as a CSF	5	5	4	5	5	4	4	5	3	4.4
	2. The need for design modification and development could be identified through good practice	4	5	4	5	5	4	5	5	5	4.65
	3. The need for material specification amendments could be identified through good practice as a CSF	4	4	4	5	5	4	5	5	5	4.6
	4. Establishing a central database and using KM could be identified through good practice as a CSF	5	4	4	5	5	4	4	5	4	4.4
	5. The Dissemination of LL to SDM projects could be identified through good practice as a CSF	4	5	4	5	4	4	3	5	4	4.2
Contracts Management	6. Developing the invitation to tender could be identified through good practice as a CSF	5	5	5	4	4	3	4	5	5	4.4
	7. Developing tendering criteria could be identified through good practice as a CSF	5	5	4	5	5	4	5	5	4	4.65
	8. Improving the payment process could be identified through good practice as a CSF	4	3	5	5	5	4	5	5	5	4.6
	9. Reviewing contract documents (cost estimation, terms& conditions and BoQ) could be identified through good practice as a CSF	4	4	5	4	5	4	4	5	5	4.4
Construction Management	10. Standardised project procedures could be identified through good practice as a CSF	4	5	4	5	4	4	5	4	5	4.4
	11. Improving the decision–making process could be identified through good practice as a CSF	5	3	4	5	4	4	4	5	4	4.2
	12. Encouragement and motivation for effective communication between all typical projects could be identified through good practice as a CSF	5	4	5	5	5	4	4	5	4	4.6
	13. The need for a methodology for identifying, capturing, documenting and reusing LL could be identified through good practice as a CSF	4	3	5	5	5	4	5	5	4	4.4
	14. Producing a project closeout report involving LL could be identified through good practice as a CSF	5	4	5	5	5	4	5	5	5	4.8

Table E4: Validation of the Framework Implementation Strategy

FRAMEWORK IMPLEMENATION STRATEGY 1 = strongly disagree & 5 = strongly agree										
Questions	**Participants' score**									**Average Score**
	A1	**A2**	**A3**	**B1**	**B2**	**B3**	**C1**	**C2**	**C3**	
Framework implementation strategy										
1. Web based tool	5	5	5	5	5	5	5	4	5	4.9
2. Manual project file	4	4	5	2	2	1	1	1	2	2.4
3. Knowledge Management (KM)	5	4	5	5	5	4	5	5	5	4.8
4. Existing KM	5	4	5	5	5	4	5	5	5	4.8

Table E5: Code Prefix Details of CSFs Validation

Component	Code prefix	CSFs
Adaptability of the SDMs to Context	AA1	Developing the collaboration between the Design and Supervision departments in the H.O
	AA2	The need for design modification
	AA3	The need for material specification amendments
	AA4	Establishing a central database
	AA5	The dissemination of LL to future SDM projects
Contract Management	CMB1	Developing the invitation to tender
	CMB2	Developing tendering criteria
	CMB3	Improving payment process
	CMB4	Reviewing contract documents (estimated cost for future projects, terms & conditions and BoQ)
Construction Management	CMC1	Standardised SDM' project procedures
	CMC2	Improving the decision–making process
	CMC3	Encouragement and motivation for effective communication between all typical projects
	CMC4	The need for a methodology for identifying, capturing, documenting and reusing LL
	CMC5	Producing a project closeout report involving LL

Table E6: Validation Code Prefix Details of CSFs through Good Practice

Component	Code prefix	Identification of CSFs through Good Practice
Adaptability of the SDMs to Context	AA1GP	Developing the collaboration between The Design and Supervision Departments at the H.O could be identified through good practice as a CSF
	AA2GP	The need for design modification and development could be identified through good practice
	AA3GP	The need for material specification amendments could be identified through good practice as a CSF
	AA4GP	Establishing a central database and using KM could be identified through good practice as a CSF
	AA5GP	The Dissemination of LL to SDMs' projects through the availability of easy access and the use of knowledge could be identified through good practice as a CSF
Contracts Management	CMB1GP	Developing the invitation to tender could be identified through good practice as a CSF
	CMB2GP	Developing tendering criteria could be identified through good practice as a CSF
	CMB3GP	Improving the payment process could be identified through good practice as a CSF
	CMB4GP	Reviewing the estimated cost for future projects, and reviewing contract documents (terms& conditions, BoQ) could be identified through good practice as a CSF
Construction Management	CMC1GP	Standardised project procedures could be identified through good practice as a CSF
	CMC2GP	Improving the decision–making process could be identified through good practice as a CSF
	CMC3GP	Encouragement and motivation for effective communication between all typical projects could be identified through good practice as a CSF
	CMC4GP	The need for a methodology for identifying, capturing, documenting and reusing LL could be identified through good practice as a CSF
	CMC5GP	Producing a project closeout report involving LL could be identified through good practice as a CSF