A hybrid model of communication and information management in mega construction projects in Dubai using a new critical success factor approach

A HYBRID MODEL OF COMMUNICATION AND INFORMATION MANAGEMENT IN MEGA CONSTRUCTION PROJECTS IN DUBAI USING A NEW CRITICAL SUCCESS FACTOR APPROACH

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ABSTRACT

Mega construction projects are complex undertakings. The complexity is increased during a construction boom in a city such as Dubai where more than 80% of material and labour resources are imported. The complexities inherent in mega construction projects include uncertainty and interdependencies, which affect project management performance at the operational level where most of the problems occur. Understanding these processes, how they interrelate and how to overcome the complexities is crucial for increasing the chances of project management success.

This research contributed to construction project management theory and practice by using a highly inductive exploratory qualitative approach for capturing formal and informal processes in mega construction projects in Dubai. A dynamic model depicting the complementary formal and informal processes is developed showing formal and informal processes and how they interrelate to reduce complexity. Guidelines on how and when to use specific processes are provided as a framework for the model. This framework may be used to help develop communication processes in future complex projects to increase chances of project management success.

The research was conducted by exploring two case study projects fitting the characteristics of mega construction projects. Both case study projects were of values above 1.5 Billion US Dollars and were similar in scope with elements including amusement parks, retail areas, hotels, extensive infrastructure and large landscape areas. Both case study projects were of an experimental character, considered an ‘engineering’ achievement, complex, and thereby, difficult to control. The research data were collected through semi-structured interviews with 83 project staff from both case study projects. Rich picture diagrams of the organization and processes were made from data collected during the interviews and case study project documents.

The analysis was performed in three phases where the results from each phase were built upon cumulatively. The first phase examined what the most crucial critical success factors (CSFs) were in the case study projects. These were revealed to be communication, top management support and effective change management. In the second phase each CSF was analyzed where it was found it that the majority of important communication modes were informal and were was most effective in reducing complexity. Furthermore, it was found that the characteristics of the client were crucial in both case study projects. The third phase involved development of the dynamic hybrid model from the rich picture diagrams created showing the interplay between formal and informal processes. It was found that informal processes are ‘ad-hoc’ and ‘chaotic’ in nature and controlled by individuals in the project. Development of guidelines for the ‘positive’ use of informal processes was required. From the analysis it was found that the characteristics of client staff and individuals in the case study projects provided the main guidelines for effective use of the hybrid model.

The research provides insights into the formal and informal processes and the reduction and management of complexity inherent in mega construction projects. Current research in managing complexity is from the perspective of the formal process where the informal processes are neglected, despite research and practice indicating their importance in construction projects. The research presents a systemic dynamic model of the processes for mega construction projects revealing that formal and informal processes are required and are complementary. Guidelines for the successful use of the model provide a framework for its application in practice. This shows how it can be used to inform understanding of processes in the context of the research. The model and guidelines were validated via discussions with practitioners experienced in construction of mega projects. Future work should expand the findings to applications of the model in practice for management of complex projects.

The model may be used by practitioners to act as a guide in how to manage construction processes to consciously overcome the inherent complexities to achieve project management objectives. This tool may also be used to inform clients of the inherent complexities and the level of informality required to overcome them. IT/IS practitioners may use the model and framework to understand the complexities in construction, and thereby, develop systems that are practically applied in construction projects. Researchers in the field may build upon the model and findings to increase knowledge regarding construction processes, particularly informal processes.

KEYWORDS: Model, construction process, communication, information management, project management, complexity, uncertainty, ambiguity.

ABBREVIATIONS

AEC Architecture, Engineering and Construction
BPR Business Process Reengineering
CMT Construction Management Team
CSF Critical Success Factor
CWP Construction Work Package
DPM Dynamic Planning Model
DTI Development Team Instruction
FSM Formal Systems Model
ICT Information and Communication Technology
IMS Information Management Systems
IS Information System
IT Information Technology
NCR Non Conformance Report
PD Project Director
PE Project Engineer
PM Project Manager
PMI Project Management Institute
PMBOK Project Management Body of Knowledge
PMT Project Management Team
PVO Potential Variation Order
QS Quantity Surveyor
RE Resident Engineer
RPD Rich Picture Diagram
SCM Supply Chain Management
SPM Senior Project Manager
SRE Senior Resident Engineer
STS Socio-Technical System
WPM Work Package Manager
WPQS Work Package Quantity Surveyor
VO Variation Order

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CHAPTER 1 INTRODUCTION

1.1 Overview

The construction industry is project based with teams assembled from various parties. With the increased complexity of projects, particularly mega projects, and tighter schedules imposed, communication and information management systems become increasingly important. An additional constraint is imposed during construction booms where resources, particularly human resources, become scarce and competition for them is higher. At the time of the research in 2007, Dubai had a vibrant economy and a construction boom was evident.

The construction literature on communication and information management concentrates on the formal (contractual) systems and IT applications to it. This research is an investigation into the communication and information management systems, both formal and informal, in construction projects and inherent complexity in construction projects. It specifically concentrates on development of a model highlighting the actual construction processes and interaction between formal and informal processes to overcome the inherent complexities. Furthermore, the research concentrates on establishing the framework by which both processes may work in tandem to achieve project objectives.

This introductory chapter outlines the background and context of the research in the construction industry, and particularly complex construction projects. It also outlines the need for new understanding, recognition and development of a model and a framework for communication and information management systems that is suitable for mega construction projects in Dubai. It further demonstrates that a model showing the interaction between formal and informal processes and a framework for it is required. The purpose of the research and the limitations placing a boundary for the research are stated. Justification of the research as well as the contributions to knowledge and the applications of the research are provided. A brief introduction to the methodology, elaborated in Chapter Five, is introduced leading to the literature review in Chapters Two, Three and Four.

1.2 Research context

1.2.1 Background to Dubai construction sector

Sheikh Rashid utilized oil revenues discovered in 1966 for infrastructure development in Dubai. The pace of development was frenetic. Schools, hospitals, roads and a modern telecommunications network were being built. A new port and terminal building were built at Dubai International Airport as well as a runway extension that could accommodate any type of aircraft was constructed. Additionally, the largest man-made harbour in the world was constructed at Jebel Ali, and a free zone was created around the port.

Dubai's strategy for development was to provide visionary leadership, high-quality infrastructure, an expatriate-friendly environment, zero tax on personal and corporate income and low import duties. The result of this strategy was that Dubai quickly became a business and tourism hub for the region. Over the past few years Dubai is being transformed into a large metropolitan city to realize that vision. However, this huge construction to realize that vision has not been without problems (Government of Dubai, 2009).

During conduct of the research in Dubai in 2007, construction contributed to 7 % of overall GDP of the U.A.E., most in Dubai. Factors driving the construction industry include; government spending on infrastructure; high rates of imported labour, both blue collar and professional; the positive outlook of private sector developers; the high oil prices providing wealth to the U.A.E., and; relaxation of investment laws to allow foreigners to purchase property. Some of the projects being constructed at the time in Dubai and their values provide an indication of the ongoing construction at the time which includes:

- Dubai Marina 4 Billion US Dollars
- Dubai World Center 33 Billion US Dollars
- Dubai Festival City 2 Billion US Dollars
- Dubai International Finance Center 2 Billion US Dollars
- Dubai World Central 33 Billion US Dollars

There are approximately 6000 construction related firms operating in the U.A.E. These are of various specializations and sizes. At the time, and to fulfil market requirements 80 % of materials were imported. To provide services for the expanding construction industry it is estimated that 85 % of major contracts were awarded to foreign contractors partnering with local companies. The labour imported, including unskilled and blue collar, constitutes 95% of the labour force in construction (Australian Government, 2009).

These factors, along with the large number of ongoing mega construction projects make Dubai a unique area to research mega construction projects. Despite this uniqueness only little research has been performed on this setting. The complexities arising from the international labour force, the number of international consultants and contractors, the vast amount of imported material, is asking for research to be performed. These complexities are compounded with the rising costs of labour and material as well as shortages of both.

1.2.2 Mega construction projects

Construction involves complex interactions within its processes. Problems with interaction within these processes cause inefficiencies and uncertainties in project execution, which can be detrimental to the project (Park, 2002). Additionally, construction project sizes are increasing and the planning and control required becomes increasingly difficult due to increased complexity and uncertainty. Furthermore, the business environment in the construction industry is becoming more competitive making time-to-market one of the most important driving forces (Park and Pena-Mora, 2002). Completing projects in shorter durations is considered crucial to success (Wheelwright and Clark, 1992).

However, this increases process and management complexity (Clark and Fujimoto, 1989; Wheelwright and Clark, 1992; Baccarini, 1996).The construction industry has displayed difficulty in coping with the increasing complexity of construction projects. The effect is that the durations of large-sized projects exceed their deadlines (Tukel and Rom, 1995).

1.3 Research background

1.3.1 Complexity, uncertainty and ambiguity

Complex projects demand an exceptional level of information flow management, where conventional systems developed for ordinary projects have been found inappropriate. Complex projects require that differentiation and interdependencies are managed by integration (i.e. coordination, communication and control). This is particularly true of construction projects, which are typified by strongly differentiated but largely interdependent parts (Baccarini, 1996).

Construction projects face a high degree of task uncertainty. Task uncertainty may be defined as “the difference between the amount of information required to perform the task and the amount of information already possessed by the organization” (Galbraith, 1973, p. 5). Therefore, task uncertainty requires information to close the gap between information available and information required, thereby enabling the achievement of the task. Galbraith (1973, p. 4), who is referenced by many authors to this day, states, “the greater the task uncertainty, the greater the amount of information that must be processed among decision-makers during task execution in order to achieve a given level of performance”. Additionally, the fragmented nature of the construction industry results in a lack of a central project information repository and the lack of effective cross-discipline communication within the project team. This reinforces the confrontational culture common in construction projects (Sun et al., 2000).

The multi disciplinary characteristic of a construction project makes it necessary to include representatives of domain-specific backgrounds within the team. The initial design will be the basis for development of detailed design for each discipline. Each discipline develops its components of the overall design. This may seem as logical and correct. However, this only provides for local optimization (i.e. of components), but may well be sub-optimal for the whole process. According to Galbraith (1973) this may be interpreted as the creation of self-contained tasks and is an information reduction strategy. Interdependencies always occur among components and decisions have to be made considering the best solution fitting all disciplines’ requirements (global optimization).

This process may be termed as “coordination”. Most of the design related problems occur where interdependencies between components are. Therefore, to achieve an optimal global solution, not only should information and knowledge be shared, but they should also be managed in a manner that actively promotes integration. (Nambayashi et al., 2002). The Latham report highlights the problem of coordination in the construction process. The report provides a description of the complexity of the design process and the potential for lack of coordination.

Information is strongly linked to activity. It enhances the ability to act, and activity creates information. Therefore, information is a crucial element in the enhancement of any organizational process, and timelines, accuracy, relevance and quality are requisites of information. The Contingency Theory (Shenhar, 2001b) states that there is no best way to organize but different methods of organizing are not equally effective. Different organization structures and networks of information flows will probably have different effectiveness and efficiencies. In order to achieve better effectiveness and efficiencies of the process, the organizational structure and the network of information flows have to be closely linked.

Anumba et al. (2002) recommend that integrated team structures be implemented at the project level. Layered or bubble structures are recommended as they are more flexible than matrix and team structures. These types of structures are recommended as they provide greater flexibility and improved communications. This is in agreement with Nikolendo and Kleiner (1996) who state that more companies operating in dynamic and unstable environments are adopting organic models. Organic models are characterized by openness, responsiveness, and lack of hierarchy.

Information flows are of primary importance in project planning and execution and serve a dual purpose. First, they provide a clear picture of the ongoing project on a real-time basis. This enables decision makers to monitor and control activities and to make corrective actions when required to meet planned milestones, schedules and budgets. Secondly, information flows between informatively linked activities may modify or affect the other when information is generated from it. Therefore, untimely information flow change requirements and resource availability affects activities and completion time or execution (Nicolleti and Nicolo, 1998).

Overall project quality depends upon the possibility and capacity to implement corrective actions in order to minimize the consequences of errors and accidents, thereby, avoiding an unplanned iteration in the project. However, the more two activities are informatively linked, the more an unplanned iteration of one of them affects the other and the overall execution of the project. The more two activities are informatively linked; the more important it is to execute them concurrently. This is supported by the definition of concurrent engineering as “a methodology to schedule concurrent activities which share common conceptual tools and information resources” (Kerzner, 1990; Kusiak, 1993).

In current processes the document structure restricts parallelization of activities since information is collected in documents and passed on. Recipients of the documents usually require a small fraction of the information in a document. However, the need for small pieces of information for successive activities is neglected. Small and flexible information units can be passed on and used very early, which advance the feedback to assess results and to actualize knowledge bases (Eversheim et al., 1997).

Completing projects quickly is critical. In response, part of the construction industry has shifted from a sequential to a concurrent development paradigm, known as the fast track process. It is designed to reduce project duration by overlapping project phases and performing them in parallel as much as possible. Large reductions in project duration are stated to have been achieved by applying fast track processes as these have become the norm in mega projects. However, many organizations are having difficulty to successfully implement fast track processes and realizing their benefits (Ford, 2002).

Two key reasons for failures to implement fast track processes are: (1) the failure to match the organization’s people, controls, tools, processes and structure with its need for efficiency, focus, incremental change, radical innovation and proficiency (Backhouse and Brookes, 1996 c.f. Ford, 2002), and (2) the effects of disaggregating work into smaller pieces (Smith and Eppinger, 1997 c.f. Ford, 2002). Fast track processes increase process and management complexity (Wheelwright and Clark, 1992; Clark and Fujimoto, 1989 c.f. Ford, 2002). Process design and management policies have largely failed to address the increased complexity inherent in fast track processes and this has been a reason for failure to realize the potential to reduce project durations.

1.3.3 Internal problems in construction projects

Some of the critical performance criteria and determinants of project success are on-time completion and within budget. Although, these criteria alone may be misleading, factors delaying the completion of the project and cost overruns shed light on problems in construction projects. Both criteria are largely dependent as delays are costly and often result in disputes and claims, and generally retard the development of the construction industry (Odeh and Battaineh, 2002).

There is general agreement in the literature emanating from a variety of countries that the factors causing most delay and cost overruns in construction projects are internal to the project environment (i.e. client, contractor, consultant, and contract). External factors are not as problematic (Odeh and Battaineh, 2002; Al-Momani, 2000; Love et al., 2002; Cox et al., 1999; Chan et al., 2001). Odeh and Battaineh (2002) provide a good overview of causes of construction delays in traditional contracts showing internal factors to be most of them.

There is evidence that internal factors in construction projects are a main issue to resolve. These internal factors are categorized by the various parties to the contract at the project operational level. Concentrating on the internal factors, but not neglecting the external factors, reorganization may provide feasible solutions to reduce or minimize the effects of many of these problems (Odeh and Battaineh, 2002). These factors point to problems in communication and information management in construction projects, and therefore, should be given due consideration.

1.3.4 Problems of communication and information

The categories of construction information are the following: (1) general information; (2) organization-specific information; and, (3) project-specific information. General information includes publicly or commercially available information such as products, regulations, etc. Organization-specific information is all information available to an organization such as solutions to design problems. Project-specific information is that related to a construction project shared by the organizations that make up the supply chain (Dawood et al., 2002). The area of interest in the research relates to project-specific information since it involves the project at the operation level.

Construction projects have problems in communication relating to project-specific information. Construction is a multi-organization process depending heavily on the exchange of large complex data and information. The nature of construction projects inhibits development of good communication links (e.g. one-off nature, temporary project teams, diversity of project members, and cyclical nature of the economic environment). Timely project completion relies on the accuracy and timing of information exchange amongst the project team (Emmitt and Gorse, 2003).

The above communication and information problems found in construction projects indicate a need to develop a framework to support communication and information management in construction projects that would be able to work within the inherent characteristics of complex construction projects.

1.3.5 Need of effective communication and information transfer

The number of factors affecting the implementation of a construction project is tremendous. Various factors such as technologies, inhibitors and internal or external constraints may lead to changes. These changes must be communicated to all those concerned or affected by them in order to enable them to make necessary modifications and changes to the project according to the new situation. The amount of information generated during the implementation of a construction project is immense. The improvement of the communication process in projects is essential (Soibelman and Caldas, 2000). The key requirement to achieve this is coordination of information exchange. Even though the technology is available, the development of an improved communication and data system to meet the needs of the various parties in the project has to be done first (Rojos and Songer, 1999).

An efficient and effective system to manage this information would affect the project's cost, time and quality (Soibelman and Caldas, 2000). Additionally, there are many calls for the construction industry to increase efficiency, productivity and performance within this uncertain environment (Latham, 1994; Egan, 1998). The need to study the communication and information management systems in construction projects is required in order to develop more efficient and effective systems.

1.4 Purpose of the research

1.4.1 Research problem

Construction projects are by nature complex (Baccarini, 1996). This complexity is further increased with speed (Laufer et al., 2008). The more complex and uncertain the project the more likely it will encounter communication and information flow difficulty (Emmitt and Gorse, 2003).

In a study performed by Ashmos et al. (2000), it was found that organizations developing a complex absorption strategy outperformed organizations with a complex reduction strategy. The former organization is one where standardization was reduced and ad hoc reactions to complexities were favoured. In the latter organization the philosophy was to reduce complexities through standardizing and formalizing within the organization. Calls for standardization are rejected by some researchers who view that this stifles the ability to solve problems (Keating et al., 2001), something practitioners require in projects. Others, such as Latham (1994) and Egan (1998) call for standardization of processes in construction. This dilemma causes one to ask which path should be taken to reduce these inherent complexities in construction project, which are tightly linked to the communication and information processing ability of construction projects (Baccarani, 1996). Yet there is no accepted method to overcome the inherent characteristics of complexity (Vidale and Marle, 2008).

There have been many researchers trying to find the Critical Success Factors (CSFs) that would lead to successful completion of construction projects (e.g. Odeh and Battaineh; Fortune and White, 2003). Some researchers provide guidelines, best practices and factors that apply to all projects (Fortune and White, 2003). Furthermore, there are two main issues for CSFs: (1) that of interrelationships between the CSFs (Bellasi and Tukel, 1996) and (2) that of changing importance of CSFs during project execution (Fortune and White, 2003). Yet there is no agreement on the most crucial CSFs on projects.

From the above, a major question that arises is do we really understand construction processes (Clarke et al., 2006) to overcome the inherent complexities? Secondly, do we understand the intricacies of communication and information processes sufficiently to develop effective communication and information management systems? The research sets out on a quest to explore the complexities in mega construction projects and to understand how these complexities may be overcome through two case study projects in Dubai.

1.4.2 Research main aim

The main aim is:

To develop a model framework for information management systems that reflects the nature of information management in mega construction projects in Dubai that would support managers in helping to overcome the inherent characteristics of complex works.

1.4.3 Research objectives

The following objectives were formulated to achieve this aim:

- To review the literature surrounding critical success factors, communication and information management, information management systems, change, socio-technical systems and human factors to identify the factors critical to communication and information management.
- To review models that place a framework around Critical Success Factors (CSFs) to provide guidance for analyzing, investigating and establishing the CSFs that are most critical in mega construction projects in Dubai.
- To establish the organization and work process within the case study projects from the perspectives of the main parties involved in order to map key communication and information flows.
- To construct a new theoretical model framework for communication and information management systems in order to provide a way of understanding key formal and informal processes and interactions within mega construction projects in Dubai.

- To verify and validate the model and the conclusions and recommendations of the research within the context of the case study projects explored in order to ensure its relevance to both researchers and practitioners.

1.5 Key Contributions to knowledge

The research has succeeded in achieving the aims and objectives it set out as outlined in Sections 1.4.2 and 1.4.3. The main research contributions to knowledge are as follows:

- The research addresses the main criticism of the body of research that provide models and general recommendations for the formal processes alone, neglecting the all important informal processes. This research in turn has developed a practical way of understanding key formal and informal processes within mega construction projects.
- The overarching contribution to knowledge of this research is the hybrid model of information management in mega construction projects that reflects the nature of formal and informal information management, which may then be used to enable a better understanding of how such processes could be managed on future projects.
- The research captures construction processes, formal and informal, in mega construction projects in Dubai where there are no descriptions of these processes in the literature.
- Presents a dynamic hybrid model showing the interplay of formal and informal processes in construction where current models concentrate solely on formal processes, which may then be used to enable a better understanding of how such processes could be managed on future projects.
- Provides insight into the interrelation between the formal and informal processes and how they complement each other, which is not described in the current literature.

1.6 Limitations of the research

As with all research there have been time and resource constraints. Thereby, the following are research limitations imposed:

- The thesis is restricted to mega construction projects in Dubai, although it may be applicable beyond the geographical boundaries set.
- The thesis is restricted to communication and information management systems and the most critical factors affecting their performance.
- The research is based on a case study methodology and so no claims of generalizability beyond these cases can be made. However, the principal aim is to generalize to a new theory of information and communication management in such projects.
- The framework developed in this research is presented to aid in the understanding of complex construction processes. It is not a protocol for direct application but is intended as a basis for developing practical applications to management of mega projects.

1.7 Application of findings

The findings may be applied equally by both researchers and practitioners. Researchers may further the development of theory of information management from the perspective of both formal and informal processes. Practitioners may use the guidelines of the framework as a starting point to develop resolutions to specific problems and a protocol for management of complex projects.

1.8 Brief overview of the research methodology and method

The research was purposely initiated with an open mind. Therefore, the research at the outset is largely inductive despite the research objectives being developed. Following the literature review questions were generated for the exploratory semi-structured interviews. It was decided that the most appropriate research approach was qualitative multiple-case studies incorporating interviews and other data describing the organization and processes of work. This would satisfy the replication logic required in this type of research (Yin, 1994; Yin, 2003b).

The primary data sources were the semi-structured interviews and documents made available from the case study projects. Triangulation of the data was achieved through multiple case interviews and multiple data sources, including documents provided and diagrams sketched during the interviews. The data was managed and analyzed using

QSR NVivo computer-aided qualitative data analysis software. Analysis of the data included open and axial coding. The research design and methodology and methods are discussed in detail in Chapter Five.

1.9 Thesis structure

The research is comprised of 12 chapters. The chapters are divided as described in the following paragraphs. Figure 1-1 shows a summary of the thesis structure.

Chapter 1 provides an introduction to the general subject domain by presenting the background to the research, background of Dubai, identifies the knowledge gap in the research, the research problem and provides the research's aim and objectives. The contribution to knowledge and the application of findings are provided. It also gives a brief description on the methodology and method adopted in carrying out the research.

Chapter 2 reviews the literature of emergent themes from the semi-structured interviews. The literature reviewed includes complexities inherent in construction projects working in a dynamic environment. Within this review, characteristics of the complexities are identified. The literature is further reviewed to identify how these complexities may be managed. Communication within a complex dynamic environment is reviewed including formal and informal methods. The social and technical aspects of information management systems are reviewed with emphasis to construction. Furthermore, top management role within complex projects is reviewed and the importance of the client is discussed. Several questions are raised within the chapter to further guide the research analysis.

Chapter 3 reviews the literature of emergent themes from the semi-structured interviews. It reviews communication and information management in complex dynamic conditions in the construction industry. It presents change and information iterations in construction projects with a focus on the complexities inherent in construction projects described in Chapter Three. Several models depicting the dynamics of information in construction are reviewed. Two models providing a depiction of the dynamics of information are introduced. Formal and informal processes are described as applied to communication and information management and in consideration of the complexities. Several questions are raised serving to further guide the research analysis.

Chapter 4 reviews the critical success factors (CSFs) body of literature and how that may be applied to filter the most critical CSFs affecting mega construction projects in Dubai. The added complexities within Dubai are discussed. Models placing a framework around CSFs are discussed and three models are described. It also gives justification for the choice of selection of the Formal Systems Model (FSM) model and justifies its applicability to construction projects. The results from Chapter Two shall serve as a basis for the initial phase of analysis to be performed in Chapter Six, which shall result in identification of the most crucial CSFs in the case study projects. Several questions are derived within the chapter to further guide the research analysis.

Chapter 5 provides a general overview on research methodologies available in the literature. It outlines the methodology followed in the research, gives a justification for the methodology chosen. Research methods are reviewed and justification for the method chosen is provided. Research design and implementation concerns are reviewed including data collection strategies, analysis techniques and interpretation of the data.

Chapter 6 applies the Formal Systems Model (FSM) to the case study projects as the first phase of the analysis. The CSFs as related to the case study projects and their application to the model followed by a cross-case comparison and comparison with the literature relating to Dubai and neighbouring countries. In conclusion, it lists the most significant CSFs on mega construction projects in Dubai. From this exercise three factors were identified as critical. The factors considered more influential in Dubai were: top management support, communication and effective change management. Hence, they were subject to further scrutiny in following chapters.

Chapter 7 examines communication as one of the most significant CSFs to be further analyzed as a result of the analysis performed in Chapter Six. The chapter builds upon the literature review performed in Chapter Four. The chapter examines communication issues in the case study projects. The modes of communication and preferences of respondents in the case study projects are briefly discussed. Formal and informal types and modes of communication are discussed as relates to the case study projects as well as the importance and problems of each. Inter-personal, intra-organizational and inter-organizational types of communication in the case study projects are discussed and conclusions drawn. Several questions are provided to guide the analysis into the third phase.

Chapter 8 examines top management support, which is the third significant CSF resulting from the analysis performed in Chapter Six. The chapter analyzes the characteristics of the main parties in the case study projects, mainly from the data collected during the interviews. The chapter discusses the characteristics of the various parties that were conducive to effective communication and information management in the case study projects. This chapter also discusses individual characteristics in the case study projects and what factors assist in the effective communication and information transfer as well as how that was crucial to the success of the projects. The chapter then discusses the results of the analysis from Chapters Six, Seven, Eight and Nine and in relation to the literature.

Chapter 9 examines effective change management as one of the significant CSFs to be further analyzed as a result of the analysis performed in Chapter Six. The chapter builds upon the findings in Chapter Seven as well as the literature review in Chapter Four and presents the formal and informal processes of work in the case study projects, particularly during change. The chapter then builds upon the literature review in Chapter Four and presents the hybrid model for communication and information management and bases results on the management of complexities in construction projects as provided from the literature review in Chapter Three. The processes are then used to discuss the management and control of communication and information during change in the case study projects and the application to the information iteration model chosen.

Chapter 10 builds upon previous chapters to develop the Hybrid Model and the guidelines for its use. The Ford (2002) and Pena-Mora (2002) models are critiqued showing that the models are not reflecting construction processes as used in practice. The chapter then provides annotations to be used in the development of the Hybrid Model. A description of each of the main phases and the processes within them is made to develop the formal part of the Hybrid Model, followed by the addition of informal processes. The Hybrid Model is presented and described including how complexity and other factors are reduced. Guidelines for use of the Hybrid Model are presented to act as a framework for it. The guidelines included the characteristics of client staff and individuals in the project team. The guidelines are justified as to their importance relative to the Hybrid Model.

Chapter 11 presents the validation of the research and the chain of thought during the conduct of the research, data collection, analysis until arrival to the conclusions. The objectives of the validation process are presented. The justification for choice of and description of participants in the evaluation of the research is made. The evaluation of the research for the performance measures of confirmability, credibility, tracsferability and dependability is made. This included presenting the history of the research and the chain of evidence established as well as laying out the chain of thought in the research. It also presents the evaluation responses for the validation conclusions and the practical applications of the hybrid model of communication and information management. This included a preliminary test of generalizability of the Hybrid Model beyond the context of the research. The conclusions and Hybrid Model are modified according to the responses of to the evaluation of the research. The modifications are presented for the conclusions and Hybrid Model.

Chapter 12 presents key and conclusive research findings, sets out how the study has contributed to knowledge, presents limitations of the work, and provides recommendations and implications for further research. It also provides a reflection into how Dubai has been affected by the Global Financial Crisis and how this affects the findings of the research.

1.10 Summary

The first chapter provides the direction and context of the thesis. The aims and objectives of the research are outlined providing focus for the research. A brief description of communication and information management systems and the need for an effective information management system is established. Further justification is provided for the research. The methodology and methods used are described briefly. The applications of findings and contribution to knowledge are outlined. Finally, the chapter summarizes the content and structure of the thesis. The purpose and context described in this chapter provides the basis for the literature review in Chapters Two, Three and Four.

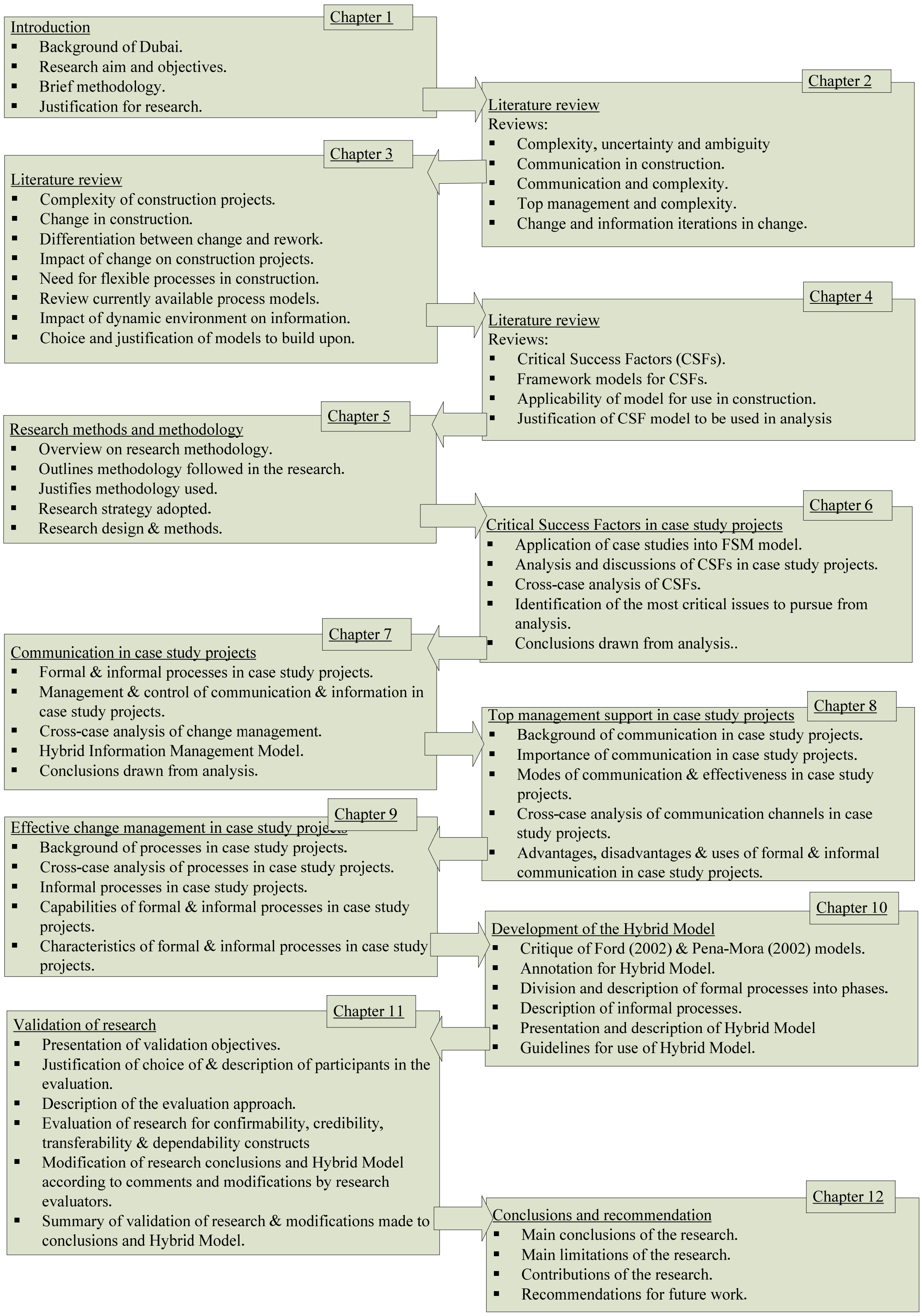


Figure 1-1 Summary of research structure

CHAPTER 2 COMPLEXITY, COMMUNICATION AND MANAGEMENT

Chapter One established the research context and background as well as the research problem, aim and objectives. Building on Chapter One this chapter reviews the literature based upon the emerging themes from the analysis of the data from the semi-structured interviews as well as issues highlighted in the literature. Additionally, it reviews the literature based upon the emerging themes from the analysis of the data from the semi-structured interviews. The main characteristics of construction project complexity and the dimensions surrounding complexity are reviewed and each dimension is defined. The literature is further reviewed to identify the importance of managing complexities in construction projects. The importance of communication in construction projects is highlighted as well as the communication routes. Formal and informal processes are described as applied to communication and information management and in consideration of the dynamic dimensions of complexity, uncertainty and ambiguity. The chapter describes the technical and human aspects of communication and information management systems as well as the role of top management in it. Several questions shall be provided from the literature review to further guide the research analysis.

2.1 Nature of construction projects

Prior to studying complexity in construction, the nature of projects should be highlighted. The literature provides several main descriptions construction projects that affect dimensions of complexity. The main descriptions of the nature of construction projects are provided in Table 2-1.

Table 2-1 Nature of construction projects

No.	Description	Author
1	Dynamic nature of construction projects	Laufer et al. (2008); Mulholland and Christian (1999); Bertelsen (2003)
2	Fragmented nature of projects	Ankrah et al. (2009); Bertelsen (2003)
3	One-off nature of construction projects (unique and novel)	Westerveld (2003); Ahadzie (2008)
4	Highly transient human system (social interaction)	Bertelsen (2003);
5	Adversarial culture	Ankrah and Langford (2005)
6	Complex	Mulholland and Christian (1999); Bertelsen (2003); Baccarini (1996)

A common belief is that poor performance of construction projects is due to its processes being inherently complex (Wood and Gidado, 2008). Baccarini (1996) considers construction projects to be the most complex and risky undertaking in any industry. Mills (2001) c.f. Wood and Gidado (2008) describes the construction industry as one of the most dynamic, risky and challenging businesses with a poor reputation of managing risks where many projects fail to meet time and cost objectives. This is supported by Mulholland and Christian (1999) c.f. Wood and Gidado (2008) who state that construction projects are performed in complex and dynamic environments resulting in high uncertainty and risk compounded by time constraints.

Adding to the complexity is the nature of construction where projects are one-off and are unique and novel (Westerveld, 2003; Ahadzie, 2008). Construction is also a fragmented industry (Bertelsen, 2003; Ankrah and Langford, 2005) where many parties are involved in completing a project. It is due to this that the construction industry has a reputation of an adversarial culture (Ankrah and Langford, 2005). Furthermore, construction projects heavily involve people and social interaction, and as such, are to be considered ‘highly transient human systems’ (Bertelsen, 2003).

An understanding of construction project complexity and how it may be managed is important (Wood and Gidado, 2008). Complexity science is a shift from traditional science, namely studying the relationships between parts which shape the behaviour of a system and how it interacts and relates with the environment (Wood and Gidado, 2008). Since construction projects are systems in their own right, complexity science is applicable (Vidale and Marle, 2008).

2.2 Projects as systems

Van Donk and Molloy (2008) state that the project management literature has largely treated projects as a part of an organization. Drawing on previous work by Shenhar and Dvir (1996) and Shenhar (2001a) who use contingency theory to distinguish between project types, the authors advocate viewing projects as organizations. It is argued that projects operate in different circumstances and each result in different structures. Thereby, projects should be considered as special types of organizations (van Donk and Molloy, 2008).

Emmitt and Gorse (2003) use the systems theory to expand and include subsystems, which can be used for identification and analysis of the interrelationships between the component parts of temporary construction organizations. The authors assume the subsystems as parties such as the main contractor. This conflicts with other authors such as Fortune and White (2006) who view subsystems as processes.

A system is defined as 'an object, which, in a given environment, aims at reaching some objectives (teleological aspect) by doing an activity (functional aspect) while its internal structure (ontological aspect) evolves through time (genetic aspect) without losing its identity'. Based on this, projects can be considered as systems (Vidale and Marle, 2008). Bertelsen (2003) views construction as complex systems.

2.3 Project complexity

Projects are complex (Davidson, 2002 c.f. Geraldi and Adlbrecht, 2007), and despite the strong association between projects and project management and complexity (Baccarini, 1996), there is a tendency to neglect this by both researchers and practitioners. This is reflected in the tools used in the management of projects such as PERT, WBS, etc. (Geraldi and Adlbrecht, 2007), which are well suited to a static (stable, known, simple) environment (Laufer et al., 2008). However, current project management tools are not well suited to the dynamic environment characteristic of construction projects (Laufer et al., 2008; Akintoye et al., 2000; Lingard, 2003; Gidado, 1996).

Bertelsen (2003) states that the general view of construction as an orderly, linear phenomenon which can be organized, planned and managed top down is incorrect. The frequent failures of construction projects to achieve time and cost objectives supports the view that the processes are not as predictable as they may appear. Bertelsen (2003) adds that construction is a nonlinear, complex and dynamic undertaking often existing on the edge of chaos.

Construction project characteristics include lack of continuity ‘within and between’ projects making efficient and effective communication challenging. In each project individuals will need to communicate with unfamiliar organizations and individuals. Every new project will have new members and relationships and communication channels are created, and thereby, what worked on one project may not work on another. Furthermore, individual projects are unique in their design and specification, making maintenance of consistent supply difficult, and thereby, new manufactures may be introduced followed by new communication routes. Additionally, projects may last for some time where participants may change making reestablishment of interpersonal communication channels a construction activity throughout its duration (Emmitt and Gorse, 2003).

The characteristics of construction projects indicate that there are several dimensions that become evident. These are dimensions of complexity, uncertainty and ambiguity (Vidal and Marle, 2008; Bacarrini, 1996; Ashmos et al., 2000; Thomas and Mengel, 2008). The definition of a project indicates a continuously changing organization, be that in its processes, performance, products or services from start to finish. Each project is unique and targets, resources and environments change (Vidal and Marle, 2008). As projects become bigger and tighter schedules are imposed, complexity, uncertainty and ambiguity become more profound (Laufer et al., 2008). Each dimension of complexity shall be discussed in the following section.

2.4 Dimensions of complexity

2.4.1 Complexity

There is disagreement as to the definition of complexity in the various bodies of literature. Sinha et al. (2001) state that *there is no single concept of complexity that can adequately capture our intuitive notion of what the word ought to mean*. Despite that, Table 2-2 presents several definitions of complexity. However, the definition of complexity that shall be used in the research is that of Baccarini (1996) as:

……consisting of many varied and interrelated parts.

Vidale and Marle (2008) state that there are two main approaches to complexity; descriptive and perceived. The first considers complexity as an intrinsic property of the system and the second is subjective assuming that complexity can only be perceived. Either applies to project complexity and project management complexity. But project managers deal with perceived complexity since they cannot understand and deal with the whole reality and complexity of projects.

Table 2-2 Definitions of complexity

Definition	Author
is that property of a model which makes it difficult to formulate its overall behaviour in a given language, even when given reasonably complete information about its atomic components and their inter-relations.	Cited by Vidal and Marle (2008) from Edmonds (1999)
consisting of many varied and interrelated parts	Baccarini (1996)
… stems from "a large number of parts that interact in non-simple ways, … [such that] given the properties of the parts and the laws of their interactions, it is not a trivial matter to infer the properties of the whole"	Cited by Sommer and Loch (2004) from Simon (1969, p. 195)
Project complexity is the property of a project which makes it difficult to understand, foresee and keep under control its overall behaviour, even when given reasonably complete information about the project system. Its drivers are factors related to project size, project variety, project interdependence and project context.	Vidal and Marle (2008)

Bacarrini (1996) proposes that project complexity be operationalized in terms of differentiation and interdependency. Differentiation in the number of varied elements and interdependency is the degree of interrelatedness of these elements. Baccarini (1996) broadly divides complexity into parts: organizational and technological. Construction projects are more technologically complex as they are bigger and more complex (Laufer et al., 2008). Sommer and Loch (2004) state two dimensions of complexity as system size and interactions.

Vidale and Marle (2008) provide several factors and characteristics of project complexity, which are: project size; variety of the project system; interdependencies within the project system, and context dependence. They continue to state that project complexity cannot be analyzed or managed without considerations of project context implications on it. They cite Koivu et al. (2004) who state the fact that:

[….] the context and practices that apply to one project are not directly transferable to other projects with different institutional and cultural configurations, which have to be taken into account in the processes of project management and leadership.

The relationship between project complexity, risks, uncertainty and performance are not clear. Project complexity is also one of the main reasons of unpredictability of success or failure of projects. The consequences of complexity may be positive or negative. The role of the project manager is to seize opportunities and diminish negative effects of complexity (Vidal and Marle, 2008).

2.4.2 Uncertainty

The influence of uncertainty and the risks generated from it has been a concern in the construction industry since the report of the Tavistock Institute (1966) (Skitmore et al., 1989). Thiry (2002) defines uncertainty by the difference between the data required and the data already possessed which means a shortage of information. This definition supports thoughts and findings provided by Galbraith (1973).

The project management literature and bodies of knowledge (e.g. PMBOK and PMI) provide risk management as a tool to be used for reducing the impact of uncertainty (e.g. PMI, 2004). However, risk management has been criticized for its "probability-based paradigm" which has its limitations, including: (1) uniqueness of projects reduces relevance and reliability of statistics; (2) human actions are generally not random, a basis for probability theory; (3) uncertainty and ignorance are inevitable on projects and future states cannot be known, an assumption for probability theory, and; (4) humans are limited in ability to absorb and process all the information required for holistic decisions (Pender, 2001). Due to the one-off nature of projects, their uncertainty is 'epistemic' (i.e. related to shortage of complete knowledge) rather than 'aleatoric', which is related to randomness (Khodakarami et al., 2007). Reymen et al. (2008) add that unpredictability corresponds to uncertainty about causes, the outcome of which is that uncertainty is not quantifiable. On the other hand uncertainty about consequences corresponds to uncontrollability. With risks, only sources of uncertainty can be indicated.

Another criticism of risk management is its association with negative outcomes (Koltveit et al., 2004; Mahmoud-Jouini et al., 2004). Ford et al. (2002) state that current management practice is for limiting project losses, and thereby, limit managers' ability to recognize and use opportunities to increase project value. Drucker (1989) points out that strategies should be based on maximizing opportunities where focus on negative outcomes leaves opportunities. The PMBOK Guide (PMI, 2004) state risk management as:

.. an uncertain event or condition that, if occurs, has a positive or negative impact on a project objective.

Thereby, uncertainty may provide both positive and negative outcomes. Some authors advocate "uncertainty" management to risk management (e.g. Ford et al., 2002; Ramgopal, 2003). Koltveit et al. (2004) cites how Achrol (1988) distinguishes between risk and uncertainty as:

risk is said to exist in situations where each outcome has a known probability of occurrence, whereas uncertainty arises where the probability of the outcome of events is unknown.

Kolteveit et al. (2004) advocate the use of opportunities during the early stage of the project cycle.

Typically, uncertainty (or learning) is reduced as more knowledge is revealed as shown in Figure 2-1 (Pender, 2001; Mahmoud-Jouini et al., 2004). At the start learning is minimal and uncertainty is reduced with time (shown as dashed line) and the courses of action that can be taken are many at the start and reduced with time (shown as a solid line). A dilemma for managing projects is trying to resolve this (Mahmoud-Jouini et al., 2004).

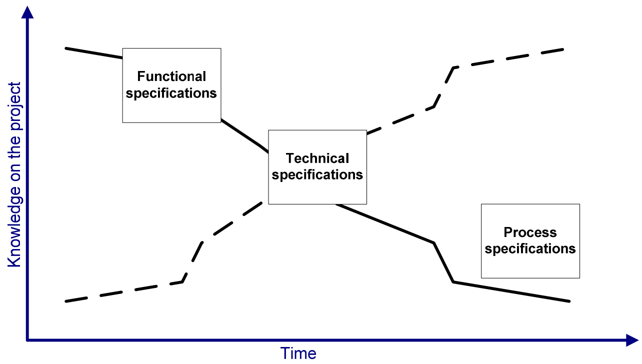


Figure 2-1 Project convergence (Mahmoud-Jouini et al., 2004)

In order to achieve concurrency, overlapping project phases and managing the relationship between the phases is important. Additionally, it seems from Figure 2-1 that making decisions earlier would reduce delay. However, accelerating a project means taking time at the start to explore options and then implement (Mahmoud-Jouini et al., 2004).

Uncertainty has been further divided into sources of uncertainty by several authors (e.g. Koltveit et al., 2004; De Meyer et al., 2002). Kolveit et al. (2004) divide sources of uncertainty into internal and external sources. External sources is *a shortage of information related to external factors that may affect project performance*, which include the political and cultural situation, the contract, the local infrastructure, among others. Internal sources are a *lack of information related to a project's internal factors that may affect the project performance*. These include: (1) project technical scope; (2) project goals, and (3) available competence and organization.

Atkinson et al. (2006) divide uncertainty management into three areas: (1) uncertainty in estimates; (2) uncertainty associated with project parties, and; (3) uncertainty associated with stages in the project life cycle. Uncertainty in estimates relates to potential variations in costs, duration, or quality. Uncertainty associated with parties is introduced by the existence of many parties in the project. Additionally, employees and agents of project owner contribute to the added uncertainty regarding future performance. Uncertainty associated with stages in the project life cycle is associated with the generic processes making up the project life cycle. Ford et al. (2002) add that the roles of project participants are important in the management of uncertainty.

De Meyer et al. (2002) provide four types of uncertainty: variation; foreseen uncertainty; unforeseen uncertainty, and; chaos. Variation is when cost, time and performance levels vary randomly within predictable range. Foreseen uncertainty is when a few factors affect the projects in unpredictable ways. Unforeseen uncertainty is when factors affecting the project cannot be unidentified, and thereby, their effects on the project cannot be predicted. Chaos is when unforeseen events undermine the project's goals, objectives and plan.

2.4.3 Ambiguity

Chapman and Ward (2004) state that understanding uncertainty *needs to go beyond variability and available data. It needs to address ambiguity and incorporate structure and knowledge*. There have been differentiations made in the literature between uncertainty and ambiguity. Thiry (2002) differentiates uncertainty from ambiguity in that ambiguity means the existence of multiple and conflicting interpretations, which is linked to confusion and lack of clarity. Pich et al. (2002) state that ambiguity is caused by lack of information due to events or causality being unknown. Chang and Tien (2006) state that ambiguity is the *existence of multiple and conflicting interpretations*.

Chang and Tien (2006) state that unlike uncertainty, new information may not resolve issues when ambiguity is high. What may resolve issues when ambiguity is high are people exchanging opinions, define problems and reach agreement. Sommer and Loch (2004) identify two fundamental approaches to management of innovation with unforeseeable uncertainty and complexity. The first is *selectionism* where several solutions are tried in parallel and selection of the best alternative *ex post*. The second approach is *trial and error learning*, which is an unplanned adjustment to new information.

2.4.4 Views on categories of complexity

Construction projects are complex in nature (Gidado, 1996; Cicimil and Marshall, 2005) where it consists of a multitude of interacting elements (Gidado, 1996). A common belief is that the poor performance of construction projects are due to the inherent processes being particularly complex (Wood and Gidado, 2008). Baccarini (1996) considers construction projects to be the most complex and risky undertaking in any industry.

Geraldi (2008) divides complexity into three groups: complexity of faith; complexity of fact, and; complexity of interaction. When solving new problems or making something unique, uncertainty is high and outcomes are not known, but complexity of faith means that there must be, or at least pretend, to have faith. Complexity of fact is the challenge of not getting lost in factual data and maintaining a holistic view of the problem. This is present when a large amount of interdependent information has to be dealt with. Complexity of interaction is present where there are interfaces between locations or humans.

Gidado (1996) divides project complexity into categories; A and B. Category A deals with components inherent in the operation of individual tasks originating from resources employed of the environment. Within category A are inherent complexity and uncertainty factors. Inherent complexity may originate from sources including technology, physical ability, availability of skills and environmental sources including site conditions. Uncertainty factors originate from the same sources as inherent complexity but refer to unknowns in both design and production which include lack of complete specifications, unfamiliarity by management of inputs and environment, lack of uniformity of work and unpredictability of the environment.

Category B deals with complexity originating from different parts put together to form a work flow. Within category B are complexities arising from placing different parts together to form a work flow. Category B components are interdependencies of various technologies involved in a task, its repeatability, rigidity of sequence of operations and overlap of construction elements. Gidado (2004) divide project complexity into six main components, which are: inherent complexity, uncertainty, number of technologies, rigidity of sequence, overlap of phases or concurrency and organizational complexity. Wood and Gidado (2008) propose to add an additional component to this list, which is information flow (internal, intra-plant and external).

Rosenhead (2001) c.f. Wood and Gidado (2008) identify lessons for managers which are drawn from complexity theory. There are two main lessons. The first includes suggestions as to how managers may approach their jobs. The second is more detailed prescriptions for particular tasks.

Bertelsen (2003) states that projects must be viewed as complex, dynamic undertakings in a complex and nonlinear setting. Uncertainty is inherent in all projects and needs to be managed (Ramgopal, 2003). Cicimil and Marshall (2005) identify three aspects of construction projects that capture persisting concerns by both researchers and practitioners. The first is the complex process of communication and power relations among the various project participants. The second is the ‘ambiguity and equivocality related to project performance criteria over time’. The third is the consequence of ‘time flux’ (i.e. change, unpredictability and the paradox of control). The following section discusses the management of complexity in construction projects from a project management perspective.

2.5 Managing complexity, uncertainty and ambiguity

Mills (2001) c.f. Wood and Gidado (2008) describe the construction industry as one of the most dynamic, risky and challenging businesses with a poor reputation of managing risks where many projects fail to meet time and cost objectives. This is supported by Mulholland and Christian (1999) c.f. Wood and Gidado (2008) who add that construction projects are performed in complex and dynamic environments resulting in high uncertainty and risk compounded by time constraints. An understanding of construction project complexity and how it may be managed is important (Wood and Gidado, 2008).

2.5.1 Stable or chaotic organizations

Working environments are becoming more complex and uncertain. Speed is making them even more dynamic (Davenport and Beck, 2001) characterized by the combined effects of complexity, uncertainty and speed (Laufer et al., 2008). The general body of project management literature is well suited to a static environment, but does not provide useful guidelines for functioning under dynamic conditions (Akintoye et al., 2000; Nicolini, 2001; Lingard, 2003; Laufer, 2008).

Contingency theory argues that when organizations view the environment they are working in as dynamic and complex the response is to organize with more complex organic structures (i.e. complexity absorption responses). These types of organizations are characterized by *multiple and conflicting goals, a variety of strategic priorities, increased connectivity among people as well as structural variety intended to maximize the flow of information and meaning in the organization.* When organizations view the environment they are working in as stable and static they respond with simpler and more mechanistic ways. In some cases organizations working in dynamic and complex organizations choose to organize in simple mechanistic ways (i.e. complexity reduction responses). These organizations are characterized by *higher value on control, predictability, and the pursuit of equilibrium even in the midst of complexity, chaos and change* (Ashmos et al., 2000). Ashmos et al. (2000) in their study conclude that organizations employing a complexity absorption response outperformed those employing a complexity reduction response.

Shenhar (2001) provides descriptions of the mechanistic and organic organizations, where the mechanistic organization is described as formal, centralized and specialized. There are many authority levels and communication level is minimal. The organic structure is informal, decentralized, have fewer authority levels, are not specialized and use extensive levels of communication. The mechanistic organization would be able to cope with the less turbulent environment, whereas the organic organization would be able to cope with uncertainty and complexity better.

Ashmos et al. (2000) state that pursuing complex absorption strategies poses challenges. The problems would inherently be the same, including conflict, ambiguity and disorder, but that managers should work with these problems rather than impose a simplified strategy on them. Uncertainty due to ambiguities improves when people work together. Therefore, uncertainty is reduced not merely by the information, but with information interpreted through the social network. Additionally, disorder can be accepted as change does not occur without a move from the current order.

Eijnatten (2004) cite the definition of “chaordic” according to The Chaordic Alliance (1998) as:

1. *anything simultaneously orderly and chaotic;*
2. *patterned in a way dominated neither by order nor chaos; and*
3. *existing in the phase between order and chaos.*

The chaordic systems are complex and are said to be able to thrive in “Far-From-Equilibrium (FFE)” conditions.

Geraldi (2008) indicates that during the early phases of projects there is chaos, whereas in subsequent phases there is a demand for order. Projects, thereby, demand both mechanistic and organic structures, requiring flexible organizations with varying degrees. Geraldi (2008) continues to state that companies, in their wish to avoid inefficiency and overcome uncertainty and risks, are pressured into higher levels of control and systemizing the work. The functions of the project manager are then to manage papers and forms, versus managing creativity, change and risk. Being at the “edge of chaos” is characterized by: (1) various challenges demand different organizational structures, enabling companies to be flexible and efficient, and; (2) it enhances dynamic capabilities of the organization, where inertia and rigidity would be harmful.

Shenhar (2001) states that the project management literature has assumed that all projects share a common set of managerial characteristics, and contingencies of projects have been ignored. In his study Shenhar (2001) provides a typology of projects based on their technical features and system characteristics. However, he adds that there are more variables that are not incorporated in this typology. Additionally, he notes that projects may not be classified according to the old organization distinction and the specific project type should be considered during project planning. This would affect the selection of project leaders, team members and skill requirements.

In light of the great confusion between how projects are organized and the complex, uncertain and ambiguous characteristics of project environments as well as the lack of practical tools to guide practitioners a question here is:

How are projects organized in practice in mega construction projects to overcome complexity?

In order to start to respond to the question the requirements for construction projects from the literature are reviewed. This is presented in the following subsections.

2.5.2 Requirements for managing complexity

Several studies have been undertaken in Hong Kong and Australia demonstrating the strong relationship between planning and control and managerial performance of construction management teams (Walker, 1994; Chan and Kumaraswamy, 1995, 1997; Chan, 1996; Vines, 1998 c.f. Walker and Shen, 2002). Key implications resulting from these studies highlight the role of the client / client representative, an acceptable working relationship that should be established, and the construction management team's response to planning and control, which should be excellent (Walker and Shen, 2002). This supports the need for agility and flexibility of response called for in lean construction. Being agile refers to the 'responsiveness of manufacturers and suppliers to customer demands and to the production process'

(Walker and Shen, 2002). The 'drivers' include the need to be agile; 'intent to be agile'; a strategy to be agile, and; having agility capabilities (Walker and Shen, 2002). Having agility capabilities include responsiveness, competence, flexibility and speed (Zhang and Sharifi, 2000 c.f. Walker and Shen, 2002). 'Responsiveness' includes the ability for identification of change required and responding to them reactively or proactively to recover from them (Ballard and Howell, 1997; Zhang and Sharifi, 2000 c.f. Walker and Shen, 2002). Koskela (2000) c.f. Walker and Shen (2002) indicate a connection between a view of the construction production as transformational, flow and value.

Walker and Shen (2002) state that the ability to be flexible or agile is dependent upon organizations and people drivers and inhibitors. Agility drivers encourage organizations and individuals to be agile, referring to the competitive environment, 'the strategic intent to be agile' and the reactive or proactive strategy adopted. Practices, methods and tools used to be agile demonstrate agility capabilities, which are enhanced by information for decision-making including information on organizations, technology, people and innovation (Zhang and Sharifi, 2000 c.f. Walker and Shen, 2002)

Planning is considered one of the most important managerial functions that when done well brings success for a given construction process, which should consider project complexity (Gidado, 1996). Planning is described as an 'evolving' process (Walker and Shen, 2002), where knowledge creation is vital for effectiveness and innovation in organizations (Nonaka and Takeuchi, 1995 c.f. Walker and Shen, 2002). A construction management team's capacity to exercise flexibility is influenced by drivers and inhibitors of agility. Manifestations of agility capability include competence, responsiveness, flexibility and speed of delivering (Zhang and Sharifi, 2000 c.f. Walker and Shen, 2002).

Pich et al. (2002) state that unforeseen events alter operations. In these cases, risk management techniques are insufficient. The challenge is to quickly recognize these events and develop an appropriate response. This requires the team to have the will and capacity to learn and replan rather than using preplanned contingency responses, as the benefits of redefining the course of action may outweigh the cost (Pich et al., 2002).

Pich et al. (2002) state that flexibility is key to overcoming unforeseen uncertainty. However, the authors continue to state that the level of flexibility cannot be achieved without relationships characterized by trust and willingness to share risks, which relieves the team members and parties from anticipating 'every little event and activity'. Therefore, a high level of project management flexibility is required. A team must be evaluated on the quality of their problem-solving and their ability to pursue opportunities arising and should not be judged by targets (Pich et al., 2002). Crawford and Pollack (2002) add that a construction team having an ability to exercise flexibility in planning, decision-making and communication does not necessarily lead to successful planning or execution. There needs to be a desire, the commitment to act flexibly and a structure to support it. How projects are planned and managed through construction projects should be studied further in relation to flexibility and agility (Crawford and Pollack, 2002).

In addition to increased complexity, there is a shortage of reliable and updated information creating uncertainty. Additionally, client demands and the need to respond quickly to markets causes further uncertainty. Under these conditions, updated information in minimum time is required, which poses a challenge for project managers. Although there are tools and methods developed, they do not address the issue of uncertainty (Laufer et al., 2008).

Over and above complexity and uncertainty, speed compounds their effects (Luafer et al., 2008). The implication to a project manager is scarcity of time and attention (Kelly, 1998). It has provided the increased capacity of information throughput, resulting in more people overwhelmed with information in a short period (Hudson et al., 2002). Communicating effectively with complexity and uncertainty is difficult and becomes even more complicated with speed (Luafer et al., 2008).

2.6 Communication and information flow within complexity

2.6.1 The need for effective communication in construction

Completion of construction projects depends on the accuracy and timeliness of information exchange between the project team (Dawood et al., 2002). Cornick (1990) in a study performed states that two thirds of construction problems are caused by inadequate coordination and inefficient means of communication and information flow. Project managers spend much of their time solving problems resulting from poor coordination, lack of timely information, inaccurate or out-of-date information, etc. (Navon and Sacks, 2007).

There is vast amount of communication that occurs simultaneously within construction projects. The importance of communication cannot be overestimated. At an individual and team level, people find it difficult to function without the development of a mutually agreed method of communication to underlie their work activities (Dainty et al., 2006). Dainty et al. (2006) further state that the management of organizational processes also demands that robust and effective communication channels are developed which enable their various components to be conjoined appropriately. Clarke (1999) states that successful communication needs to be focused and timing is critical. The benefits of good communication use include: (1) reduction of non-productive effort; (2) avoiding duplication; (3) assisting elimination of mistakes; (4) assisting in managing uncertainty; (5) probability of leading to identification of problems earlier; (6) generation of ideas that lead to better solutions; (7) encourages teamwork; (8) increases motivation, and; (9) ensures the involvement of all key players.

Information transfer, exchange and use are what construction is about. Information flow and transfer and control of knowledge are a main concern. The construction process relies on generation of large amounts of information, its transmission, interpretation, maintenance, reuse and eventual recycling. Communication and information are tightly linked and should be addressed together. Therefore, communication and information management is of criticality in construction (Emmitt and Gorse, 2003).

2.6.2 Formal and informal communication

Higgin and Jessop’s (1966) c.f. Emmitt and Gorse (2003) pilot study describe the communication and information flow as stemming from uncertainty and interdependence of different pieces of information to each other. They highlighted that organizations are not static. They recognized that if communication flow is blocked different organizational groupings developed relative to others where communication was integrated and flowing. The study recommended that construction required collaborative leadership.

The current competitive market is determined by clients who are more knowledgeable, demanding and dictating higher standards (Fryer, 1997, Dulaimi and Langford (1999) c.f. Laufer et al., 2008). This has made the working environment even more dynamic (Davenport and Beck, 2001 c.f. Laufer et al., 2008). Project managers are required to function under dynamic conditions (Akintoye et al., 2000; Nicolini, 2001; Lingard, 2003 c.f. Laufer et al., 2008). Effective communication under dynamic conditions, amplified by its affects of complexity, uncertainty and speed poses a great challenge (Laufer et al, 2008). Gidado (1996) adds that communicational challenges are likely to increase with time.

In relation to project dependent characteristics, as well as complex structure and temporary supply change characteristics, there is influence in the way organizations and individuals interact during execution of a project. The client will influence the communication culture in the project by setting the budget and time for completion. The chosen procurement route will affect formal communication routes and responsibilities of various organizations working in the project. The individual organizations employed to work in the design or assembly of the project is rarely stable as their age and culture will change over time. People change jobs over a project duration affecting informal communication channels where new employees have to learn about the project quickly and develop informal communication channels. Organizational communication tends to focus on vertical communication, whereas, the project further requires effective inter-organizational communication. Individuals within various organizations have to communicate. Sometimes personality clashes happen which can affect a communication route. Formal communication routes are complicated by informal routes adopted, usually to overcome problems with the formal route. Both inter-disciplinary and inter-organizational communication requires careful consideration (Emmitt and Gorse, 2003).

Murray (1976) c.f. Emmitt and Gorse (2003) provides communication skills most needed in a public sector environment and ranked them by importance as: (1) Oral communication; (2) Written communication; (3) Interpersonal skills; (4) Group leadership abilities; (5) Ability to persuade, and; (6) Small-group dynamics. A survey of 25 organizational communication studies performed by Di Salvo (1980) c.f. Emmitt and Gorse (2003) identified most common communication skills as: listening, written communication, oral reports, motivating, interpersonal skills, information interviewing and small-group problem solving. However, there is a lack of studies on the use of communication modes (Emmitt and Gorse, 2003).

The modes of communication have presented a challenge to construction projects in how these are used and which are preferred (Tai et al., 2009). Emmitt and Gorse (2003) state that the selection of one medium over another is dependent on the set of circumstances. Factors such as the context, characteristics of individuals communicating, environment in which communication takes place in addition to time pressures may determine the most effective communication (Emmitt and Gorse, 2003). In a study performed by Gorse (2002) it was found that all of those surveyed found each communication mode having varying degrees of effectiveness.

All parties involved in a project potentially influence it. The challenge faced by the management team is to interact with the various parties positively to ensure production of required information and its successful use. Reality of this interaction is more complex than one party interacting with another as formal and informal links will have either a positive or negative influence on those they are communicating with. This is seen in Figure 2-2. The task of the management and project team is to interact to ensure a positive influence on the communication process to ensure that action leads to completion of a project to its objectives (Emmitt and Gorse, 2003).

Pietroforte (1992) c.f. Emmitt and Gorse (2003) in the study performed found that the interaction between professionals was different than that set out in contracts and stated in textbooks. The author found that much of the process was performed through informal relationships and ‘causal roles’ with exchange of small pieces of information amongst participants to assist in understanding. Furthermore, Hill (1995) c.f. Emmitt and Gorse (2003) concluded that formal communication routes were ineffective. This ineffectiveness resulted in use of informal channels, largely for reduction of time to get information, which would allow work to continue without delay. In a study performed by Gorse (2002) it was found that most professionals identified informal communication as the most effective environment.

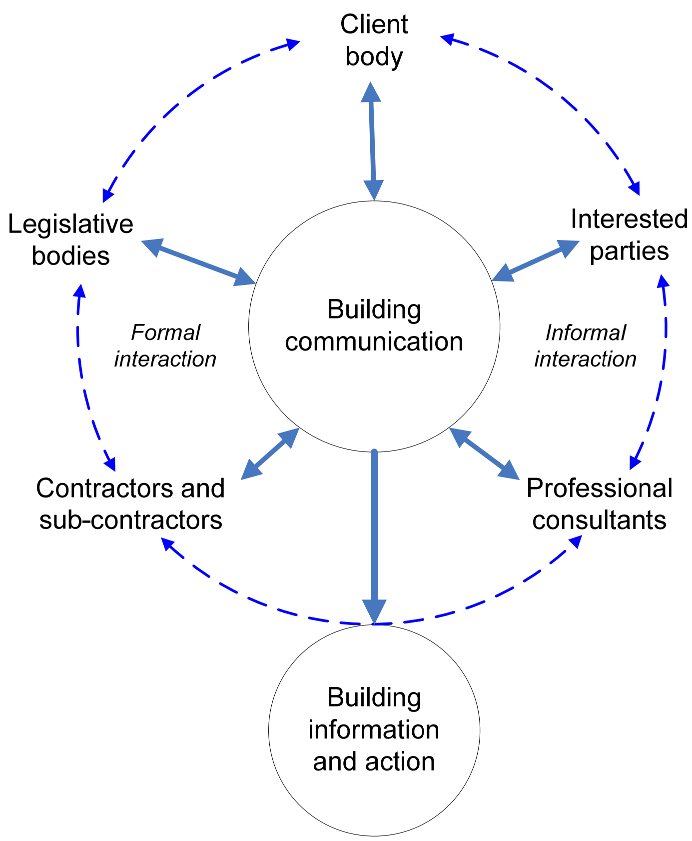


Figure 2-2 Influential parties and interaction to manage building information (Developed from Emmitt and Gorse, 2003)

Applebaum (1982) describes the resulting situation of an introduction of computer methods into a large, bureaucratically organized management team of a construction project as follows:

"*... we have virtually two separate organizations; one for the management function and one for getting the work done. The two organizations do not coordinate their work, and they are characterized by different goals and viewpoints*" (p. 229)

Pietroforte (1997) reinforces this view where he finds that demands of fast-tracking increases the distance between the pattern of roles and rules provided by standard contracts and the one that emerges in practice. The Tavistock Institute (1966) in a study found that two important characteristics of construction were interdependence and uncertainty. It was found that the construction industry relies on an informal system to work adequately. The relationships between the formal and informal systems and their characteristics in regards to the task conclude that the formal system does not recognize the uncertainty and interdependence between operations in the construction process. The informal system is more adept in handling uncertainty and interdependence. However, the disadvantage of the informal system is the constant crisis that it produces.

Emmitt and Gorse (2003) provide three levels of networks in construction projects. The formal network is established by the client or client representative, which is still affected by contributions of some with no contractual links. The second level of network is the statutory network depending on the physical location of the project. The third level is the informal network, which is beyond the control of the project manager, whereby he or she, to the best ability, can only ‘manage’ relationships that develop.

However, the standardizations and attempt at providing standards and enforcing IT solutions may be counterproductive. Communication is about problem solving. If standards are used, the process becomes a formal one. The level of formality reduces the ability to solve problems (Keating et al., 2001). Keating et al. (2001) suggest formal approaches for “problem solving has been linear, stepwise, and sequential in nature”. Keating et al. (2001) continues to add that “formal methods relying on rational sequential logic are of limited utility for problems emerging from complex turbulent environments”.

In support of problems in formal systems, Antoniadis et al. (2006) state that construction projects rely on the effective organization and integration of several subsystems to reduce the effects of complexity. The authors state that reporting is generally considered as a written form of communication and is viewed as a feedback mechanism. However, they add that the interconnections and factors affecting reporting in reality increase the level of complexity and often work against managing the project efficiently. This view is shared by practitioners who view reporting as difficult and is perceived as a bureaucratic process which does not contribute to the decision-making process (Antoniadis et al., 2006). Antoniadis et al. (2006) state that communication and information flows into and out of the process, created within and by it, generates reports, and thereby, is affected by complexity.

In a study performed by Gorse (2002), informal communication was generally found to be essential for management and administration of day-to-day activities and solving minor problems. Issues requiring agreement across organizations required a more structured and formal form of communication. However, it was viewed that informal environments were more effective allowing free flow of communication and informal interaction was rated more highly than formal interaction (Gorse, 2002).

2.6.3 Technology and information systems

Strategic implementation of IT/IS projects in construction are stated to require the development of strategic implementation plans before commencement of IT/IS project applications (Stewart, 2002). There are several attempts made in order to achieve success in IT/IS application in construction. For example, Pena-Mora et al. (2002) provide an IT planning framework for large-scale construction projects.

IT has been claimed to be widely used by the construction industry (Fuchter, 1998). Some researchers claim that there is a failure to realize the potential of IT due to organizational issues (Markus and Robey, 1988). Whyte et al. (2002) provides a glimpse of VR (Virtual Reality) application in architecture through use of 3-D applications. Researchers have demonstrated the benefits of the technology in architectural design (Kurmann et al., 1997). Yet, there are few users of the technology (Whyte et al., 1999). Additionally, characteristics of the technology may also contribute to its success or failure (Yetton et al., 1999). Thus attainment of sustained IT-based competitive advantage may be more a process of building organizational infrastructure in order to enable innovative action strategies rather than being first on the scene (Peppard and Ward, 1999).

The literature on the introduction of early CAD systems shows that implementation often took longer than anticipated (Schaffitzel and Kersten, 1985). Implementation was led by technical staff at middle-management level, and often through newly created positions or departments (Currie, 1989). The technical managers who led the implementation shouldered responsibility for it, and implementation was hampered by insufficient user-developer interaction (Schaffitzel and Kersten, 1985), and a mismatch between the investment in CAD and broader corporate strategy (Currie, 1989). Databases have since been developed incorporating CAD, a Project Management Package and Graphical User interfaces (Dawood et al., 2002).

Aouad and Sun (1999) state that in order to improve efficiency of communication in the construction industry it is necessary to establish an information structure using state of the art technology. The authors indicate that integrated processes are gaining importance as evidenced from the number of research projects in Europe and the U.K. On the other hand, Weippert et al. (2003) in their study for online ICT state that from the data collected it could not be determined whether the Web-based IT solutions developed positively influenced communication between project participants.

Information management as defined by Johnson (1992) is “the overall management and control of an organization’s investment in information, including identifying and sharing management information, and ensuring standardization, control, security and integrity of data stored”. Gyoampoh-Vidogah et al. (2003) and Joia (1998) define documents as “the presentation of information in a structured way”. Gyoampoh-Vidigah et al. (2003) state that documents remain the best way of communicating and creating information despite the emergence of modern information technology (IT), which is especially true for the construction industry.

Better means of managing the information flow in construction projects results in enhanced productivity of projects (Titus and Brochner, 2005). Stewart (2003) states that continuous project improvement through the implementation of information and communication technologies are essential for the long-term survival of construction firms. Moore and Dainty (1999) state that IMSs will drive the construction industry towards fully integrated project teams.

Some researchers have focused on the technical features of Electronic Document Management Systems (EDMSs) and their correspondence with user requirements (Luedke et al., 2001). Bjork (2006) studies the web-based EDMs in project-based industry (i.e. construction projects) and provides guidelines to the service of the EDM in construction projects. Stewart et al. (2002) provide a case study for the successful implementation of IT/IS in construction projects. Craig and Sommerville (2006) state the benefits achieved by use of Information Management Systems in construction projects will aid transfer of information and increase communication between the parties, but they warn that IMSs will change the way people work.

Other researchers have focused on the organizational and behavioural aspects of taking systems into use (O'Brian, 2000), which is in line with the general literature on IT adoption (Venkatesh et al., 2003). Nitithamyong and Skibniewski (2006) provide a list of factors to consider in the implementation of web-based project management systems, which include project team characteristics including team attitudes towards IT. Additionally, Alshawi and Ingirige (2003) conclude that for successful IT adoption equal consideration should be given to technology, processes and people. Mohammed and Stewart (2003) went a further step and studied user perceptions of the use of an EDM system in a case study where the results indicate a high level of satisfaction with the system itself but low levels of satisfaction with training and support. Craig and Sommerville (2006) state that many major construction industry clients and main contractors are now adopting integrated construction processes using information management systems. The underlying premise being that all project participants are able to develop core skills in creating, communicating and transferring project data electronically.

Clarke et al. (2003) state that IT applications seem efficient and promise a productivity increase when considering supporting a task. However, the authors continue to state that investigations into the actual impacts of IT in construction have not been as claimed in the literature, especially regarding site construction. IT has not brought any major benefits and it is claimed that there may have been negative impacts. The claims and visions of the positive impacts of the use of construction IT have turned out to be distant from reality.

There are several views regarding why IT has not been successful in construction. Strassman (1997) argues that IT investments have been poorly managed. Davenport (1994) states that the underlying view that IT implementation leads directly to benefits and improvement in construction has become a bottleneck in itself due to its excessive focus on technology versus the context of its application. Gann (2000) provides reasons that support Davenport's argument. Another explanation by Clarke et al. (2003) relates to the situation where in production the majority of costs originate from the physical processes and that the impact of information processes on physical processes is indirect only and strong casual relationships are not necessarily present. Johnson and Kaplan (1987) have argued that the traditional way of thinking has been that costs are caused by direct work, and thereby, the indirect costs of IT is difficult to relate to direct costs. Yet another argument by Korela (2000) is that IT has been largely addressing individual tasks, which cannot influence the share of cost and time caused by non-value-adding activities caused in large part by lack of coordination of tasks. Another argument is that it is not easy to influence physical processes by means of IT (Applebaum, 1982).

The majority of the literature seems to equate information management systems with document management systems. Even in defining information management due regard is given solely to the movement of documented information electronically. Additionally, there is too much concentration in the literature on technology and little focus on the human aspect and there is a tendency to lose sight of what is required on construction sites.

2.6.4 People side of information systems

Sabaa (2001) states that the most important skills required by a project manager are the human skills, organizational skills and technical skills. Managing human factors is critical for project success and includes competition, skill, motivation, loyalty and revenge, and is random in nature (Pender, 2001). It is noted that the majority of construction practitioners recognize the importance of human factors to construction project success (Thevendran and Mawdesley, 2004). Despite the recognition of the importance of human factors by construction practitioners and the wide recognition that human factors are a main contributor to construction project failure, human factors are still not addressed adequately (Oldfield and Ocock, 1997).

Tai et al. (2009) state that communication is the means linking members of the organization for the purpose of achieving common objectives. In essence, if there is no communication, there are no objectives to achieve. Communication is at the heart of management and is the determining factor of efficiency. Communication problems during project execution cause an increase in unnecessary expenses, and affects progress and quality of the project (Anunmba et al., 1997; Anunmba and Evbuowan, 1999; Higgin and Jessop, 2001). Communication problems are further compounded during project execution since that is where the largest volume of communication occurs (Tai et al., 2009).

Communication is best described as a 'pipeline' through which information flows from one entity to another (Axley, 1984 c.f. Dainty et al., 2006). Therefore, without communication there can be to information flow (Dainty et al., 2006). Emmitt and Gorse (2003) use the definition provided by Rogers and Kincaid (1981; pg 63) as "a process in which the participants create and share information with one another in order to reach mutual understanding". Emmitt and Gorse (2003) use the main competent provided by Tubbs and Moss (1981) to further explain the information exchange occurring during the communication process by participants as:

- *The creation of meaning between two or more people;*
- *The essence of communication being to send, place, exhibit or manifest a message, signal, code, movement or other stimulus which means something to the receiver;*
- *Information communicated will not mean the same to the sender, but invoke a reaction, manifest a thought that has relevance to both receiver and sender;*
- *The relevance of the communication need not be the same to the sender and the receiver.*

Effective communication under dynamic conditions is challenged due to the "combined and amplified" effect of complexity, uncertainty and speed (Laufer et al. (2008). The number of organizations in a project and the diverse disciplines gathered together for a limited time to execute a construction project poses increased complexity (Bacarrini, 1996). The result is a noncohesive multiorganization structure (Laufer et al., 2008). Munns (1995), as cited by Laufer et al. (2008), states that under these circumstances the success of the project manager depends on their ability to create personal connections and trustful relationships between people in the project.

The nature of construction projects is stated to inhibit communication. Construction projects are performed using a mixture of organizations and individuals with various skills to create a team for the first time for one specific project for a specific objective. This implies that the 'project team' is a 'loose coalition' of organizations and people, which changes during the life cycle of the project. It is people who build and people who communicate to achieve a common objective. Effective communication between project participants is key to a successful project (Emmitt and Gorse, 2003). Cooke-

Davies (2002) asserts that it is people who deliver projects and not processes or systems.

The ability to exercise flexibility during construction to overcome unexpected problems is influenced by the ability to be flexible and the commitment to do so (Walker and Shen, 2002). The ability of teams and individuals to be flexible is influenced by the extent of understanding of project complexity and flexibility to ‘adopt options to overcome unexpected problems’ (Walker and Shen, 2002). A system is only as good as the people who use it (Emmitt and Gorse, 2003).

Much of the formal communication during construction flows through the architect or contractor where design information is communicated through the architect and building and assembly information through the contractor. Some of the information may travel through long chains before reaching a central hub. If problems are encountered face-to-face interaction may be required to resolve them. Large amounts of information may cause the person at the hub to be overloaded with information (Emmitt and Gorse, 2003). Formal structures present barriers to open discussion (Dainty et al., 2006) as many professionals avoid seeking help in formal environments (Lee, 1997 c.f. Gorse et al., 2006). Many decisions are made outside the formal environment (Emmitt and Gorse, 2003).

Group networks and relationships are important. No group, whether formal or informal can function properly without effective communication. The free flow of information determines to a large extent the efficiency and satisfaction of the group (Shaw, 1981 c.f. Emmitt and Gorse, 2003). Furthermore, interpersonal interaction is more likely to allow individuals to seek assistance (Gorse et al., 2006), where cooperative patterns of behaviour tend to be reciprocated (Patchen et al., 1993 c.f. Gorse et al., 2006). In fact, group workers cite poor interpersonal and communication skills as a main cause of group failure (DiSalvo et al., 1989 c.f. Gorse et al., 2006b). Additionally, Shaw (1981) c.f. Emmitt and Gorse (2003) found that with increased complexity of the task the decentralized (comcon, circle) network was found to be the most efficient.

2.6.5 Information management systems within complexity

Jaafari and Manirong (1998) c.f. Antoniadis et al. (2006) state that as project environments become more complex and demanding there is an importance for the project information system to be flexible, instantaneous, comprehensive and intelligent. The creation of flexible and structured information systems is critical (Antoniadis et al., 2006). A key aspect of a good information management system is to plan, monitor, and control and manage the process effectively, taking into account the iterative nature of the process and the changing needs of the project stakeholders (Choo and Johnston, 2004). Questions at this junction to guide the research are:

Q2: *What are the modes and routes of communication used in practice, when is each effective and which are considered formal or informal?*

Q3: *What are the advantages and disadvantages of formal and informal communication and what are the technical and human roles in it?*

Q4: *How do formal and informal communications relate in practice in mega construction projects to handle complexity?*

2.7 Top management role in communication and complexity

Projects are complex structures. Various organizations are involved in different capacities where there is little consideration for cooperation and collaboration. There is no single 'team' but a temporary (ad hoc) arrangement of various organizations to complete a project. Additionally, there is no overall goal except for 'shared and /or individual project deadlines'. A well managed project would create a 'unified' approach (Emmitt and Gorse, 2003).

Cicimil and Marshall (2005) state that various contractual arrangements have been studied by researchers such as Green (1998), Green and May (2002), Bresnen and Marshall, (2000) and Walker (2002). Despite the vast body of literature it is acknowledge that structural intervention (i.e. contractual forms) are insufficient in dealing with the complexity of construction projects and the inherent paradox of construction. The inherent paradox is the relationship between project performance and control, and the process of cooperation, collaboration and learning and is often highlighted as key issues (Cicimil and Marshall, 2005).

Reliance of construction on various sectors for input into the project as well as the duration of design and construction phases is a reason for people changing, sometimes several times. Thereby, contact is temporary. In such circumstances co-operation may be difficult (Emmitt and Gorse, 2003).

Construction projects rely on the integrated efforts of several parties using differentiated skills, knowledge and technology (Li et al., 2000). Construction is built on temporary alliances between several parties for the objective of completing a project (Emmitt and Gorse, 2003). Significant cultural differences exist in task organization, sources of power and influence, control and coordination, formality, people issues and nature of the task. From this, conflicts are most likely to occur between the parties. Awareness of the differences may assist in achieving the right "project chemistry" when establishing the team resulting in overall project performance (Ankrah and Langford, 2005).

More than half of the alliances between firms fail (Dyer et al., 2001). These are several reasons for this high rate of failure; one is the risky nature of alliances themselves where deceit is one potential risk (Adobor, 2006). Das and Feng (1994) provide two main risks in alliances, which are:

- Performance risk - the probability of not achieving performance objectives, even when partners cooperate fully with each other.
- Relational risk – probability that partners will not cooperate fully.

Relational risk may be reduced by use of contracts and monitoring. Another means of reducing risks and managing alliances is reliance on interpersonal relationships between individuals in the alliances. Development of friendships and trust between people in alliances is encouraged (Spekman et al., 1996). “It would be difficult for two firms to work well together if managers and key people at the boundaries of the firms did not get along” (Adobor, 2006). According to John Browne, CEO of British Petroleum, “You never build a relationship between your organization and a company ….. You build it between individuals” (Pietroforte, 1997, Pg 155 c.f. Adobor, 2006).

Cheng and Li (2001) refer to project application as the execution of the informal relationship to accomplish mutually agreed project objectives. Adobor (2006) provides a diagram relating the importance of personal relations to the life cycle of an alliance. This is shown in Figure 2-3. From the diagram it is evident that personal relations are more important in the early phase of alliances than later (Seabrigist et al., 1992 c.f. Adobor, 2006).

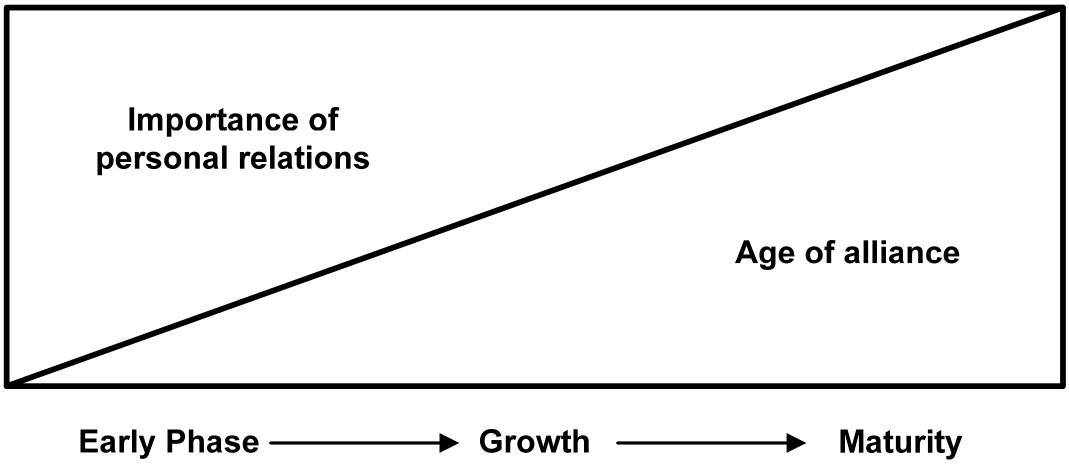


Figure 2-3 Importance of relations to life-cycle of alliance (Developed from Adobor, 2006)

Adobor (2006) lists advantages of personal relationships between managers on alliances:

- Speed up the alliance formation process - many alliances are formed on the impetus of personal relationships (Volcon et al., 1999; Uzzi, 1996 cf Adobor, 2006)
- Reduce relational risk - strong initial trust is often provided on the basis of interpersonal relationship (Zaheer et al., 1998 c.f. Adobor, 2006). It helps reduce the relational risk.
- Build and strengthen trust - At early stages of alliances, uncertainty exists and personal relationship can provide the "comfort" required in the alliance to be formed. Interpersonal relations can provide the groundwork for collaboration as small conflicts can be resolved before they escalate (Kanter, 1994, Pg 106 c.f. Adobor, 2006).
- Help reduce uncertainty in the alliance – sociologists indicate that trust reduces social "uncertainty".

Even weak ties between people who rarely interact and do not have close relationships may still benefit from these relationships as this can be an important means for information exchange between groups that do not interact. A manager experienced in alliances states “there is not good system for working out problems except through personal relationships” (Adobor, 2006).

As stated previously, construction projects involve several organizations including the client, consultant, contractors and suppliers (e.g. Emmitt and Gorse, 2003). Kometa et al. (1995) performed a study of client’s needs and responsibilities in construction projects and conclude that understanding of construction client needs by both clients and consultants as well as proactive involvement of the client increases the chances of producing successful projects. The authors add that the client has a tremendous responsibility in ensuring the success of their projects. Bennett (1985) c.f. Kometa et al. (1995) provide a range of far reaching scope of involvement of the client under the headings of: (1) project objectives; (2) outline of project organization; (3) selection of project team; (4) established method of control over project team, and; (5) establish the project culture. Inexperienced clients would not be able to handle the responsibilities due to their lack of knowledge of the construction process (Higgin and Jessop, 1965 and NEDO, 1983 c.f. Kometa et al., 1995). The four most important client responsibilities are: (1) planning/design; (2) project finance; (3) project implementation/management, and; (4) project definition/formulation, which are confirmed by the consultants in the survey, although the ranking was different (Kometa et al., 1995).

Walker (1998) states that when the client places a high priority on construction time and quality construction projects appear to be faster when those objectives are identified, committed to and communicated. The author provides four main characteristics of the client representative that retain confidence from their construction and design teams. These are: (1) sophistication in terms of knowledge of the project scope and complexity and are able to offer as well as accept advice regards both design and construction; (2) good communication skills; (3) good team-building and interpersonal skills, and (4) clearly communicate the client priority objectives. The client (or client representative) role in establishing the culture in the project is documented in the literature (Emmitt and Gorse, 2003; Walker, 1998). Good political and leadership skills of the client representative can contribute to effective communication and decision-making as well as facilitating cooperation between teams to focus on, and achieve, client objectives (Emmitt and Gorse, 2003; Walker, 1998).

In a study performed by Gorse et al. (2002) it was found that the degree of effectiveness of a contractor’s representative was judged by their previous ability to deliver contracts within time and budget. The main characteristics of those viewed as more effective included: (1) used a broader range of communication acts to achieve their objectives; (2) seek information, explore suggestions, ask for explanations and then make others commit to their proposals; (3) direct the group ensuring their productivity and attempting to solve as many problems within the time available, deemphasizing irrelevant issues; (4) use emotion to convey the importance of a priority issue, and; (5) use emotional interaction to maintain relationships.

A question to guide the research is:
Q5*: What is the role of top management in construction projects and what characteristics are required for effective communication and which party is most crucial in its establishment?*

2.8 Summary

This chapter provides the framework surrounding the main causes of problems in communication and information management in mega construction projects. From the literature review this chapter outlined the nature of construction projects and establishes the need to view projects as systems. The chapter reviewed the literature on complexity, uncertainty, ambiguity and interdependence from the perspective of the nature of construction projects viewing them as systems. The chapter then reviewed the literature on management of complexity, uncertainty and ambiguity introducing a debate on the suitability of stable and chaotic organizations for that purpose. Furthermore, the requirements for managing complexity are reviewed from the literature.

The chapter reviewed the literature on communication and information flow within the dimensions of complexity establishing the need for effective communication in construction. The chapter reviewed the literature describing how formal and informal communication relate to complexity and the effectiveness of each as well as the debate on the roles of technology and information systems and people therein. The role of top management in communication and complexity is provided form the literature review highlighting the importance of individuals for overcoming complexity and establishing effective communication in construction projects. The chapter included several questions to guide the research analysis. The following chapter discusses communication and information management processes in construction projects to perform a transformation of the product.

CHAPTER 3 DYNAMIC COMMUNICATION AND INFORMATION MANAGEMENT

3.1 Introduction

Due to the dynamic nature of construction projects (e.g. Laufer et al., 2008 and Mulholland and Christian, 1999), change is a fact of life in light of the inherent complexities (Laufer et al., 2008). Dynamic describes a state of constant change (Collyer and Warren, 2009). Furthermore, several authors have described the increasingly 'chaotic' environment where the future of management is change management. The vital role that project management has to play is dynamic information management (Russell-Hodge, 1995). Change is a prominent cause of problems in construction projects. Current approaches to change coordination are mostly reactive. For example, changes are likely to cause schedule conflicts among subcontractors because of the interdependence of works with other subcontractors in tight schedules in construction projects (Motawa et al., 2007).

Chapter One established the research context and background as well as the research problem, aim and objectives. Chapter Two discussed complexity issues and communication within it as well as the importance of the role of top management in establishing effective communication in construction projects. Building on Chapters One and Two this chapter reviews the literature based upon the emerging themes from the analysis of the data from the semi-structured interviews as well as issues highlighted in the literature.

Building upon the previous chapters, this chapter discusses the processes of communication in performing the transformation of the project. This chapter initiates by a review of the project types establishing construction projects as 'dynamic'. A review of change in the literature is provided including a differentiation between change and rework, the relationship between change and complexity and differentiating between formal and informal communication of change.

Construction processes are then reviewed including the need to understand the construction process, the requirements of information management systems, review of available dynamic process models and acknowledgement of formal and informal processes. Two of the process models are described in further details, which show the dynamic processes and further developments made on them. The chapter then critiques the models and provides questions to further guide the analysis.

3.2 Project types

Shenhar (2001) provides a differentiation between projects based on their characteristics of technological uncertainty and levels of system scope. The typology presented provides various classifications of projects departing from the classical contingency theory of organic and mechanistic organizations. The argument is that the projects are a variation of the two extremes.

Pich et al. (2002) provide a different typology of projects based on unknowns in its environment. The authors describe projects encountering unknown unknowns as best suited to a ‘learning’ strategy involving scanning, problem-solving and flexibility. Projects working in a well understood environment are suited to ‘instructionism’. Projects which are in between these extremes are suited to ‘selectionism’ where the best choice is made following several trials.

Turner and Cochran (1993) provide yet another typology of projects. They describe four different types of project based on how well defined the methods and goals are. In the ‘goals and methods’ matrix a project with poorly defined goals is rated as ‘fire’. Projects with poorly defined methods are ‘water’. Projects with both poorly defined goals and methods are rated as ‘air’.

Cioffi (2006) provides a typology of projects based on ‘newness’. The typology is placed on a scale ranging from ‘operational’ to ‘project’ by Collyer and Warren (2009) as shown in Figure 3-1. The unknowns include all aspects of the project including objectives, methods and the environment it operates in. Table 3-1 describes the difference between operational work, classical project and dynamic project.

Projects conducted in a dynamic environment face uncertainty from the start, but also include changes during execution. In a dynamic environment projects are faced with changes of methods and goals due to external forces. Efforts at resolving uncertainties from the start are met with difficulties due to introduction of new unknowns during execution due to the fact that what has been learned may become obsolete as their introductions may be provided at a faster rate than learning. Furthermore, materials, methods and goals are always changing (Collyer and Warren, 2009).

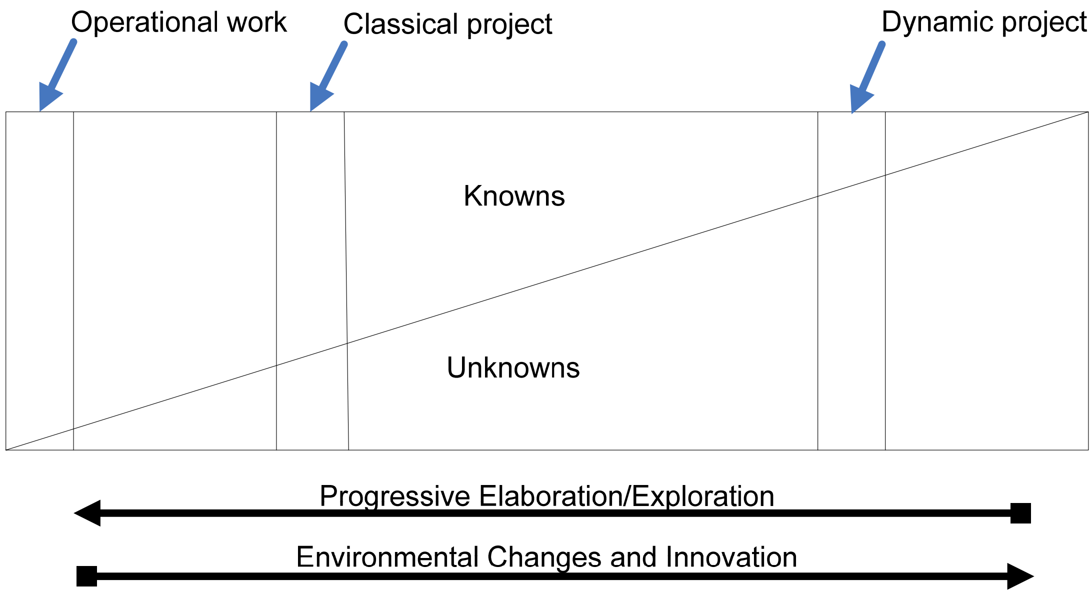


Figure 3-1 The rate to resolve project unknowns (redeveloped from Collyer and Warren, 2009)

Table 3-1 The dynamic project category (redeveloped from Collyer and Warren, 2009)

Work type	Description
Operational	Established controls. ‘Operational’ processes. Lower levels of unknowns.
Classical project	Requires the creation of new controls, usually a project plan, for a significantly new body of work, usually only carried out once. May have high levels of unknowns at the start but most resolved early, and few new unknowns arise during execution.
Dynamic project	Requires the creation of new controls that are changed regularly during execution. Has high levels of unknowns at the start and a high rate of unknowns throughout. Must resolve the unknowns at a higher rate than they appear, and in time for completion.

Collyer and Warren (2009) add that the rate of resolving unknowns is particularly critical in dynamic projects. A ‘resolution lag’ may result as adjustments made to operate in a dynamic environment as the rate of resolving the unknowns must be sufficient to resolve those from the start as well as any appearing during execution. The ‘appearance rate’ of new unknowns is high in dynamic projects and may occur in ‘bursts’ after planning is complete.

Disregarding how a project may be classified, dynamic construction projects, as provided in the previous chapter, are inherently complex. Dynamic projects face high inherent complexity, uncertainty and interdependence. This is made worse when change is introduced during execution, a subject discussed in the following subsections.

3.3 Change in construction projects

Construction projects are inherently complex (Baccarrini, 1999) and dynamic in nature (Bertelsen, 2003). Despite the dynamic nature of construction projects they have been treated as static (Lee et al., 2006). The planning and control tools available are unsuitable for dynamic environments as they ignore prevalent multiple feedbacks and nonlinear relationships of a project (Lyneis et al., 2001 c.f. Lee et al., 2006).

3.3.1 Change cause and effect

The causes and effects of change have been studied by various authors. Chan and Kumaraswamy (1997) grouped change in eight categories related to: (1) Project; (2) Client; (3) Design team; (4) Contractor; (5) Materials; (6) Labour; (7) Plant-equipment, and; (8) External factors. Akinci and Fisher (1998) divide change causes into three categories: (1) Construction specific factors; (2) Economic and political environmental factors, and; (3) Contract specific factors. Other authors such as Assaf and Al-Hejji (2006) extended this to show the differing views of the parties such as client and consultant. Wu et al. (2005) c.f. Sun and Meng (2009) extend this classification of change causes into hierarchal levels. The first level consists of eight components of external and internal cause groups. Level 2 then breaks down the cause groups into cause subgroups. Level 3 further divides subgroup causes into more specific causes. Using this, Sun and Meng (2008) developed the taxonomy for change causes and added taxonomy for change effects as shown in Table 3-2 and Table 3-3.

Despite the various categorizations of change causes and effects, change can be caused by various, or a combination, of factors. Construction projects are complex undertakings and an understanding of change cause and effects is required for effective change management. Furthermore, while the taxonomies provide the diverse nature of change cause and effects they do not show the complexity of project change itself (Sun and Meng, 2008). This requires showing the process of change, which is described, further in Subsection 2.6. However, the taxonomy shown assumes change is negative, whilst others (e.g. PMI, 2004) state that it could be either positive or negative. Furthermore, the taxonomy does not differentiate between change and rework, which is described in the following subsection.

Table 3-2 Taxonomy of change causes [Developed from Sun and Meng (2008)]

Level 1	Level 2	Level 3
External causes	Environmental factors	Conservation restrictions
		Weather conditions (wind, temperature, rain, etc.)
		Natural disaster (flood, earthquake, etc.)
		Geological conditions
		Unforeseen ground conditions
	Political factors	Changes in government policies (environmental protection, sustainability, waste recycle, brown field use, etc.)
		Changes in legislation on employment and working conditions
		Delays in planning permission approval
	Social factors	Demography change and its impact on labour demand and supply
		Skill shortage on certain trades
		Opposition of neighbouring community
	Economical factors	Economic development cycle and its impact on demand
		Inflation impact on material, equipment and labour price fluctuation
		Market competition
	Technological factors	New materials
		New construction methods
		Technology complexity
Organisational causes	Process related	Organisation business strategy
		Business procedures, including payment practices
		Quality Assurance procedure
	People related	Competence and skills
		Culture and ethics
	Technology related	IT and communication systems
		Technical supports
Project internal causes	Client generated causes	Requirement change and variation
		Funding change, i.e. shortage of funding
		Slow decision making
		Payment delays
		Difficulty in site acquisition
	Design consultant generated	Poor, incomplete drawings
		Design changes due to poor brief, errors and omissions
		Inconsistent site conditions
	Contractor/subcontractor generated	Poor project plan/schedule
		Poor site/project management skills
		Delays in appointing subcontractor
		Delay of subcontractors' work
		Poor workmanship
		Low productivity
		Poor logistic control
	Other	Poor interdisciplinary communication
		Team instability, i.e. disputes, bankruptcy, etc.
		Inappropriate project organisational structure

Table 3-3 Taxonomy of change effects [Developed from Sun and Meng (2008)]

Level 1	Level 2	Level 3
Time effect	Time extension	Addition of work
		Deletion of work
		Rework/redesign
		Work duration extension
	Loss of productivity	Productivity degradation
		Procurement delays
		Logistic delays
		Unbalanced rhythm
	Increased risk	Acceleration measures
		Interruption of flow of work
		Loss of float
		Increased sensitivity to further delays
Cost effect	Direct cost increase	Waste on abandoned work
		Demolition costs
		Increase in overheads
		Additional equipment and materials
		Additional payment to contractors
	Indirect cost increase	Interrupted cash flow
		Increased retention/contingency sum
		Overtime costs
		Litigation costs
Relationship and people effect	Relationship related	Claim and dispute
		Arbitration and litigation
		Team change
		Poor co-ordination
	Working conditions	Revision to work method
		Site congestion
		Poor safety conditions
	Staff related	Loss of learning curve
		Lower morale
		Staff turnover
	Quality	Quality degradation
		Damage to reputation

3.3.2 Change and rework

Motawa et al. (2007) state that changes in construction projects are common and can occur at any stage, from any source, for various reasons and may have considerable impact. The authors continue to state that based on time, change can be ‘anticipated or emergent, proactive or reactive, or pre-fixity or post-fixity’. Based on need change can be ‘elective or required, discretionary or non-discretionary, or preferential or regulatory’. Based on effect change can be ‘beneficial, neutral or disruptive’.

A change order is an order from the client approving or authorizing a variation. It is estimated that post contract design changes amount to 5.1 to 7.6% of the total project cost (Cox et al., 1999). Additionally, changes are considered to be one of the major causes of project delays (Al-Saggaf, 1998).

“Change orders may be defined as a change, alteration or addition with respect to the original plans, specifications or other contract documents, as well as a change in cost, which follow the creation of a legal relationship between client and contractor" (Wallace, 1994) cited in Chan and Yeong, 1995; Hanna et al., 1999; Charoenngram et al., 2003). Charoenngram et al. (2003) provide several characteristics of change orders. These are: a) it is an authorization of a change contained in a written document, b) the change is not the fault of the contractor, and c) the changed work is outside the scope of work described in the original contract and is not included in the contract price.

Change orders need to be managed carefully. The result of mismanagement of change orders may be a dispute between the client and contractor related to cost and time to perform the change order. A change order is complex as it involves all the construction teams. It involves a large amount of information that needs to be produced, checked, corrected, approved, requested, clarified, submitted, among other things (Charoenngram et al., 2003).

Furthermore, Park and Pena-Mora (2003) divide construction change into two parts as shown in Figure 3-2. The first is unintended change and the second is managerial change. Unintended change is change that takes place unintentionally and occurs without the intervention of managerial actions. Unintended change is a result of low work quality, poor work conditions or from external scope changes. They may also result from upstream "hidden changes", which are changes to work that has been inspected but not found.

Managerial change on the other hand is implemented by managerial decisions during quality management. In order that an impact of a change that has occurred is minimized, managerial changes are made on succeeding tasks. This is done by adopting a different method or process than that provided in the original contract documents.

Rework is another option during quality management. It is differentiated from managerial change in that rework does not trigger changes in subsequent tasks. Rework is done on the change to achieve what was originally intended in the original contract documents (Park and Pena-Mora, 2003). Figure 3-3 describes the differences between the above.

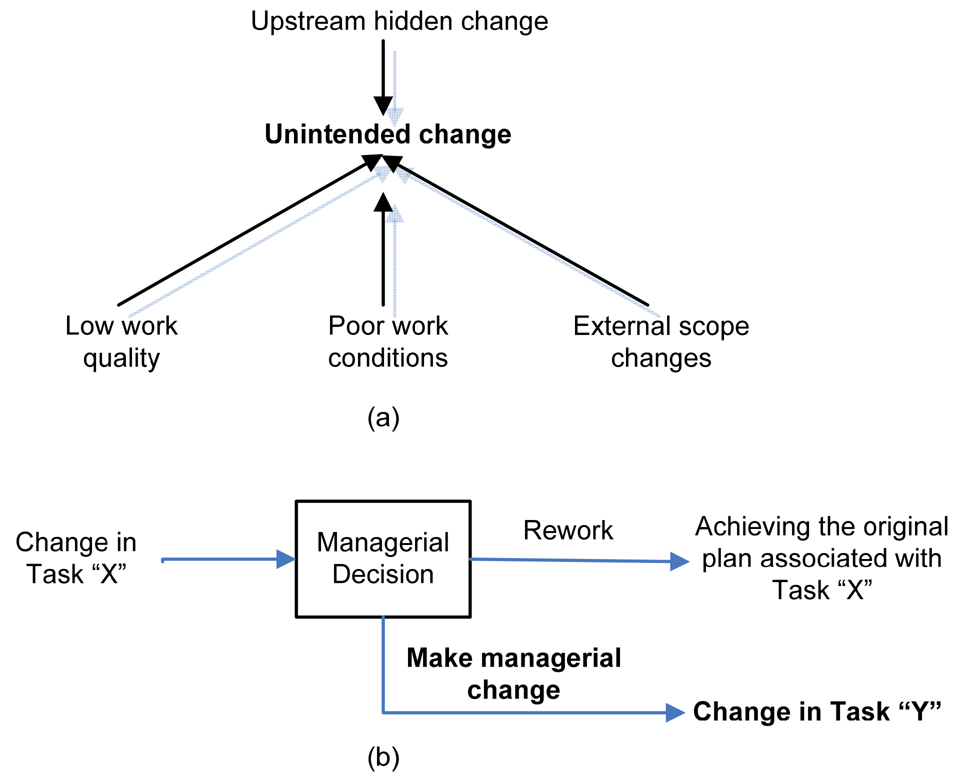


Figure 3-2 (a) Unintended and (b) managerial change processes [Developed from Park and Pena-Mora (2003)]

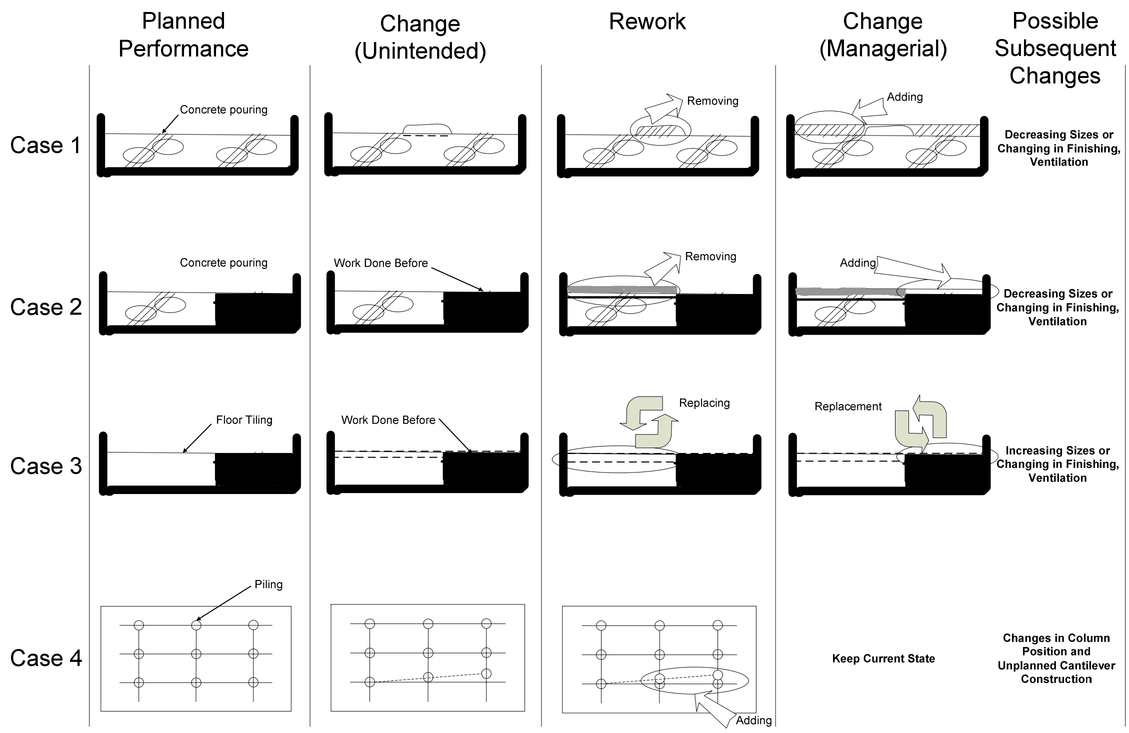


Figure 3-3 Clarification of differences between rework and change redeveloped from Park and Pena-Mora (2003)

Love et al. (2002) use system dynamics to better understand change and rework in construction. They provide a dynamic model divided into two main categories called "attended dynamics" and "unattended dynamics". Attended dynamics is dynamics designed to implement management objectives such as decision-making, techniques and technology, behavioural responses and project structure. Unattended dynamics represent unexpected events or uncertainties causing changes to a project system potentially affecting its performance.

Love et al. (2004) provide different definitions of rework from several sources. The first is from Ashford (1992) and define rework as "the process by which an item is made to conform to the original requirement by completion or correction." Another definition provided is from the Construction Development Agency (1995) which defines rework as "doing something at least one extra time due to non-conformance to requirements." Love et al. (2004) state that "rework can arise from errors, omissions, failures, damage, and change orders that occur in projects".

Despite the various definitions of rework there is no conflict in the effects of any type of change. The effects include cost and time overruns (Love et al., 2004). This is well documented in the literature. Love et al. (2004) provide a list of sources that estimate the direct costs of rework from 3% to 23% of total contract value. In this research the differentiation between change and rework is used. Concentration will be given to the change component.

3.3.3 Change and complexity

The information needs during any change is naturally more than in the normal set of procedures. This is logical since during a change there are two loops to go through. The first is the change process and the second is the redesign for the change and the information dissemination that follows. This indicates that the information requirements are larger during change.

With any change the level of uncertainty is increased. It is this uncertainty caused by any unexpected event or uncertainties causing changes to a project system. This uncertainty may be caused by both external and/or internal factors. These changes require effective and quick responses from the project team. Effective and quick responses to these changes by the project team requires the team to be dynamic, which means establishment of new relationships between resources and adjusting the mix of resources assigned to team members (Love et al., 2002).

Park and Pena-Mora (2003) state that non-value-adding iterations are created in the construction process. They further clarify that some of these iterations are unavoidable and result from complexities and uncertainties embedded in the construction process or are due to uncontrollable factors such as weather conditions. However, they further state that non-value-adding iterations in construction are mainly associated with construction changes.

Lee et al. (2005) state that due to demands for faster delivery times, concurrent design and construction is becoming more important. Increased uncertainties and complexities resulting from concurrent design and construction make projects more difficult to control. One of the main reasons is that successor activities have to start with incomplete information from predecessor activities. Due to the interrelatedness of activities, a chain of wrong decisions may result.

Sun and Meng (2008) further add that in addition to the various causes and effects of change, a change can have multiple effects. Some of the effects are interlinked. Furthermore, there are not only dependencies between causes and effects of change but also between one change and another. The authors conclude that the success of a construction project lies mainly in the ability of the project team to handle the changes.

3.3.4 Formal and informal change

Chan and Yeong (1995) provide certain elements that can be used to manage change orders. Two of these elements are quality contract documents and good communication and cooperation between the project team. Good documentation may be facilitated by establishing an effective change order system. Good communication may be facilitated by provision of information in a timely manner (Charoenngram et al., 2003).

The literature recognizes that there are other considerations than formal documentation during change. Love et al. (2002) add that relationships between team members ‘are governed formally by the contract(s) but are supplemented and moderated by informal understandings and protocol that have evolved over time; very often to cope with unforeseen difficulties’. This is due to uncertainties that may not be foreseen during a risk management exercise. It is of importance to study the construction process as communication is used to perform the process to achieve project objectives. This is the subject in the following subsections.

3.4 Processes in construction

3.4.1 The need to understand construction processes

Hill (1995) c.f. Emmitt and Gorse (2003) concluded that diversity and complexity of communication processes do not readily fit any model. Fragmentation seems to stifle the adoption of more effective organizational structures (Emmitt and Gorse, 2003). Paterson (1997) c.f. Emmitt and Gorse (2003) suggests that the solution in construction is not sophistication of current solutions but reconsideration of the problem posed by building. The author advises that if communication and information flow are to be improved a view of the whole and not parts is required as the interface between the parts may be incompatible rendering the whole inefficient. Emmitt and Gorse (2003) support this view as viewing parts leads to increased specialization, hybrid forms, fragmentation and reduced efficacy. Construction can be a simple process.

Clarke et al. (2003) provide a view on IT in construction initiated by a direction given by Ferves (1996). This direction is based on one of the components in his call for a scientific form of application of IT in civil and structural engineering. This component would deal with understanding the operational process such as planning, design and management, which engineers use.

"……we need to agree on an intellectual framework, in order to create a scientific understanding or abstraction of engineering processes in practice" (Ferves, Pg. 5)

The lack of use of IT in construction is not due to insufficient technology but rather on insufficient understanding of construction. Therefore, what is needed for construction IT research is an understanding of operations in construction. It is posited by Clarke et al. (2003) that better theories and concepts and not IT alone, can cure the problems in construction. The relationships between operations management, understanding of construction and IT is shown in Figure 3-4 below.

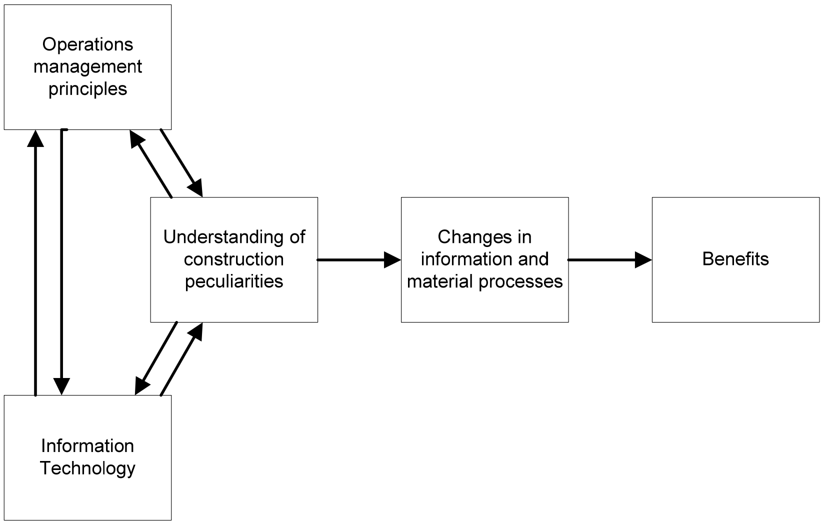


Figure 3-4 The interrelationship between operations management, understanding and construction and information technology (Redeveloped from Clarke et al. 2003, Pg. 70)

This provides that only all of three factors can bring about changes in information and material processes; which are:

- New operation management principles.
- Understanding of construction peculiarities and their implication in construction, such as informal decision making.
- Information technology.

All the ways the three factors interact may influence information and material processes. IT alone is not worthwhile without consideration of operations and the understanding of the peculiarities of construction. The value of IT is in its contribution to the "realization of the principles of production". The changes and benefits that may be realized in construction information and material processes depends on the fit between the interactions from the three factors (Clarke et al., 2003).

Clarke et al. (2003) provide examples on how each of these factors may affect and contribute to construction information and material processes. IT may contribute to: mechanization of tasks people perform; realization of an operation management principle, and; eliminate problems peculiar to construction. However, this may be constrained by operations management principles in that IT may increase variability; a concept operations management calls to be reduced (Hopp and Spearmann, 1996). Construction peculiarities such as one-of-a-kind product and temporary organizations may constrain IT applications in that IT should support uncertain and qualitative information (Pietroforte, 1997).

3.4.2 Requirements of Construction Processes

Cardinal and Marle (2006) define a project as ‘a transformation process, from an initial to an expected final situation, evolving in an often complex and changing environment’. Construction may be regarded as process-based, in unfixed locations involving multiple organizations (Slaughter, 1998 c.f. Lee et al., 2006). There have been several attempts at providing formalized models of the construction process. However, the intent of most of these has been for application of IT in construction (Bjork, 2002).

Abdomerovic and Blakemore (2002) state that there can be no process without product nor process interactions in absence of processes. The authors divide the project into processes that create project product and processes that organize work necessary to create project product. They are termed product-oriented processes and project management processes, respectively. This research is concerned with the project management processes. ‘Project management processes are concerned with describing (specifying) and organizing the work of the project’ (PMBOK, 1996: pp. 27 c.f. Abdomerovic and Blakemore, 2002).

A process is defined as ‘an activity or group of activities that produce required outputs by taking a variety of inputs and adding value from the perspective of internal or external customers’ (George, 1996 c.f. Jeong et al., 2006). ‘Process thinking’ is used to address problems in the construction industry including uncertainties from various sources, long delivery times and adversarial relationships (Jeong et al., 2006). Benefits claimed include producing consistently higher quality, timely delivery, cost reduction and higher customer satisfaction (Carr, 1999; Davenport and Short, 1990; Earl and Khan, 1994; Hammer and Stanton, 1999 c.f. Jeong et al., 2006). Learning from other industries has been called for (Egan, 1998; Latham, 1994 c.f. Jeong et al., 2006) but viewed by some as inappropriate due to the unique characteristics of construction. Lillrank (1995) c.f. Jeong et al., (2006) states that exploring best practice in other industries may be adapted to the construction industry. The research takes the view that the construction industry’s uniqueness requires studying construction project processes.

Jeong et al. (2006) state that process definition should be for development of and sharing of common understandings of organization-wide good practices. In the study of large construction organizations performed by Jeong et al. (2006) highlighted the need to increase communication and visibility of process improvement activities. The 'soft' side of process improvement was highlighted which includes norms and values of people. Furthermore, the study highlights the need, and calls for, more informal rather than technologically based communication. Suggestions made were low tech and simplistic in nature indicating that although communication problems may seem complex, the solutions are normally simple – greater clarity rather than increased frequency of communication.

Today's organizations predominantly use procedures designed to control or influence behaviour in a linear manner to provide stability and order (Brodbeck, 2002). Procedures remain as these are 'rigid rule-bounded organizations that spell out how people should behave are incapable of generating new forms of behaviour to meet new situations' (Stacey, 2000, p. 153 c.f. Brodbeck, 2002). It is proposed to make procedures that would guide people to achieve a desired outcome via a structured self-organizing framework consistent with 'organizations that utilize a deeper level of human consciousness or the intelligence of natural law for greater simplicity' (Harald et al., 1999; Sherman and Schultz, 1998; Lewin, 1999 c.f. Brodbeck, 2002). Brodbeck (2002) adds that a different type of control is required, which 'influences without force and without guarantee of detail, but with confidence in patterns'. A fundamental principle of complexity is that natural order evolves through self-organization (Lewin, 1999 c.f. Brodbeck, 2002). This overcomes the realist approach that assumes that facts about the world existed but waiting to be discovered (Brodbeck, 2002).

Kelly and Allison (1999) c.f. Brodbeck (2002) define organizational 'fitness' as the organization's ability to self-organize and adapt internally and externally to face change. Brodbeck (2002) states that organizational fitness involves flexibility of procedures to enable and encourage its members (employees) to self-organize. Kelly and Allison (1999) c.f. Brodbeck (2002) state that the creation of flexible organizations involves the process of a state of change and stability and is one of the most important functions of leadership and managers.

Organization flexibility is rather contradictory. Organizations systemize interdependent and coordinated parts into a whole. In contrast, flexibility is based on adaptation. Therefore, a dilemma is how to design and manage differentiation and integration, how to encourage divergence and cohesion and how to group people, processes and operating units to support their unique situation (Englehart and Simmons, 2002). In this regard a review of currently available models describing construction processes is required, which is described in the following section.

3.5 Construction dynamic process models

3.5.1 Introduction

Austin et al. (2002) state that the Architecture, Engineering and Construction (AEC) industry has experienced difficulties in the identification of ways to capture, understand and replicate work processes. The authors further state that once the process has been captured, identification and removal of waste from the processes can be achieved. With this in mind a review of construction process models in the literature was performed. A review of existing models describing construction processes is summarized in Table 3-4. As can be seen there has been a surge in the study of construction processes in the past decade. However, most are performed with a view to IT applications (Bjork, 2002).

Other models define a single component of construction processes such as the change process (e.g. Motawa et al., 2007). In this regard, the process models are descriptions of how documents are moving. These models acknowledge the inherent complexity in construction projects and provide a dynamic process to account for that. However, they again describe the effects of the formal document process even though most acknowledge the informal processes and their effects (e.g. Ford, 2002).

The literature on change management focuses on the identification of the change process and best practice for managing change. Little attention is paid to modelling the dependent data or simulating the iterative cycles of concurrent design and construction resulting from unanticipated changes and the subsequent impact on project performance (Motawa et al., 2007).

Some of the IT systems developed for change management are integrated systems representing design information, record design rationale, facilitate design coordination and changes and notify users of file changes. These systems were mainly developed to deal with reactive changes, particularly design changes. Therefore, there is a need in the construction industry to focus on modelling the dependency to enable systems to be proactive rather than reactive (Motawa et al., 2007). Furthermore, there is a need to study this within the formal and informal framework.

Table 3-4 Various models of construction processes from the literature

Description of model	Author(s)
Engineering document management system for changes incorporating document approval and release procedures	Peltonen et al. (1993)
System establishing rules for coordination of concurrent changes, identification and resolution of conflict modification	Spooner and Hardwick (1993)
System capturing history of design process, back-tracking abilities and determination of decisions affected from the changes made for spatial design of residential buildings	Ganeshan et al. (1994)
Change management model supporting multi-disciplinary collaborative design environments	Krishnamurthy and Law (1995)
Change management system for management of design change in a collaborative environment	Mokhtar et al. (1998)
Object-oriented (OO) information model for construction scheduling, cost optimization and change order management	Karem and Adeli (1999)
Virtual-reality-based model integrating site-related activities into the planning and scheduling of the entire construction project	Retik and Shapira (1999)
Information model to store design information, recording design rationale, facilitate design coordination and management of design changes	Hegazy et al. (2001)
Model of information and materials handling activities in the construction process	Bjork (2002)
The model developed is based on Dynamic Planning Model (DPM). The purpose is to provide a dynamic model to enhance planning and control of projects.	Park and Pena-Mora (2002)
Dynamic project model developed to investigate the causes of fast track project failure.	Ford (2002)
Web-based change order management system that supports documentation management, communication and integration between various team members in the change order workflow	Charoenngam et al. (2003)
Dynamic construction project model with change management and construction policy-making at the strategic and operational levels	Park and Pena-Mora (2003)
Information system platform, 4D Management for Construction Planning and Resource Utilization (4D-MCPRU) developed to implement the model 4DSMM+ integrating dynamic resource management at the project level and decision-making support with other features	Wang et al. (2004)
Quality and change management model for evaluation of negative impacts of errors and changes on construction performance using the system dynamics model of dynamic planning and control methodology (DPM)	Lee et al. (2005)
4D site management model including planning and visualization of building and site	Chau et al. (2005)
Model-based dynamic model for construction resource management	Park (2005)
System combines a systems dynamic model with traditional network based tools to support strategic and operational project management	Lee et al. (2006)
A dynamic model of enterprise system innovation (Enterprise resource planning (ERP)). Presents new model of ERP CSFs	King and Burgess (2006)
Integrated change management system-Generic process model defining change over time of its occurrence and representing the key decisions required to implement changes	Motawa et al. (2007)
Simulation model for construction and demolition waste using system dynamic method	Hao et al. (2007)

The process models that have the depiction of the information flow are a strain from the Ford (2002) and Park and Pena-Mora (2002) models. These two models are quite similar showing the dynamics of information in construction processes. However, the Pena-Mora model was further developed by other authors such as Lee et al. (2006) and Motawa et al. (2007). These models shall be used as a basis for further analysis and development of the model in this research. A description of the main models of Ford (2002) and Park and Pena-Mora (2002) is provided in the Section 4.6. The development of the research model is provided in Chapter Eight.

3.5.2 Formal and informal processes

There are many definitions of formal and informal communication in the literature. Two of these definitions are shown in Table 3-5. Despite the many attempts in the literature there is no universally accepted definition of what constitutes formal and informal communication and how they are differentiated. However, for this research the definition of formal processes shall be close to that of Emmitt and Gorse (2003) with a slight modification:

... are the officially designed system of communication within the organization where official sources of information use prescribed channels

The definition of informal processes shall use the definition of Emmitt and Gorse (2003):

... are routes of communication other than those identified by the organisation.

Table 3-5 Definitions of formal and informal systems

Definition	Author(s)
Formal system	
are the accepted system of communication within the organisation; they are the official sources of information using prescribed channels	Emmitt and Gorse (2003)
a network comprising all the various cooperative ties between organizational positions that have been intentionally created to safeguard economic processes	Rank (2008)
Informal system	
are routes of communication other than those identified by the organisation	Emmitt and Gorse (2003)
voluntary cooperative relationships between organizational actors, not determined by the organization's formal structure	Rank (2008)

To further understand formal and informal processes, understanding their characteristics is necessary. Table 3-6 provides characteristics of formal processes or transactions from the literature. Formal systems are characterized as communication that is in some way structured and is associated with fulfilment of contractual obligations in order that information is recorded for future reference. Formal processes are usually adopted to show whom to ask for information and whom to inform, whether in the communication is vertical or horizontal (Emmitt and Gorse, 2003). However, formal processes can never fully reflect the organization communications. Formal processes assume rationality, and therefore, fail to cope with the non-rational dimensions of organizational behaviour. Furthermore, formal ties may be utilized or disregarded, particularly in the horizontal direction (Rank, 2008).

Table 3-6 Characteristics of formal communication

Characteristics of formal processes	**Author(s)**
Communication events that are formalized are in some way structured	Emmitt and Gorse (2003)
Associated with the project's contractual obligations	Emmitt and Gorse (2003)
These systems are usually structured so that information exchange is recorded for future reference, a process facilitated by information technologies	Emmitt and Gorse (2003)
Organisations will adopt a formal structure for communication so that all members, regardless of position, know whom to ask and whom to inform	Emmitt and Gorse (2003)
May be classified by vertical or horizontal communication in some way controlled or organised	Emmitt and Gorse (2003)
fails to cope with the non-rational dimensions of organizational behavior	Rank (2008)
can never adequately or fully reflect the concrete organization to which it refers	Rank (2008)
formal ties may be utilized or disregarded	Rank (2008)

The informal processes have different characteristics than formal processes. Characteristics of informal processes compiled from the literature are provided in Table 3-7. Unlike the formal process, informal communication is largely unstructured (Emmitt and Gorse, 2003), does not have a permanent structure (Subramanian, 2006), is unplanned (Whittaker et al., 1994; Subramanian, 2006), emerges through contact between individuals in the organization (Whittaker et al., 1994; Emmitt and Gorse, 2003; Subramanian, 2006). These brief but frequent communication events (Whittaker et al., 1994; Subramanian, 2006) are unofficial ways of exchanging information (Emmitt and Gorse, 2003). Furthermore, Rayadu (1998) c.f. Subramanian (2006) states that informal communication is the most effective in speed of information transfer.

Table 3-7 Characteristics of informal communication

Description of model	Author(s)
largely unstructured	Emmitt and Gorse (2003)
emerge through friendships or contacts between individuals	Emmitt and Gorse (2003); Rayadu (1998) c.f. Subramanian (2006)
may be viewed as communication shortcuts	Emmitt and Gorse (2003)
unofficial ways of exchanging information	Emmitt and Gorse (2003)
avoidance of bureaucratic channels and/or organizational gatekeepers	Emmitt and Gorse (2003)
connected to help-seeking behaviour	Emmitt and Gorse (2003)
may be used to encourage supportive communication and break down defensive communication, helping to strengthen informal relationships	Emmitt and Gorse (2003)
Improves coordination activities	Middleton (1996) c.f. Emmitt and Gorse (2003)
mechanism for improvizing interim solutions to unexpected problems	Middleton (1996) c.f. Emmitt and Gorse (2003)
a forum for the development of common knowledge or working intelligence	Middleton (1996) c.f. Emmitt and Gorse (2003)
necessary to make construction contracts work	Pietroforte (1997) c.f. Emmitt and Gorse (2003)
may aid problem –solving and decision-making in meetings	Pietroforte (1997) c.f. Emmitt and Gorse (2003)
it is often in these social interactions that bonds are formed and real issues get discussed	Hastings (1997) c.f. Emmitt and Gorse (2003)
situations with incomplete contracting and unverifiable messages	Olszewiski (2001)
In this setting the correctness of the sender's message can not be verified even after the receiver implements the decision	Olszewiski (2001)
taking place synchronously in face-to-face settings	Whittaker et al. (1994)
brief, unplanned , and frequent	Whittaker et al. (1994); Subramanian (2006)
Supports a number of different functions: the execution of work-related tasks; co-ordination of group activity; transmission of office culture; and social functions such as team building	Whittaker et al. (1994)
develop as a result of patterned interactions between organizational actors	Whittaker et al. (1994)
may help rather than hinder the achievement of the organization's stated objectives	Rank (2008)
Informal ties may not only represent a structural supplement to the formally designed relationship system but may even be replacing it	Rank (2008)
grows spontaneously from personal and group interest	Rayadu (1998) c.f. Subramanian (2006)
is the most effective one and transmits information with considerable speed	Rayadu (1998) c.f. Subramanian (2006)
Operates in the organisation as a network on a non-official basis yet, most of the time official matters are discussed and decisions are taken	Subramanian (2006)
there is no permanent structure	Subramanian (2006)
it suggests how communication networks actually work	Subramanian (2006)
it can route around to damage formal communication network	Subramanian (2006)
it is situational and spontaneous	Subramanian (2006)
it creates an organizational structure of its own	Subramanian (2006)
comes into play between people due to proximity, perception of each other as a reliable or knowledgeable member, and friendship or trust	Subramanian (2006)
is important because without grapevine employees can not fill in gaps left from official word; they may not feel ownership of information	Subramanian (2006)
informal chats can lead to disasterous consequences	Kalvar (2005) c.f. Subramanian (2006)

Informal processes develop structures of their own and actually show how communication networks work (Subramanian, 2006). This informal structure may supplement and assist the formal processes to support different functions including: *the execution of work-related tasks; co-ordination of group activity; transmission of office culture; and social functions such as team building* (Whittaker et al., 1994). Informal processes fill in the gaps left by formal processes (Subramanian, 2006). Young (1995) in a study of electronic and face-to-face communication concludes that electronic information systems' effectiveness for obtaining work related information is substantial and complements but does not eliminate the need for or value of face-to-face communication. Another study performed by Burke (1996) concludes that employees found formal, informal and interpersonal sources of information valuable in achieving their work objectives. However, they viewed that most of their information came through interpersonal and informal venues, which they preferred. Kaye (1995) provides several sources of information and divides them into four groups; formal and informal, and; internal and external.

Informal processes are sometimes viewed as communication shortcuts to avoid organizational bureaucracy. It is connected to help seeking behaviour used to encourage supportive rather than defensive communication, thereby strengthening informal relationships (Emmitt and Gorse, 2003). Informal processes improve coordination activities, assists in problem-solving (Middleton, 1996 c.f. Emmitt and Gorse, 2003) and decision-making (Middleton, 1996; Pietroforte, 1997 c.f. Emmitt and Gorse, 2003). Subramanian (2006) adds that although the informal process is unofficial it is through it that most official matters are discussed and decisions taken. This is further supported by Hastings (1997) c.f. Emmitt and Gorse (2003) who state that it is through these social interactions that bonds are formed and real issues discussed. In a three year study performed by Mangrum et al. (2001) on a high technology computer manufacturing company, it was found that technology does not reduce the need for face-to-face communication. The authors found that 'informal' activities are not only prevalent but were critical to achieving collaborative problem solving. This is supported by Pietroforte (1997) c.f. Emmitt and Gorse (2003) who states that informal processes are necessary to make construction contracts work.

Informal processes come into play as a result of proximity, perception of each other as reliable or knowledgeable members and from friendship or tust (Subramanian, 2006). Yet, despite all the positive characteristics of informal processes, they can damage formal processes (Subramanian, 2006). Rank (2008) adds that informal systems can even replace formal processes. Kayala (2005) c.f. Subramanian (2006) further adds that informal chats may lead to disastrous consequences from such things as rumors. Furthermore, Olszewiski (2001) describes informal communication as settings with incomplete contracting where the sender's message cannot be verified even after the receiver implements the decision.

The formal and informal processes are viewed as necessary. Each has characteristics the other does not have. In essence, they may be complementary. Yet, none of the construction process models reviewed has any component to account for the informal processes that are viewed by many authors, including those developing the process models, as crucial.

3.6 Information and complexity

Construction projects face a high degree of task uncertainty. Task uncertainty may be defined as "the difference between the amount of information required to perform the task and the amount of information already possessed by the organization" (Galbraith, 1973, p. 5). Therefore, task uncertainty requires information to close the gap between information available and information required, thereby enabling the achievement of the task. Galbraith (1973, p. 4) states, "the greater the task uncertainty, the greater the amount of information that must be processed among decision-makers during task execution in order to achieve a given level of performance". Additionally, the fragmented nature of the construction industry results in a lack of a central project information repository and the lack of effective cross-discipline communication within the project team. This reinforces the confrontational culture common in construction projects (Sun et al, 2002).

Information flows are of primary importance in project planning and execution and serve a dual purpose. First, they provide a clear picture of the ongoing project on a real-time basis. This enables decision makers to monitor and control activities and to make corrective actions when required to meet planned milestones, schedules and budgets. Secondly, information flows between informatively linked activities may modify or affect the other when information is generated from it. Untimely information flow change requirements and resources availability, and hence affects activities completion time or execution.

Overall project quality depends upon the possibility and capacity to implement corrective actions in order to minimize the consequences of errors and accidents, thereby, avoiding an unplanned iteration in the project. However, the more two activities are informatively linked, the more an unplanned iteration of one of them affects the other, and the overall execution of the project. The more two activities are informatively linked; the more important it is to execute them concurrently (Ford, 2002). This is supported by the definition of concurrent engineering as “a methodology to schedule concurrent activities which share common conceptual tools and information resources” (Kerzner, 1990; Kusrak, 1993 c.f. Nicolleti and Nicolo, 1998). Achieving concurrency is faced with the problem of the dynamics of information iterations, which is described in the following subsections.

3.6.1 Dynamics of information iterations

Williams et al. (1995) term the iteration process in a project for design and manufacturing of a vehicle as the “vicious circle of parallelism”. The design process where the design of cross-related parts of the product occurs concurrently causes the design activities to take longer as each part affects the other(s). This causes delay, and with time limitations, the project becomes more concurrent as delayed activities overlap succeeding non-delayed activities in order to attempt completion within project duration. This is shown in the following Figure 3-5, Figure 3-6 and Figure 3-7.

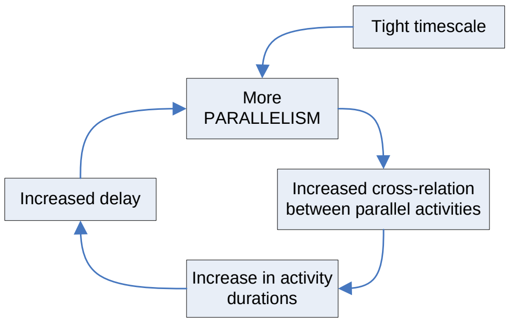


Figure 3-5 Key loop – redeveloped from Williams et al. (1995)

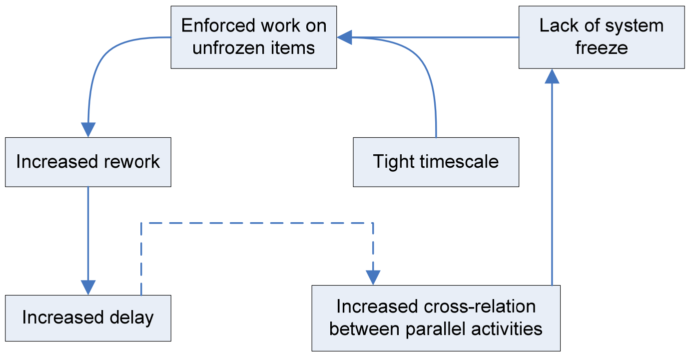


Figure 3-6 Additional loop 1– redeveloped from Williams et al. (1995)

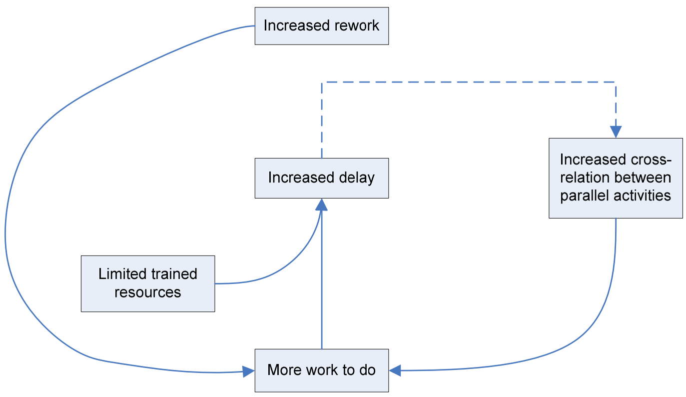


Figure 3-7 Additional loop 1– redeveloped from Williams et al. (1995)

Even though this effect may be accounted for during planning, the process becomes non-robust. A change in one element causes a loop to be set up where the tight time scale causes more parallelism, which increases cross-relation between activities, thereby increasing activity durations and results in increased delay resulting in even more parallelism. This loop magnifies the following loop (Figure 3-8).

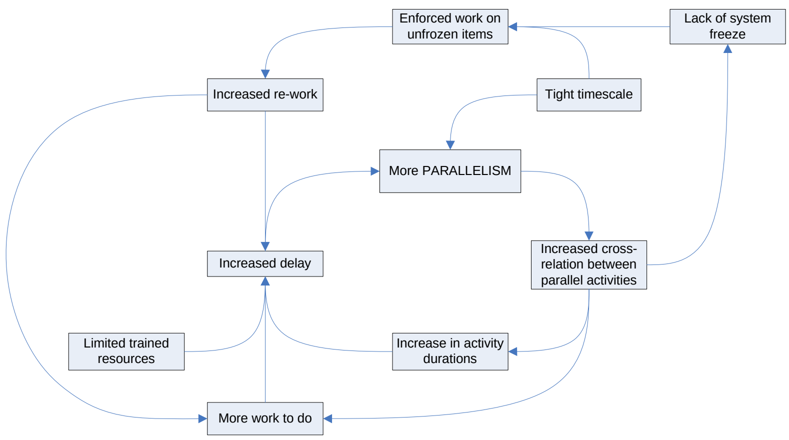


Figure 3-8 Loops combined– redeveloped from Williams et al. (1995)

However, there are further loops that accelerate this loop. Increased cross-relations between parallel activities imply difficulty in freezing the system as a change in one component will affect other components. Without a system freeze, and within time limitations, management is forced to work on items where the surrounding parts are yet not frozen. This has two main effects. The first is that it demotivates the design staff who work with unclear parameters and know that their work may be done in vain. The second and more important is that the design of such components may have to be reworked if any changes are made to any of its cross-related components. Another exacerbating loop is created by the increasing use of parallel cross-related activities, which increases the need for rework, and hence, increases the amount of work required to be done in the system. This situation will be worsened where there are limited trained resources.

This model covers only the design phase. However, further loops are created when concurrent manufacturing is considered. This makes the system even more non-robust (Williams et al,, 1995). Since construction projects are dynamic, they are not able to make a system freeze until the end of the project. Change plays a major part in the dynamics of construction projects. Therefore, a solution needs to be devised that enables the control of the vicious iterations of information without a system freeze, particularly for change.

Iterations of Information during change

The main problem with information management is the iterative cycle of the information. In many instances the number of iterations of information is considerable. Ford (2002) and Park and Pena-Mora (2002) provide dynamic models of the iterative cycle of information. Each shall be described in the following subsections. Despite the developments made in the above models, the basic model shall be described and used in the research for simplicity.

3.6.2 *Ford's Model of Information Iteration*

Ford (2002) develops his model from the need for concurrency to reduce project durations. The dynamic project model was developed to investigate the causes of fast track project failure. The result of the application of the model is that iteration management would reduce project durations in fast track projects. However, concurrency is limited due to information interdependency requirements.

Ford (2002) provides a model for the storage and flow of work in a single development phase (e.g. steel erection) as shown in Figure 3-9. The model integrates five constraints: task durations, task sequencing, dynamic information requirements, work release policies and coordination. The flows of work and information between project phases defining the network structure of the project represent several forms of inter-phase interaction. These include the following descriptions.

Work progress where supplying phases provide developmental products or other information to receiving phases. Rework may be required by receiving phases from supplying phases. A task requiring rework corrupts work done by receiving phases, and is returned to the phase where the change requirement was made in order to be reworked. Coordination is required between the phase discovering the change requirement and the phase generating and must correct it. Any rework cannot occur before coordination.

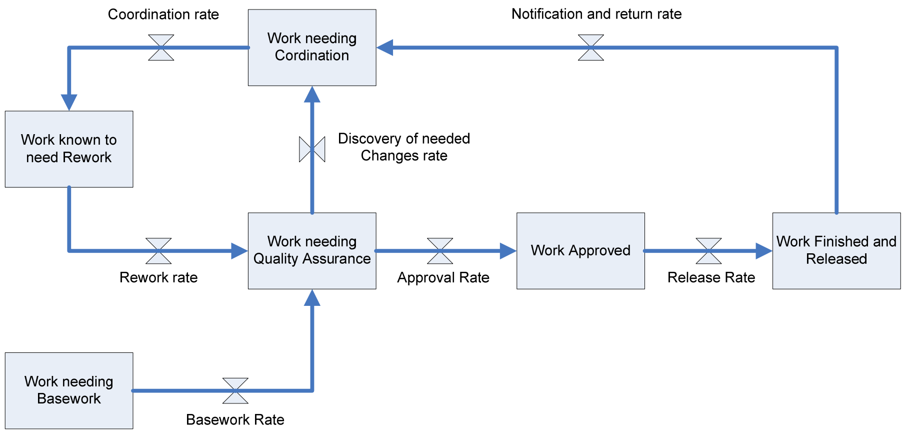


Figure 3-9 The storage and flow of work in a single project phase [Developed from Ford (2002)]

Information flows in the model are bi-directional. Flows of work through a construction project are constrained by physical and information relationships among tasks and phases, including task durations and precedence relationships, as well as information dependencies leading to iteration (Smith and Eppinger, 1997). Policies about the availability of work, coordination mechanisms and the characteristics of information transferred among development phases (Krishnan et al., 1995) as well as the number, skill and experience of project staff can affect progress. These process and policies can interact to constrain progress.

Base work is completion of the work for the first time and needs checking. Quality assurance inspects for defects and improvement needs. Tasks that do not require rework or tasks with undiscovered changes during quality assurance are approved. They then go to the stock of work approved until they are received by managers of the receiving phases or to the customers and is then work finished and released. Quality assurance may discover work requiring changes due to flows by developers within the phase or receiving defective, incomplete or preliminary work from supplying phases. Rework attempts to correct errors or improve tasks previously completed. Reworked tasks are returned to the completed-not-checked stock for re-inspection.

Since recognition and reworking errors is critical to the success of projects, work discovered to need changes move from the stock awaiting inspection to the stock of work to be coordinated (Figure 3-9). Coordination is the integration of project phases. Following resolution of any disputes in coordination, tasks move to the stock of work to be changed and are reworked. Defective work may be missed during quality assurance to be discovered in a receiving phase. When discovered, the generating phase is notified and the affected work is moved from the stock of work considered finished to the stock of work to be coordinated.

Generally, the rate at which any of the developmental activities (base work, quality assurance, coordination and rework) is performed depends on two types of constraints. The first is inadequate resources or insufficient supporting infrastructures (e.g. CADD). The second is interdependencies among phases and tasks.

There are limits to performing work concurrently. Availability constraints limit the base work available. An important availability constraint on work arises from the fact that not all tasks can be fully developed concurrently. The progress of work within a phase can limit work in the same phase. The progress of work in a phase can be constrained by the completion and release of work by the phases that supply it with development products and information. These work availability constraints are based on amount of work completed at the time, and therefore, limit the concurrency of tasks.

Fast tracking is traditionally seen as more concurrence should reduce projects' durations. However, it has been shown that decreasing concurrence by 25% delays the project 49%, but that increasing concurrence by the same amount improves schedule duration by only 7%. The flows of work through the model show that the iteration cycles as critical in understanding project behaviour.

The impact of concurrence on performance is asymmetric because effects of unplanned iteration cycles increase as projects become more concurrent. Errors generate additional work and iteration cycles as concurrency is increased. Additionally, the average iteration path length is increased with increased concurrence by delaying the discovery of the need for rework to phases farther from the generating phase.

The failure to achieve the full potential of fast track processes results from process-constrained progress magnified by concurrent development practices. Iteration cycles increase duration even with availability of ample resources since the process is constrained by the underlying recursive structure of information exchanges. Iteration cycles delay projects by being more in number, longer in the distance which information must travel, slower in traversing that distance and occurring later than possible. With increased concurrence, development processes become more difficult to manage.

Managers generally have more influence on resources than processes, and thereby, have few effective tools and methods to accelerate with when iteration cycles constrain progress. Effective strategies to reduce durations of fast track projects are not obvious. Investigating the interactions of information process and managerial behaviour can identify linkages constraining performance and design process and policy changes for improvement. To improve fast track project performance the impact of development project processes on iteration must be understood (Ford, 2002).

3.6.3 Park and Pena-Mora model of information iteration

By focusing on the iterative cycles caused by errors and their impacts on performance to overcome uncertainties and complexities, the dynamic planning and control methodology was developed (Park and Pena-Mora, 2003). Park and Pena-Mora (2002) develop the model to counter the deficiencies of static planning methods such as the Critical Path Method (CPM). The model developed is based on Dynamic Planning Model (DPM). The purpose is to provide a dynamic model to enhance planning and control of projects. Information iterations and the effects of interdependence are evident from the model.

Figure 3-10 represents the construction process as a set of conceptualized processes. Side effects of decisions are represented by feedback processes which result in self-correcting or self-reinforcing side effects. If a control action is taken to reduce variations from planned performance, it can fix problems and enhance performance. However, at the same time it can worsen performance due to self-reinforcing side effects of the action.

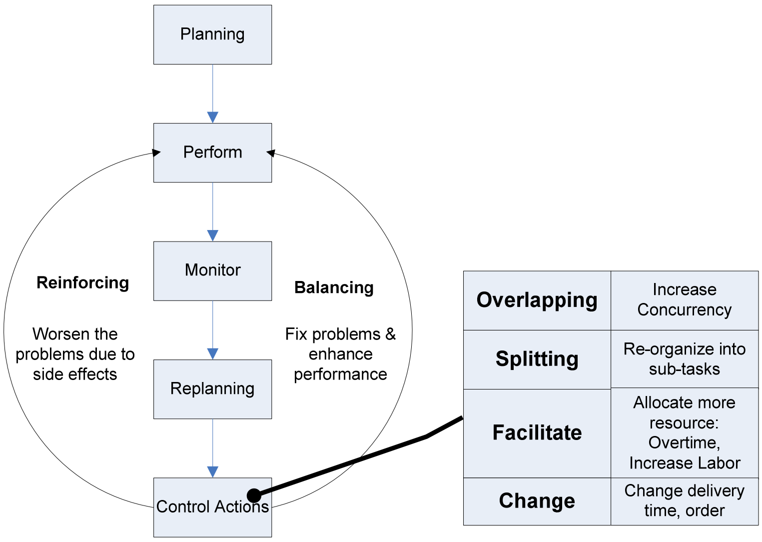


Figure 3-10 Primary Feedback Loops (Conceptualized) – redeveloped from Park and Pena-Mora (2002)

Park and Pena-Mora (2002) provide a systems model (Figure 3-11) representing the construction process. In this model, tasks flow into and through four stocks in the unit of a Construction Work Package (CWP): CWP Done, CWP to be Released, CWP waiting for Redesign, and CWP to be Corrected. Tasks are completed and accumulate in the stock, CWP Done. The work packages achieving quality standards leave CWP Done stock and through the Approve Rate flow into the stock of CWP to be Released and wait to be released. If there are design changes, and the work packages need to be corrected, the packages go to CWP Waiting for Redesign. Upon completion of redesign, the packages move to the CWP to be Corrected stock. If there are no redesign changes to the work packages, they are released to the next stage. The work packages failing quality standards pass through the process of Defective CWP Rate flow from the stock of CWP Done to the stock of CWP to be Corrected. They are corrected or improved through the Change Completion Rate process and returned to the stock, CWP Done.

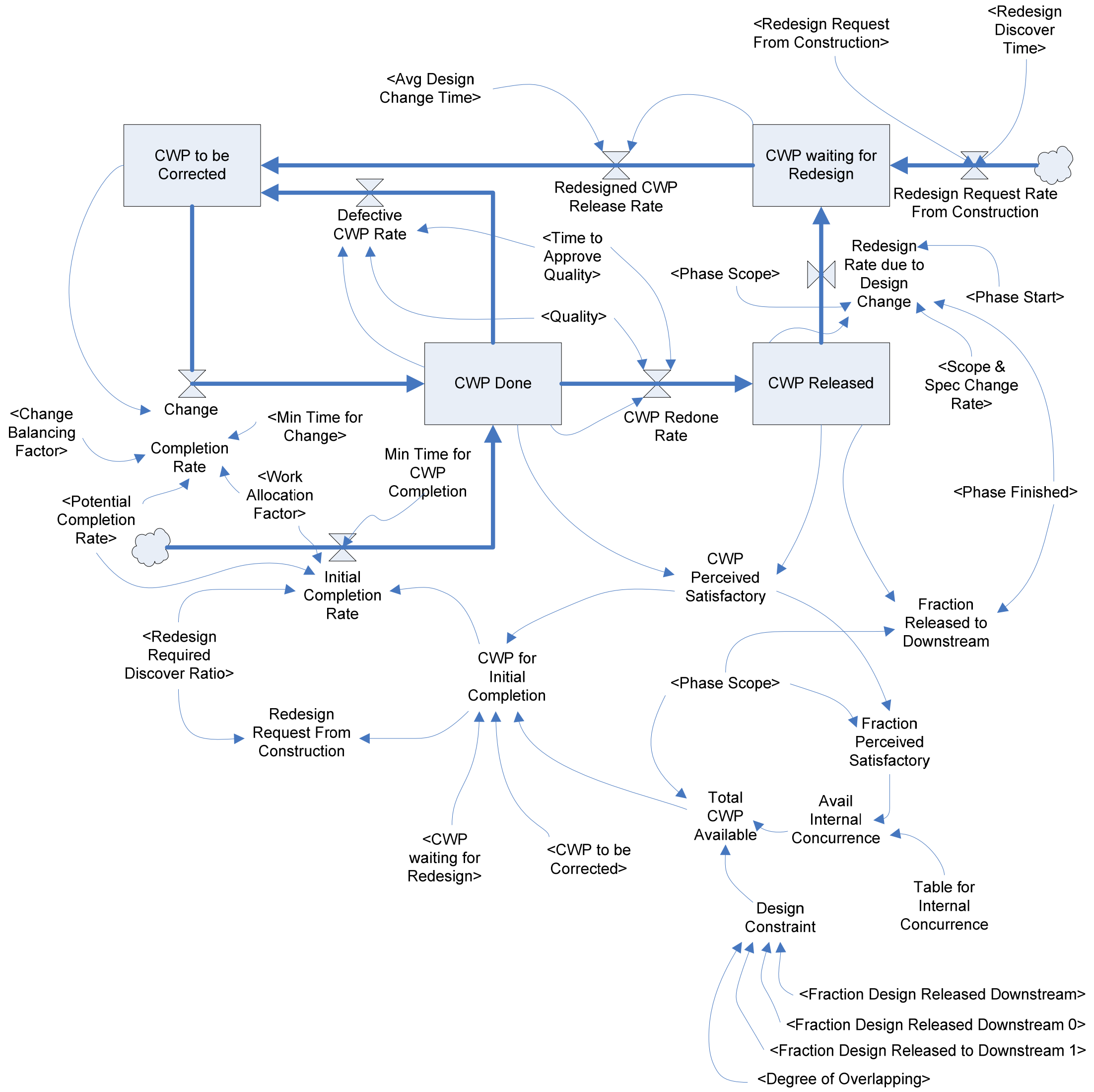


Figure 3-11 Generic Structure for Construction Process (Park and Pena-Mora, 2002)

The Total CWP Available is determined by phase scope, as well as several constraints including concurrence dependency, design constraints, and inter-phase concurrence dependency. Also, every construction work package is dependent on upstream tasks and the required design work. Each CWP has different external dependency decided by inter-phase concurrency and the relevant upstream phases (Park and Pena-Mora, 2002).

3.6.4 Critique of models

With increased complexity of construction projects and number of parties involved more effective planning and communication tools need to be developed (Chua et al., 2005). Improvement of ways for management of construction processes is needed (Jeong et al., 2006). Furthermore, capturing the construction process is required for the ability to develop effective processes (Austin et al., 2002).

Park and Pena-Mora (2003) state that a construction project model requires more flexibility in determining project scope and work dependencies than other project development models such as product or software developments since:

- Construction deals with a physical object where construction 'rework' usually entails demolition of what has been built
- Construction is process-based and involves an unfixed location and temporary multi-organization alliances
- Number of construction project activities vary across projects and are governed by physical and precedence relationships

For dynamic projects working in dynamic environments, flexibility is required to achieve the state of 'self-organization'. Three conditions are required for a system of change or emergent self-organization (Brodbeck, 2002):

- An open system approach
- A state of non-equilibrium (i.e. the ability to continuously change)
- Feedback loops (Tasaka, 1999 c.f. Brodbeck, 2002)

Nadler in Coleman (1999, p. 38) suggests:

The idea is to design the formal organization such that structures, systems and processes 'fit' the goals, rewards and structures of the informal organization.

Jaafari and Manivong (1998) provide a definition for a project management information system as 'a system which supports and facilitates the delivery of any project, particularly those which are complex, subject to uncertainty, and under market, time and money pressures or otherwise difficult to manage'. According to this 'logical' definition, the information includes both formal and informal. Yet many of the models developed have an inclination to be adapted for formal information (i.e. documented) and an IT application. An example is Chua et al. (2005) who state that with increased complexity of construction projects there is a need to use computers for the accomplishment of effective planning and management.

The models provided by Ford (2002) and Park and Pena-Mora (2002) provide the basis to understand the concept of information iteration and achieving concurrency. However, the models have three main shortcomings. The first is it implies that the process reflected in the model is for the formal process, although both concede that informal aspects are important. There is no clear reference or implication of informal communication and processes. The second is the division of the tasks in terms such as 'Work to do', which does not resemble the terms used in practice for such items as 'submittals' or 'RFIs'. The problem with that is that all tasks are treated similarly, whereas this may not be the case in practice. The third is the models do not show the constraints caused by interdependency of tasks or the clear separation of preparatory work and execution of the work. For example, the information required from the RFIs may affect the production of the submittals. Each task may be performed by separate individuals or teams. To overcome these shortcomings of the models presented a question at this stage is:

Q3: How are construction processes performed in practice capturing the formal and informal components to perform the tasks required to transform and produce the project?

Despite the shortfalls of the models presented they do provide a good basis to start from as they do have merit. In this research we shall develop a model showing the interaction between the formal and informal processes. This model is referred to as the "Hybrid Model for Communication and Information Management". In addition to showing the formal and informal process and how they interrelate, the model shall provide the constraints caused by interdependencies between tasks and how this relates to the formal and informal processes. The model shall use the processes as provided from the interviews.

3.7 Summary

This chapter established the "dynamic" nature of construction projects, the problems to communication and information management as a result and the need to review construction processes. The literature was reviewed regarding project types establishing construction projects as "dynamic", meaning in constant change. The literature on change in construction is reviewed including change causes and effects. Furthermore, the chapter differentiated between change and rework and the relationship between change and complexity including formal and informal change.

Construction processes were reviewed establishing the need to understand construction processes and the requirements for them where project processes were defined as well as highlighting the debate in that regard. The chapter then reviewed the literature on available ‘dynamic’ construction processes highlighting two models that depict information flow. The literature is reviewed for definitions and characteristics of formal and informal processes establishing the characteristics of each for the research. The relationship between information and complexity is then reviewed form the literature showing the importance of information in reducing complexity.

The dynamics of information iterations is reviewed from the literature highlighting interdependence and its effects on the achievement of concurrency and change effects. Two dynamic models of construction processes are presented and described. The models are critiqued and questions raised to guide the research analysis. The following chapter reviews CSFs within the inherent nature of construction projects.

CHAPTER 4 CRITICAL SUCCESS FACTORS

4.1 Introduction

Chapters Two reviewed the inherent complexities as well as introduced communication and management in mega construction projects. Chapter Three provided the dynamics of communication and information flow in mega construction projects and introduced several dynamic models showing construction processes. This chapter builds upon Chapters Two and Three presenting a literature review of CSFs in order to focus the research analysis on the most crucial CSFs within the context of the research.

The purpose of this chapter is to review the literature regarding CSFs to find the most suitable method to provide the most crucial CSFs in construction projects. The most crucial CSFs within the context of the research would: (1) provide a view into what mega-projects in Dubai should be focusing on in its management; (2) provide direction for the research analysis to achieve the research objectives and,; (3) provide a 'new' method to find the most crucial CSFs in construction projects. This is important as it would incorporate the inherent characteristics of mega construction projects including complexity, uncertainty, ambiguity and the dynamic nature of such projects. The analysis for the most crucial CSFs for the case study projects is provided in Chapter Six.

Building from Chapters Two and Three, this chapter presents the literature review of CSFs in order to focus the research on the crucial CSFs for further investigation. The chapter initiates by defining project and mega construction projects are provided from the literature and defined for the research. The characteristics of mega-projects are provided form the literature and established for the research.

The main question in the chapter is provided followed by justification for use of CSFs. A general review of CSFs is provided including its importance, problems and distinctions between factors, criteria and success. Three methods for arriving at the most crucial CSFs in the case study projects are presented and one is justified for use in the research. The need for use of a framework of CSFs is established and three 'systems' frameworks showing interrelationship between CSFs are further described and one is justified for use in the research. Several assumptions made are presented for use in the research. Questions are developed in the literature review to guide the research analysis.

4.2 Definition of terms used in the research

4.2.1 Definition of project

There are several definitions of projects in the literature. Table 4-1 provides a few of these definitions.

Table 4-1 Definitions of projects

Definition	Author
organizational processes of planning, organizing, directing, and controlling resources for a relatively short-term objective established to complete specific goals and objectives	Cited by Shenhar (2001) from Kerzner (1994)
is a unique endeavour undertaken to deliver a result.	Vidal and Marle (2008)
A human activity that achieves a clear objective against a time-scale	Reiss (1992)
temporary endeavor undertaken to create a unique product, service or result.	PMI (2004)

The definition of a project as provided by the PMBOK Guide (PMI, 2004) shall be used in the research:

… temporary endeavor undertaken to create a unique product, service or result.

However, there are a variety of project typologies (e.g. Shenhar, 2001). According to these typologies there are various ‘types’ of projects. The topic of the research is mega construction projects and is defined in the following section.

4.2.2 Mega construction projects

The definition of mega-projects is elusive and is defined in several ways by various authors in the literature (e.g. King and Burgess, 2006 and Pellegrinelli, 1997). Mega construction projects are described as being carried out in an environment that includes a complex management structure (Stones-Stoddart, 1988). King and Burgess (2006) state that large-scale projects are by definition complex and difficult to implement. Morris and Hough (1987) relate the term “mega-projects” to large construction projects which involve related projects to achieve an integrated structure. Pellegrinelli (1997) compares the relationships between mega projects and projects as similar to the relationship between a project and a work package. Therefore, a mega project is similar to a project but require several “sub-projects” to achieve it.

Due to the lack of an accepted universal definition the characteristics of mega-projects may provide a better understanding and indication of what they are. They are shown in Table 4-2.

Table 4-2 Characteristics of mega projects

Characteristics	Author
colossal in size and scope	Frisk (2008)
captivating because of size, engineering achievements and aesthetic design	Frisk (2008); Chung et al. (2009)
costly: costs are often underestimated	Frisk (2008); Bruzelius et al. (2002)
controversial: funding, mitigation packages, impacts on third parties	Frisk (2008)
complex: risk and uncertainty in terms of design, funding and construction	Frisk (2008); Chung et al. (2009)
contract issues: who are the key decision- makers, funding, operation, etc	Frisk (2008); Chung et al. (2009)
high investment expenditures of US$1 billion and more	Bruzelius et al. (2002); Chung et al. (2009)
long life time of 50 years and more	Bruzelius et al. (2002)
club good property (not public in the sense of exclusion and free riding, but substantial role of the state)	Bruzelius et al. (2002)
considerable share of indirect benefits which cannot be captured by the operator (benefits not occurring to the users of the project rather than to third parties)	Bruzelius et al. (2002)
technologically complex with an innovative, and largely, of an experimental character	Bruzelius et al. (2002);); Flyvberg et al. (2009)
socially complex	De Bruijn and Leijten (2008); Chung et al. (2009)
Prone to delusion and deception	Flyvberg et al. (2009)
High level of stakeholder engagement	Chung et al. (2009)
Attract public attention	Chung et al. (2009)
Usually commisiioned by governments and delivered by private enterprise	van Marrewijk et al. (2008)
Involves a large number of partners	van Marrewijk et al. (2008)
Conflict and poor cooperation between partners	van Marrewijk et al. (2008)
Culture is ambiguous	van Marrewijk et al. (2008)
Usually no center of calculation and control but many collaborators	van Marrewijk et al. (2008)

Megaprojects are complex (Frisk, 2008) with a long lifetime of 50 years or more (Bruzelius et al., 2002). This complexity has many facets to it. The complexity arises from the high risk and uncertainty in terms of design, funding and even construction (Frisk, 2008). Furthermore, megaprojects are controversial in terms of funding and impacts on third parties (Frisk, 2008). As such, they aatract public attention (Chung et al., 2009) and are politically-sensitive (van Marrewijk et al., 2008). Bruzelius et al. (2002) add that there is a considerable role for the state. Megaprojects are usually commissioned by the state and delivered by private enterprise (van Marrewijk et al., 2008).

Adding to the complexity is the high level of stakeholder involvement (Chung et al., 2009) and large number of partners, usually with conflict and poor cooperation amongst them (van Marrewijk et al., 2008). It may be due to the large number of partners that the culture is ambiguous in megaprojects. Furthermore, in mega projects there usually is no center for calculation and control, but rather many collaborators (van Marrewijk et al., 2008). Frisk (2008) confirms this by describing the burden of contractual issues in megaprojects including who the key decision-makers are, funding, operation and other related issues.

Megaprojects are characterized as being colossal in size and scope and costly (Frisk, 2008). Several authors state a high investment cost of more than one billion US Dollars (Bruzelius et al., 2002; Chung et al., 2009)., where costs are often underestimated (Frisk, 2008). There is considerable uncertainty in terms of cost estimation and demand forecasts (Bruzelius et al., 2002; Chung et al., 2009, Flyvberg et al., 2009). This difficulty of forecasting may be due to megaprojects characterized as being unique and having a complicated design (Chung et al., 2009). Frisk (2008) terms this as ‘captivating’ due the large size of mega projects where the engineering achievement and resulting designs are great.

Megaprojects are often technologically complex with an innovative, and largely, of an experimental character. Over and above technological complexity there is also social complexity (De Bruijn and Leijten, 2008). Phenomena applicable to mega-projects include: *technological complexity, social complexity, cost overruns, strategic behaviors, contested information* (Flyvberg, 2008).

Mega-projects are further characterized by cost overruns of 50-100% and above (Bruzelius et al., 2002; Flyvberg et al., 2009). Forecasts of project viability are overtimistic such that costs are understated and benefits are overstated. This is further confirmed by Brady and Davies (2010) where they refer to a study performed by British Airlines prior to construction of Terminal 5 in Heathrow Airport. The results of this benchmarking study found that no major UK construction project (over one billion sterling pounds) over ten years was delivered on time, within budget and to quality standards in addition to poor safety records.

Flyvberg et al. (2009) state that executives typically attribute poor project performance to project complexity, technological uncertainty, demand uncertainty as well as other issues. The authors, although conceding the effects of these factors on cost and time, add that complex projects are systematically over-optimistic in the planning phase of the project relative to less complex projects. The authors conclude that delusion and deception are the main cause of underperformance of megaprojects. This view is challenged by van Marrewijk et al. (2008) where their research concludes that cost overruns or poor project performance are due to the complexity, uncertainty, ambiguity, paradoxes and influences surrounding these types of projects.

The definitions and characteristics of mega- projects as provided in the literature are vague, raise questions and at times conflicting. For example, a One Billion US Dollar project may be considered ‘not complex’ if it has few ‘interdependent’ elements (Baccarani, 1996). Yet a 500 Million US Dollar project may be considered ‘mega’ in another context such as a small town (Flyvberg, 2008). Furthermore, most of the characteristics described above are ‘relative’. Terms such as ‘colosal’, ‘complex’, ‘captivating’, ‘costly’ and ‘controversial ‘ mean different things to different people in different contexts.

Therefore, in this research ‘megaprojects’ are defined to be:

1. Projects of value above 1 Billion US Dollars.
2. Projects having various elements: e.g. buildings, landscape, etc.
3. Projects providing an ‘engineering’ achievement within the context of Dubai
4. Projects that are ‘novice’ and of an experimental character.
5. Projects complex in terms of risk, uncertainty and methods.
6. Projects that are, thereby, difficult to control.

4.3 CSFs

4.3.1 Introduction

The literature on CSFs for mega construction projects is scarce. In addition, the mega construction projects studied are in the particular context of Dubai, where the literature regarding CSFs is even scarcer. In the quest for providing guidance to the research analysis studying the CSFs is found a good starting point. Abdomerovic and Blakemore (2002) state that many factors affect project management. Therefore, and for the reasons aforementioned, studying the CSF literature aimed at understanding the project management processes all the while simplifying the complex analysis process of the research by focusing on the most crucial CSFs.

4.3.2 Need for identification of CSFs

Clarke (1999) states that there is evidence supporting the existence of CSFs for project management in the literature (e.g. Pinto and Slevin, 1989). The importance of identifying CSFs in projects is well documented (e.g. Chan et al., 2001; Toor and Ogunlana, 2008; Clarke, 1999). Identification of key success criteria in the construction industry would allow construction executives and project managers to appropriately plan resource allocation (Chua et al., 1999; Toor and Ogunlana, 2008). Consensus on key success criteria will allow monitoring of project outcomes effectively and provide an ongoing framework to assist in tracking key project results (Chan et al., 2001; Toor and Ogunlana, 2008). There are further reasons to identify CSFs as shown in Table 4-3. Ashley et al. (1987) even state that 'construction project success is repeatable' making identification of CSFs all the more important.

Table 4-3 Importance of identifying CSFs

No.	Reason for importance of CSFs	Author
1	CSFs may assist in the analysis of potential reasons of project success or failure	Toor and Ogunlana (2008)
2	CSF appraisal may help in selection of team members, identification of development needs and forecast of levels of performance of project	Toor and Ogunlana (2008); Chan et al. (2001)
3	CSFs provide underlying decision framework	Toor and Ogunlana (2008); Songer and Molenaar (1997)
4	CSFs assist firms to decide strategic standing on project	Toor and Ogunlana (2008); Phua (2004)
5	CSFs enable effective allocation of limited resources	Toor and Ogunlana (2008); Chua et al. (1999)
6	CSFs may assist project team members to identify and prioritize critical issues for implementing project plan	Toor and Ogunlana (2008); Clarke (1999)
7	Focusing on 'important few' CSFs would deliver the greatest benefit	Toor and Ogunlana (2008); Clarke (1999)

4.3.3 Overview of CSFs

CSFs have been initiated in the 1960s (e.g. Rockart, 1982) and since then many authors have published lists of CSFs. The CSFs in the literature are at times showing their relative importance in order (e.g. Ahadzie et al., 2008), relating them to specific domains and tasks (e.g. Ogunlana et al., 2002; Li et al., 2000) or proving their significance to all projects (e.g. Toor and Ogunlana, 2009). Despite the vast literature on CSFs there is very little agreement on the factors that affect project success (e.g. Fortune and White, 2006).

The literature on CSFs varies by industry. There are specific CSFs such as the manufacturing industry and the construction industry (Toor and Ogunlana, 2009). Some of these factors are related to the party in the project such as that provided by Odeh and Battaineh (2002). Other authors have published a list of factors affecting certain aspects such as quality, performance, schedule, etc. (e.g. Jha and Iyer, 2007; Cheng and Li, 2006). Other authors have even provided factors for certain aspects in certain types of projects in specific countries such as Frimpong et al. (2003) by providing causes of delay and cost overruns in construction projects of groundwater projects in developing countries. Still other CSFs are provided for certain types of procured projects such as Chan et al. (2001) in their study of design and build projects.

The CSF literature on the construction industry provides a long list of CSFs. Although these are enlightening, there are two main problems with them. The first is how the CSFs relate to each other is not provided (Fortune and White, 2006 and Bellassi and Tukel, 1996). The second is how the CSFs can be rated in projects as CSFs vary in importance within the context of the project (Fortune and White, 2006). A methodology addressing these problems in establishing what CSFs are crucial is required. A question at this point is:

Q1: What are the most crucial CSFs in mega construction projects in Dubai?

Since the construction industry is project oriented, effective project management is necessary for successful completion of sophisticated construction projects. Factors conducive to successful project management are abundant in the literature (Isik et al., 2009). Sommerville and Robertson (2000) state that many construction contractors succeed in their business with only a financial measure. However, reliance solely on this measure may disregard investment of time and money in improving key success factors. In order to compete in the dynamic market, contractors need to continuously improve their construction project management, project quality and their operations (van Truong et al., 2008). This is particularly required in developing countries where risk and uncertainty in construction is higher (Ezeldin and Sharara, 2006).

Several researchers have termed success criteria as ‘Key Performance Indicators’ (KPIs) (e.g. Chan and Chan, 2000; Zwikael and Globerson, 2006; Mohamed, 1996).

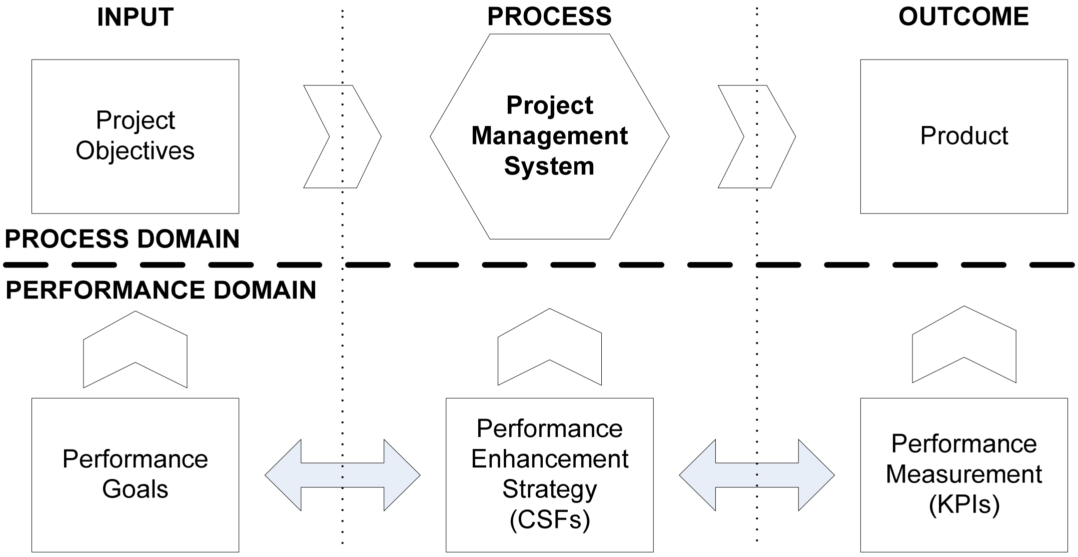
The essence of benchmarking is to use KPIs to measure project management performance through the benchmarking approach where the use of success factors may be measured (e.g. van Truong et al., 2008). Benchmarking may be internal or external. Internal benchmarking is where the organization collects data on its performance and assesses it by comparison to past years in order to make improvements. External benchmarking is where comparison of KPIs of various organizations may be used as a source of improvement as 'best practices' of one organization may be used by another to improve their performance (van Truong et al., 2008).

Despite the vast body of literature providing factors conducive to successful project management, there are several issues to be considered when studying CSFs. At this junction there is a need to discuss and define criteria, factors and project success, which is done in the following section.

4.3.4 Distinctions of criteria, factors and success

Distinguishing between criteria and factors is viewed as necessary (Cooke-Davies, 2002; Belassi and Tukel, 1996; Fortune and White, 2006). The concise English Dictionary c.f. Lim and Mohammed (1999) state a criterion as 'a principle or standard by which anything is or can be judged'. On the other hand, a factor is stated as 'any circumstance, fact, or influence which contributes to a result'. Toor and Ogunlana (2009) present a conceptual illustration of project management as shown in Figure 4-1. They categorize it into three main phases – input, process and outcome and two main domains – process and performance. It shows the relationships between factors and criteria. Lim and Mohammed (1999) criticize some project management literature for using the term critical factors as synonymous with criteria. They continue to state that 'criteria are the set of conditions sufficient for a judgment to be made, or result in certain outcome'. Success criteria are the measures by which success or failure of a project will be assessed, whereas success factors are the inputs to the management system that lead directly or indirectly to the success of the project or business (Cooke-Davies, 2002; Fortune and White, 2006). Belassi and Tukel (1996) further differentiate between success factors within and outside the control of the project manager.

Figure 4-1 Input, process and outcome of project management [Developed from Toor and Ogunlana (2009)]



There are several authors who distinguish between project successes perspectives from several view points. Bryde and Robinson (2005) in their study of client and contractor perspectives on project success find that the perspectives are different. Additionally, Lim and Mohammed (1999) provide a “macro” and “micro” views of project success, which are termed “project” and “project management “ success, respectively, by other authors (Cooke-Davies, 2002; Fortune and White, 2006). The latter terms are used for their ease of interrelation with other terms used in the research. Project success is measured against the overall objectives of the project (Cooke-Davies, 2002; Fortune and White, 2006), which may extend beyond the project main parties and duration of construction (Lim and Mohammed, 1999). Additionally, Westerveld (2003) states that success criteria vary between projects depending on issues such as size, uniqueness, and complexity. Project management success is measured against the traditional performance measures of cost, time and quality (Cooke-Davies, 2002; Fortune and White, 2006).

Despite the seemingly clear view of project success, the concept remains somewhat an “enigma” (Cooke-Davies, 2002). There is no agreement among researchers on critical success criteria in construction and there are ambiguities in their identification as well as disagreement over definitions. There are also differing views as to the differences between “project management” and “project success” (Ahadzie et al., 2008).

Cooke-Davies (2002) adds that the CSFs that 'really' lead to project success depend on three questions to be asked. The three questions are:

- *What factors are critical to project management success?*
- *What factors are critical to success on an individual project?*
- *What factors lead to consistently successful projects?*

The answer to the questions affect the CSFs, further reinforcing the lack of consensus on definitions of project success. Problems of CSFs are discussed further in the following section.

4.3.5 Problems with CSFs

Fortune and White (2006) state that there are three main criticisms of the CSF literature. The first of the three main criticisms are that there is no general agreement on the CSFs that affect project success as stated above. The second criticism is that there is no mechanism to adequately address the inter-relationships between the factors. The third criticism is that 'the factor approach tends to view implementation as a static process instead of a dynamic phenomenon, and ignores the potential for a factor to have varying levels of importance at different stages of the implementation process' (Larsen and Meyers, 1999; Fortune and White, 2006).

There are more criticisms of research on CSFs. The main criticisms are shown in Table 4-4. There are some fundamental problems including a lack of consensus on definitions of criteria (Ahadzie et al., 2008; Jha and Iyer, 2007), factors (Toor and Ogunlana, 2008) and project and project management success (Cooke-Davies, 2002). Additionally, there is no agreement on the CSFs themselves. Furthermore, the main problem is that there is little advice on how CSFs may be used to assist in the resolution of many of the problems occurring in project management (Clarke, 1999).

Even CSFs are now debated to be divided into 'hard' and 'soft' issues. Crawford and Pollack (2004) state that the terms 'hard' and 'soft' are used in a 'loose and ambiguous' way both in practice and in the literature, albeit the project management literature. The authors provide references made to 'hard' and 'soft' projects (McElroy, 1996); programs (Thiry, 2004); approaches (Yeo, 2002); methodologies (Fernie et al., 2003); systems (Crawford and Bryce, 2003); goals (Kadefors, 2004); outcomes (Li et al., 2001); aspects (Jaafari, 2001); criteria (Andersen et al., 2002; Wateridge, 1999); measures (Thiry, 2004); costs (Farrell, 2003); situations (Thiry, 2001); issues (Cheung et al., 2003); knowledge (Kasvi et al., 2003); ideas (Williams, 1999); logic (Buckle and Thomas, 2003); values (Andersen and Jessen, 2003); and, skills (Martin, 2000). Identification and response to ‘hard’ and ‘soft’ aspects can influence project success (Crawford and Pollack, 2004). Wateridge (1999) states that the lack of attention of project managers to soft criteria has been perceived to be a cause of project failure. Yeo (2002) states that soft criteria, in addition to technical quality, affect product acceptance. Williams (1999) identifies soft issues as the key success factors in projects. Furthermore, Jaafari (2001) indicates that soft issues have a high impact on projects. However, differentiation between ‘hard’ and ‘soft’ CSFs is not clear (Crawford and Pollack, 2004).

From the discussion above it is evident that a method to establish the most crucial CSFs for mega construction projects are required that follows the inductive case study approach in the research. This is discussed in the following sections.

Table 4-4 Problems with CSFs

No.	Problem	Author
1	No agreement on critical success criteria in construction	Ahadzie (2008); Jha and Iyer (2007); Nguyen et al. (2004)
2	No agreement on definitions of critical success criteria	Ahadzie (2008); Lim and Mohamed (1999)
3	Contrasting views between the terms ‘project management success’ and ‘project success’	Ahadzie (2008) ; Jha and Iyer (2007);
4	Without consensus on determinants of success, there is difficulty in monitoring and anticipating project outcomes	Ahadzie (2008) ; Lim and Mohamed (1999)
5	Lack of knowledge of key success criteria creates difficulty in planning resource allocation	Ahadzie (2008); Nguyen et al. (2004)
6	No standard definition of project success	Ahadzie (2008); Gidado (1996)
7	No accepted methodology for measuring project success	Ahadzie (2008)
8	No agreement on what the CSFs are on construction projects	Toor and Ogunlana (2009)
9	Success factors vary across projects	Toor and Ogunlana (2009)
10	Stakeholder perspectives on project success and success factors may vary	Toor and Ogunlana (2009); Pinto and Slevin (1987)
11	Vast majority of literature focus on ‘static’ CSFs	Toor and Ogunlana (2009); Fortune and White (2006); King and Burgess (2006)
12	CSFs not explicitly linked to outcomes	King and Burgess (2006)
13	Unique nature of projects may render CSFs inapplicable to a particular project or may not be existent	Belassi and Tukel (1996)
14	Relative importance of CSFs may vary with stages of the project life cycle	Pinto and Prescott (1988); Fortune and White (2006); Larsen and Meyers (1999)
15	No mechanism to adequately address the inter-relationships between factors	Fortune and White (2006); Larsen and Meyers (1999); Belassi and Tukel (1996)
16	Differentiation between ‘hard’ and ‘soft’ CSFs	Crawford and Pollack (2004); Williams (1999); Jaafari (2001)

4.3.6 Method to generate most crucial CSFs

The requirements for the most crucial CSFs in the research are to assist in focusing the analysis on the CSFs that would result from a method that would maintain the inductive case study approach used in the research. In order to get the required CSFs, there were two main approaches that may be used as found in the literature. The first is to use a questionnaire and the second is to use a 'general systems' model that is capable of resulting in the most crucial CSFs. The questionnaire was not considered suitable for several reasons, which are:

- The objective of the research was not to find the most crucial CSFs per se but to find them as a means of achieving the research objectives.
- The development of a questionnaire to identify the most crucial CSFs carries the same problems of surveys, most notably, that questionnaires have limited potential due to preset responses (Gidado, 1996; Phua and Rowlinson, 2004) as well as the lack of rapport with the respondents (Blaxter et al., 2006). This is discussed in Chapter Five.
- The survey method was viewed as going against the methodology of the research of 'openness' to allow respondents to 'direct' the 'responses' and allowing 'emergence' of 'untapped' dimensions (Gidado, 1996; Glaser, 1992). Gidado (1996) states that due to the complex and multi-faceted concept of project success many other underlying dimensions cannot be tapped using a conventional deductive approach.
- The author is of the view that a survey method does not show the interrelationship between CSFs.

The alternative to use of a questionnaire is to use the data from interviews, documents and observations and apply it to a 'general systems' model. This alternative was found more suitable for several reasons:

- This method maintains the 'openness' of the research and allows 'emergence' of 'untapped' dimensions by using data from interviews and observations (Gidado, 1996; Glaser, 1992), as well as documents.
- The use of a 'general systems' model would better provide the most crucial CSFs due to its complexity and multi-faceted concept (Gidado, 1996). Furthermore, the interrelationships between CSFs would be incorporated in the model (Fortune and White, 2006).
- The 'soft' aspects of CSFs are incorporated in the 'general systems' model (Fortune and White, 2006; Crawford and Pollack, 2004).
- The use of a 'general systems' model provides a 'dynamic' basis by which to 'systematically' debate the CSFs (Belassi and Tukel, 1996; Fortune and White, 2006).

- The 'general systems' model does not deny that all CSFs are important but that concentration should be placed on the 'most important few' (Fortune and White, 2006).

In the following section several frameworks from the literature are reviewed. The purpose is to choose one to be used in this research to arrive at the most crucial CSFs in the case study projects. Furthermore, the framework should maintain the inductive case study approach that the research uses.

4.3.7 Frameworks for CSFs in projects

Toor and Ogunlana (2009) state that relationships among CSFs contributing to project success may provide important insights on how to succeed on future projects. There have been few attempts in the literature to show the relationship between CSFs under various categories. This is despite the fact that large lists of CSFs under various categories are found in the literature (Toor and Ogunlana, 2009). Li et al. (2005) c.f. (Toor and Ogunlana, 2009) state that "While many CSFs have been identified, their importance relative to one another has received less attention". The assumption made by most research that CSFs are independent and are not interrelated may lead to deceptive conclusions (Toor and Ogunlana, 2009).

Attempts at analysis of the interrelationship of CSFs have been performed by several researchers as shown in Table 4-5. From the summary of studies shown in Table 4-5, there are several issues of concern that are raised. These are:

- The categories are different for each of the frameworks presented
- Following from the above point, if the categories are different so are the interrelationships between the CSFs
- The context from which each of the frameworks was developed is different raising the question of 'universality' of CSFs (Belassi and Tukel, 1996)
- The objectives of the frameworks vary
- Only few of the frameworks present a model showing the interrelationships between CSFs

These issues present a challenge choosing among the various frameworks. From Table 4-5, there are only three frameworks that provide a 'systems' approach showing the interrelationships between CSFs. These are the Belassi and Tukel (1996) model, the Project Excellence Model (Westerveld, 2003) and the FSM model (Fortune and

White, 2006). These three frameworks and models shall be further described in the following sections. However, at this junction several assumptions need to be made regarding factors, criteria and success for this research.

Table 4-5 Attempts showing interrelationships of CSFs [Partly developed from Toor and Ogunlana (2009)]

No.	Research study	Categories of CSFs	Summary of interrelationships	Context of framework	Purpose of framework
1	Chan et al. (2001)	o Project team commitment o Contractor's competencies o Risks and liability assessment o Client's competencies o End-user's needs o Constraints imposed by end-users	Insight into key factors/criteria relationships	Design and build construction projects	Assist in selection of team members. Identification of development needs. Forecast performance levels of project prior to commencement.
2	Chua et al. (2000)	o Project characteristics o Contractual arrangements o Project participants o Interactive processes	To identify CSFs according to objectives of time, cost and quality	Construction projects	Distinguish CSFs according to project objectives of time, cost and quality
3	Nguyen et al. (2004)	o Comfort o Competence o Commitment o Communication	Present four questions to be asked along lines of grouping to assist in project success	Large construction projects in Vietnam	To identify CSFs in construction projects and uncover relationships between them
4	Fortune and White (2006)	o Goals and objectives o Performance monitoring o Decision-maker(s) o Transformations o Communication o Environment o Boundaries o Resources o Continuity	Application of CSFs by use of a dynamic systems model	IT projects	To enable identification of crucial CSFs for a project by application to dynamic systems model
5	Yu et al. (2005)	o Project-related factors o Human-related factors o Business-related factors	Identifies, categorizes and prioritizes CSFs for project briefing	Construction project briefing	Identification and establishment of checklist to be used in project briefing
6	Belassi and Tukel (1996)	o Factors related to the project o Factors related to the project manager and the team members o Factors related to the organization o Factors related to the external environment	Factor groups are interrelated and system response to obstacles caused by several factors coming into play simultaneously	Construction projects	Analysis of cause-effect relationships may enable identification of effects of combinations of CSFs working at same time
7	King and Burgess (2006)	o Organizational context o Supporters o Project organization o Outcomes	Model of ERP CSFs and relationship between them	Project resource planning	To encourage exploration of appropriate implementation strategies
8	Toor and Ogunlana (2008)	o Comprehension o Competence o Commitment o Communication	The categories of CSFs are absolute necessities for project success	Large-scale construction projects in Thailand	To provide the most crucial CSFs in large-scale construction projects

9	Westerveld (2003)	o **Organization areas**
		  o Broad
		    o Leadership and team
		    o Policy and strategy
		    o Stakeholder management
		    o Resources
		    o Contracting
		  o Narrow
		    o Project management
		o **Results areas**
		  o Broad
		    o Appreciation by client
		    o Appreciation by project personnel
		    o Appreciation by users
		    o Appreciation by contracting partners
		    o Appreciation by stakeholders
		  o Narrow
		    o Project results
			Linking broad and narrow organization CSFs and broad and narrow results	Project management of various types of projects.	To help project managers deal with large and complex projects. To be used in setting up, managing and evaluating a project.

4.3.8 Assumptions related to CSFs for the research

The first issue to be settled is the issue of definitions. In order to bring this issue to rest the following definitions were used for the research. These are:

Factors – are inputs to the management system that lead directly or indirectly to the success of the project.

Criteria – is the measure by which success or failure of the project is assessed (Cooke-Davies, 2002; Fortune and White, 2006).

Success – in this research the “micro” (Lim and Mohamed, 1999) or “project management” view of success shall be used. The main reason is that the research is limited for the duration during which the case study projects were being executed, which does not allow for judgment of project success (Cooke-Davies, 2002). Therefore, the criteria used to judge project success are cost, time and quality as per responses of interviewees in this regard. Additionally, the main question for CSFs in the research that is asked is ‘what factors are critical to success on an individual project?’ (Cooke-Davies, 2002). This would provide the CSFs for each individual case study project. However, during the cross-case analysis of CSFs, the second question to be asked is ‘what factors are critical to project management success?’ (Cooke-Davies, 2002) within the context of the research.

The second important issue to be addressed is from what perspective is the analysis to be conducted? As concluded by Lim and Mohamed (1999), CSFs vary considerably as to whose perspective is considered. In this research the perspective of the project managing entity is viewed to be practical since it has been established that the main cause of construction project problems are internal to the project and at the operational level (Love et al., 2002; Al-Momani, 2000; Odeh and Battaineh, 2002; Cox et al., 1999; Tan and Lu, 1995; Chan et al., 2001).

The third issue to be addressed is regarding the ‘hard’ and ‘soft’ aspects of CSFs. In this research both ‘hard’ and ‘soft’ issues are considered. Despite the lack of differentiation between ‘hard’ and ‘soft’ CSFs (Crawford and Pollack, 2004), it was viewed that the frameworks presented in the following sections considered both aspects.

An additional note to be considered is that of the basics of focusing on a few CSFs. In concentrating on a few key CSFs project success may be more likely. Clarke (1999) states that management of all CSFs simultaneously and dividing attention amongst them equally is virtually impossible. Figure 4-2 indicates some of the factors to consider in project management. The underlying reason to do this is that project management of large projects involves ‘planning, organisation and control of a large number of complex factors, activities and their interrelations’. None of the key CSFs alone may be responsible for ensuring a project’s success as they are all interdependent and requires a holistic approach to be taken (Clarke, 1999). The issues of complexity and interrelatedness will be further discussed in Chapter Three as relates to construction projects. Additionally, an understanding of the complete system and the fit between the parts is required (Clarke, 1999). This is discussed in Chapter Four.

Figure 4-2 Some factors to consider in project management [Developed from Clarke (1999)]

4.4 Framework Models of Critical Success Factors

4.4.1 Introduction

A criticism of CSFs in the literature is that lists of CSFs are provided without attempting to interrelate them (e.g. Fortune and White, 2006) or to link the CSFs with success criteria (Westerveld, 2003). In order to enable the use of CSFs systematically a framework around the CSFs should be used in studying it. Therefore, a framework is viewed as necessary in the analysis of CSFs in this research.

The following section presents three models placing a framework around critical success factors. The first is the Project Excellence Model by Westerveld (2003). The second is the model developed by Belassi and Tukel (1996). The third is the Formal System Model (FSM) developed by Fortune and White (2006). Each of the models is presented and one is chosen to be applied to the case studies in this research. The justification of the choice of model is made and the chosen model is further scrutinized regards its applicability to construction projects, particularly in Dubai.

4.4.2 Project Excellence Model

The Project Excellence Model is developed by Westerveld (2003). This section summarizes the model. The Project Excellence Model links project success criteria to critical success factors. The model is shown in Figure 4-3. The model is developed in response to the criticism of how success is judged and the criteria to determine if the project is successful.

Table 4-6 provides groups of success criteria forming the results area of the model. The grouping was performed to broadly cover the whole issue of project success. Additionally, the results areas represent a clear and distinctive set of goals. Table 4-7 provides the definition of six organizational areas in the model. It is based on an extensive review of the CSF literature.

Figure 4-3 Project Excellence Model [Developed from Westerveld (2003)]

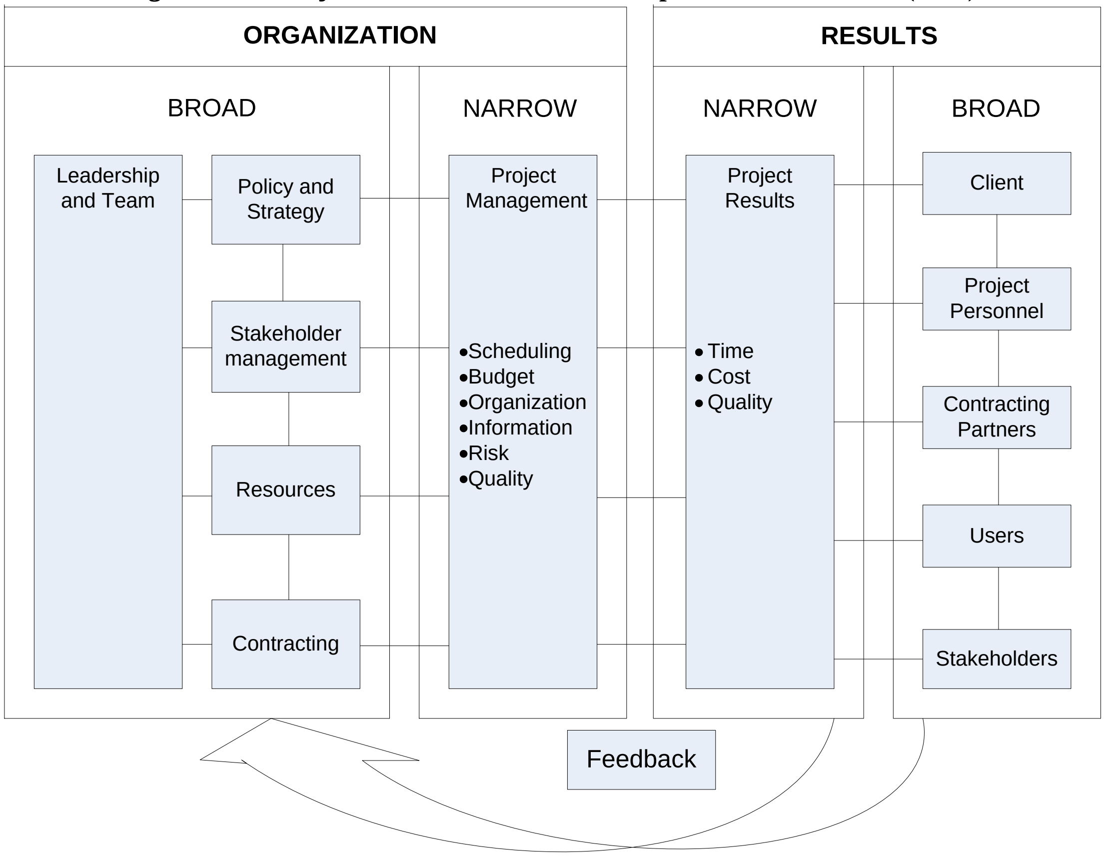


Table 4-6 Result areas of the Project Excellence Model [Developed from Westerveld (2003)]

No.	Result area	Explanation
1	Project results Budget Schedule Quality	The original golden triangle of project goals. Almost all projects will have specific scheduling, budget and quality constraints.
2	Appreciation by the client	The client initiates the project to fulfil a specific need. What aspects and factors does the client value in judging the success of the project?
3	Appreciation by project personnel	The workers of the project will be concerned with reaching their personal goals as well as a good working atmosphere.
4	Appreciation by users	Users are concerned with their overall influence in the project and the functionality of the end product.
5	Appreciation by contracting partners	Contracting partners try to make a profit at the project. They are also concerned with getting new orders and learning possibilities.
6	Appreciation by stakeholders	Those parties that are not directly involved in the project but have a large influence. For example environmental groups, citizens and government agencies. These parties manage their specific interest.

Table 4-7 Organizational areas of the Project Excellence Model [Developed from Westerveld (2003)]

No.	Result area	Explanation
7	Leadership and Team	Represents the way the project manager runs the project and how tasks and responsibilities are divided. Leadership style of and co-operation in the project team greatly influence the working habits within the project organization.
8	Policy and Strategy	What are the project goals and how are they accomplished. Combining the interest of stakeholders into an end-product.
9	Stakeholder management	How does the project interact with various stakeholders? The co- operation of the project organization with external parties determines the place of the project in its environment.
10	Resources	Resources have to be utilized in an effective and efficient manner in order to achieve maximum benefit to the stakeholders involved.
11	Contracting	Each project organization establishes contractual relationships. The choices of contracts and partners evolve around the tasks at hand and the competencies of contraction parties.
12	Project management Scheduling Budget Organisation Quality Information Risks	How does operational control of the project take place? The traditional aspects of sound project control play a key role in this process.

The 12 areas in the model play a key role in managing a project. Success is achieved when choices from the organizational areas match with project goals in the results areas and the external factors of the project. External factors of projects can be those related to the:

- Project manager and team members (i.e. skills and background).
- Project (i.e. size, uniqueness and urgency).
- Parent organization (i.e. management support and structure).
- External environment (i.e. political and technological).

As projects vary widely, five project types were developed to visualize the choices of parent organizations. The most suitable project type is based on the required project goals, results areas and external factors. Excellence is achieved by choosing a suitable project type.

Although the Project Excellence Model is a ‘systems’ model accounting for both external and internal as well as ‘hard’ and ‘soft’ factors it does not assist in arriving at the most crucial CSFs in a project. Its use is for setting up, managing and evaluation of a project (Westerveld, 2003). Therefore, this model was not considered suitable for use in the research to arrive at the most crucial CSFs in the case study projects.

4.4.3 Belassi and Tukel Framework for Determination of CSFs

Belassi and Tukel (1996) provide a model framework for the determination of CSFs in projects based on a vast literature review. The literature review made provides seven lists of critical success factors and are then grouped into four main categories. These categories and factors are then provided in a framework as shown in Figure 4-4.

The model framework groups the main critical success factors into four main categories. These categories are:

- Factors related to the project
- Factors related to the project manager and the team members
- Factors related to the organization
- Factors related to the external environment

The main factors and their interrelationships are provided in the model framework as presented in Figure 4-4. As can been seen from the figure, the groups are interrelated and a factor in one group can influence a factor in another group. Additionally, a combination of several factors from various groups may lead to project success or failure. The effects of the factors are called “system responses” which lead to project success or failure.

Factors related to the project

Project characteristics are considered one of the essential dimensions of project performance and have long been overlooked in the literature (Belassi and Tukel, 1996). Factors related to the project include the size and value of the project, the uniqueness of project activities, the density of the project network, project life cycle and the urgency of project completion. In a study performed by Tukel and Rom (1995) it was found that many large-size projects exceeded their deadlines and concluded that caution should be given to the number of activities and the familiarity of the organization with the type of project being undertaken.

Project manager performance may be affected by the uniqueness of the activities where more standard projects are easier to plan. Project density is defined as the number of precedence relationships to the total number of activities where it affects the allocation of resources, and particularly man hours. Another characteristic is urgency of a project, which is defined as the need to implement the project as soon as possible. Due to urgency of a project some of the performance criteria may not be met, and in these situations not enough time is provided for planning and scheduling. The result is projects are more likely to exceed budgets.

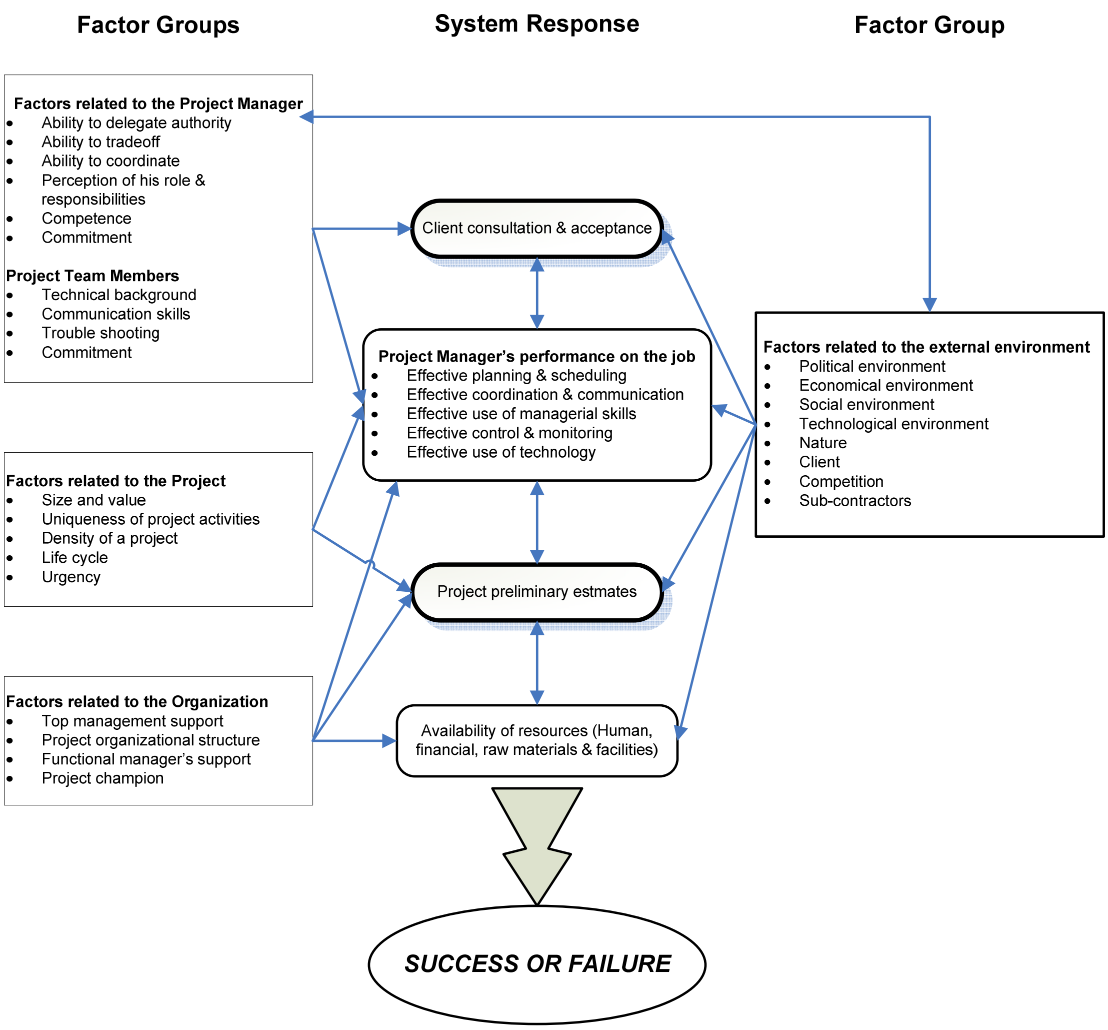


Figure 4-4 CSF framework by Belassi and Tukel (1996)

Factors related to project manager and team members

Factors related to the skills and characteristics of project managers and team members are considered for the successful completion of projects. Pinto and Slevin (1989) found that in selecting project managers, their technical and administrative skills are necessary for successful project completion. Additionally, the project manager's commitment and competence are most critical during the planning and termination stages. Team member competence is considered most critical during the implementation phase. These factors affect project performance as well as client satisfaction.

Factors related to organization

One of the most critical success factors for successful project completion is top management support, and is usually strongest if the project champion is from them, as he helps project managers in understanding and achieving the project management objectives. Top management usually control project managers' access to resources through their functional managers and the support provided by the functional managers reflects top management support. It is the view that if the project is part of a functional organization, then the project manager is the functional manager and there is no problem. However, it is different with project or matrix organizations where acquiring resources is difficult, requiring negotiating skills and positional power within the organization.

Factors related to external environment

Factors external to the organization may have a positive or negative impact on the project. Some of these environmental factors include political, economic and social factors as well as factors relating to technology and nature. The client, if outside of the organization, is considered an external factor affecting project performance. Subcontractors, as well as other external factors that might influence the project manager's performance on the job, are also considered external factors. It is noted that environmental factors, such as competitors in the market, may influence client consultation and acceptance and the client himself may be the reason for ineffective consultation.

The intermediate effects of factor groups

The factors alone are insufficient to determine project success or failure. The factors in each group are regarded as the input affecting project implementation, but often do not directly affect project outcome. The system may respond in various ways to obstacles caused by several factors coming into play simultaneously, which may cause further problems during project implementation and cause project failure. The framework provides a set of system responses. By analyzing the cause-effect relationship in the framework, project managers may be able to identify and eliminate the factors that have a negative impact on their performance.

Critique of the Belassi and Tukel Framework of CSFs

There are several criticisms regarding the CSF framework model of Belassi and Tukel (1996). Fortune and Peters (2005) provide criticisms of the Belassi and Tukel model, and which may be applicable as well to the critical success factor approach in general. One of the criticisms is the difficulty of assessing project performance by factors as a set of criteria because of lack of definition of the "optimal state" for any particular project. Another criticism is that the many factors available largely fit into the classifications made by Belassi and Tukel (1996), where there is disagreement among authors on the contents of the set of factors. The third main criticism is based on the emphasis by Belassi and Tukel (1996) that the interrelationships between factors in the different groups are as important as the individual factors:

"As can be seen from the figure [Reproduced here as Figure 4-4*], the groups are interrelated. A factor in one group can influence a factor in another group, and a combination of several factors from various groups which might lead to project failure. For instance, top management support is a factor related to an organization which can be affected by the general state of the economy. Similarly, the uniqueness of the project activities can affect the project manager's competence on the job. Lack of top management support together with the project manager's lack of competence on the job might lead to project failure."*

(Belassi and Tukel, 1996, p. 143)

Fortune and Peters (2005) state that despite the importance stressed on the interrelationships there is no mechanism to account for it. Fortune and White (2006) provide an alternative model and provide a framework for CSFs. This is described in the following section.

Although the Belassi and Tukel (1996) model provides for the interrelationships between CSFs, it is mainly to be used to analyze the effects of CSFs interacting simultaneously. The model is not suitable to be used for arriving at the most crucial CSFs in a project. In addition to the criticisms of the model above, it is for this particular reason that this model is not used in the research.

4.4.4 Formal System Model (FSM)

The FSM model was developed mainly from the "systems failure approach". The concept is that successful systems can be developed by avoiding failure (Bignel and Fortune, 1983). The FSM model is adopted from Checkland (1981) and unites most systems concepts (Fortune and White, 2006). The FSM model is created by Bignell and Fortune (1984) and applied to CSFs by Fortune and White (2006). The model is an attempt to address the main criticisms of CSFs.

Fortune and White (2006) provide an extensive review of the literature on CSFs. 23 of 27 CSFs identified in the literature are integrated with the features of the Formal System Model (FSM). It addresses the inter-relationships between the CSFs in system components and it is a dynamic model responding to decision-making and interacts with its environment. The CSFs mapped onto the FSM are as shown in Table 4-8 made by Fortune and White (2006).

A simple definition of a system from Bignell and Fortune (1984) is to view it as a transformation process which converts a set of inputs to a set of outputs and can be expressed as an arrangement of subsystems. The following attributes are assumed for a system:

a. *A system is an assembly of components, connected in an organized way such that each component is connected directly or indirectly to every other component.*
b. *The components are affected by being in the system, and the behaviour of the system is changed if they leave it.*
c. *The organized assembly of components does something.*
d. *This assembly has been identified as of particular interest.*

(Bignell and Fortune, 1984; p. 11)

Figure 4-5 shows the Formal System Model (FSM) developed by Bignell and Fortune (1984). The three main components are: the system (the Formal System); the wider system; and the environment. The Formal system is made up of three subsystems or components, which are: a decision-making subsystem; a performance monitoring subsystem and subsystems and components that carry out the transformations.

Table 4-8 Critical success factors\mapped onto components of the Formal System Model (Fortune and White, 2006)

Components of FSM/ Project attributes	Critical success factors from literature
Goals and objectives	Clear realistic objectives
	Strong business case/sound basis for project
Performance monitoring	Effective monitoring/control
	Planned close down/review/acceptance of possible failure
Decision-maker(s)	Support from senior management
	Competent project manager
	Strong/detailed plan kept up to date
	Realistic schedule
	Good leadership
	Correct choice/past experience of project management methodology/tools
Transformations	Skilled/suitably qualified/sufficient staff/team
Communication	Good communication/feedback
Environment	Political stability
	Environmental influences
	Past experiences (learning from)
	Organizational adaptation/culture/structure
Boundaries	Project size/level of complexity/number of people involved/duration
Resources	Adequate budget
	Sufficient/well allocated resources
	Training provision
	Proven/familiar technology
	Good performance by suppliers/contractors/consultants
Continuity	Risk addressed/assessed/managed
Other	User/client involvement
	Different viewpoints (appreciating)
	Project sponsor/champion
	Effective change management

The decision-making subsystem in the formal system manages the system and thus it is responsible regarding how objectives are to be achieved and for provision of resources to achieve the objectives. It is this subsystem that provides the expectations required to both the performance monitoring subsystem and the subsystems and components that perform the system's transformations. Responsibility to observe the transformation activities and processes is borne by the performance monitoring subsystem. It is also responsible to observe and report deviations from expectations to the decision-making subsystem to take corrective actions. The last subsystem is the set of subsystems and elements to perform the tasks of the system by converting inputs into outputs. The relationships between the subsystems are shown in Figure 4-5. The transformation subsystems and components may have their own decision-making and performance monitoring subsystems. Additionally, these relationships do not mean that each subsystem may not have a certain degree of autonomy in decisions as to how the expectations are met (Fortune and Peters, 2005).

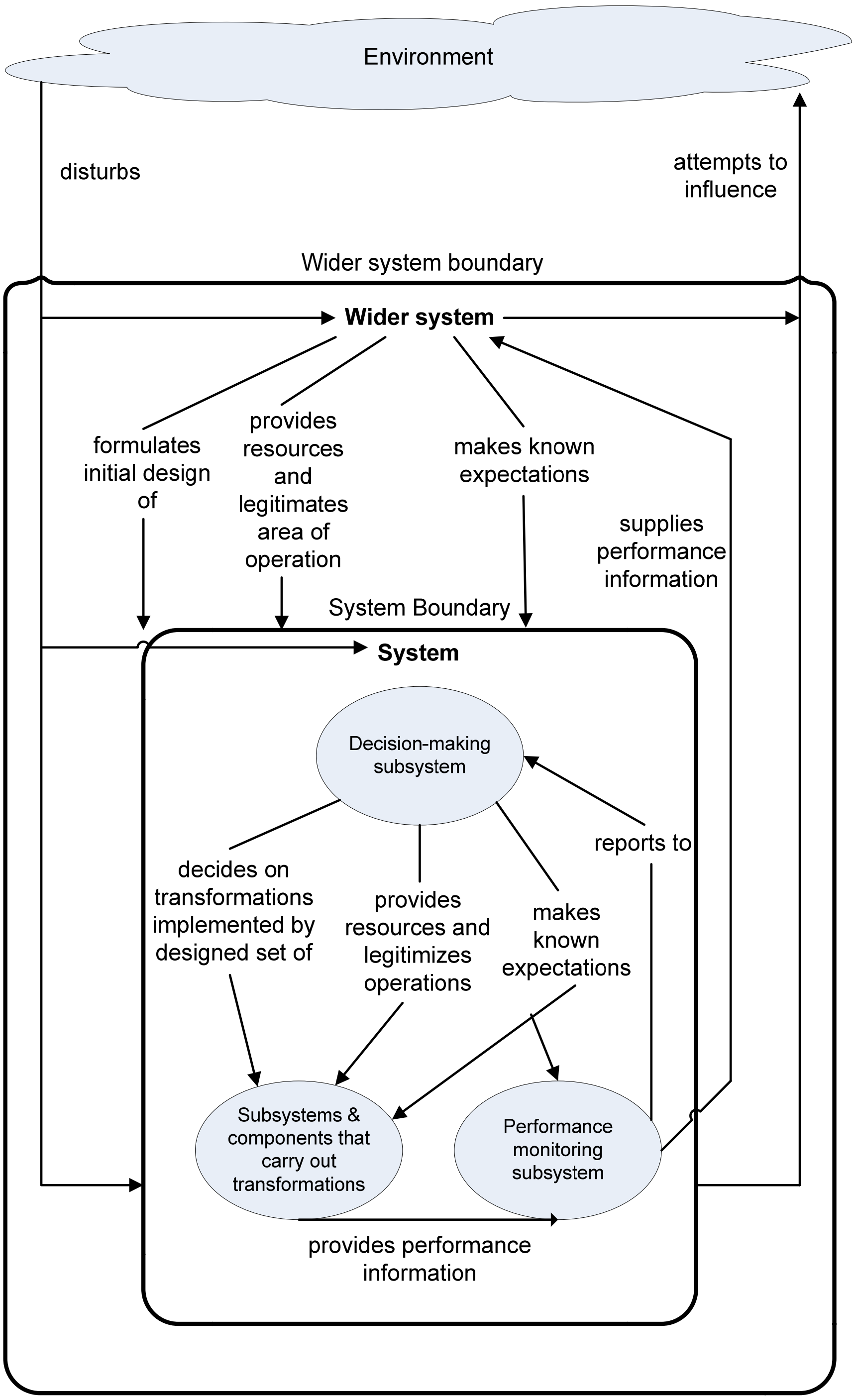


Figure 4-5 Formal System Model (FSM)-(Bignell and Fortune, 1984)

Two subsystems are identified to be of particular interest for work in “human activity systems”, which are linked sets of activities which people undertake. The first is a decision-taking subsystem to manage the system and is responsible for decisions regards the transformations to be made as well as for the design of the rest of the system. This system exhibits choice and sometimes autonomy. The second is a performance monitoring subsystem which checks that the system is performing to the expectations of the decision-making subsystem and reports any deviations to it to take action (Bignell and Fortune, 1984).

There may be two types of surroundings that a system may have; a wider system and environment. Surrounding the system is the wider system, which will:

- *set the objectives or define the purpose of the system*
- *strongly influence the decision taken within the system*
- *monitor, or measure the performance of the system*
- *provide the resources to allow the system to function*

(Bignell and Fortune, 1984; p. 13)

The environment is the collection of entities outside the wider system which can influence the system but is not significantly influenced by it. Thus the influence of a powerful environment can be disadvantageous to the system and serves to constrain it, but may provide no benefits to it. This is unlike the wider system which constrains the system but could provide resources to the system.

The environment, and its components, could provide an input to the system and influences it. These are referred to as “uncontrollable inputs” or “disturbances”, which may influence the performance and output of the system, because the system cannot control the environment despite attempts to influence it. Therefore, and due to the influence of the environment, control is needed on the activities or process of the system being controlled (Bignell and Fortune, 1984; Fortune and Peters, 2005; Fortune and White, 2006).

Critique of the Formal Systems Model of CSFs

Critical success factors are applied into the FSM model by Fortune and White (2006). The literature review made is largely based on an IS/IT perspective. It is also applied on IT projects in the same article. Its applicability to construction should be viewed critically. This will be performed in Subsection 2.5.

Additionally, the factors that have not been placed in the main components of the model could be fit in them. User/client involvement and project sponsor/champion could fit well in the decision-maker(s) component of the model. Different viewpoints (appreciating) may fit well in the boundaries component of the model. Furthermore, effective change management fits well in the transformation component as in effect it is part of the transformation process.

4.5 Choice of CSF model

4.5.1 Introduction

Three models providing critical success factors in frameworks have been presented in the previous section. This section will provide the justification for the pursuit of the model chosen for the analysis. The model chosen will then be further scrutinized for applicability to construction projects.

4.5.2 CSF framework models and justification of choice of model

An underlying concept showing the interaction between the project management processes is the plan-do-check-act cycle (PMI, 2004). This is the basis for the Project Management Process Groups developed within the PMBOK which include processes of Planning, Executing, Monitoring and Control, Initiating and Closing. This is presented in Figure 4-6. It highlights the main components of the process and the relationship between them.

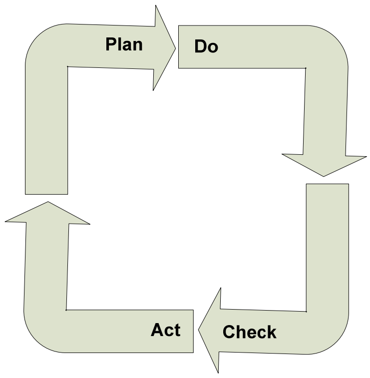


Figure 4-6 The Plan-Do-Check-Act Cycle (Redeveloped from PMBOK Guide, 2004)

The FSM model provides the main aspects that any project or business goes through. The FSM model shows the main systems as per the management cycle. It also shows the relationship between the subsystems and the feedback loops. The FSM model provides a “systems view” and provides for the dynamics between the subsystems. The model is also versatile allowing various subsystems and elements to be placed within each of the subsystems in the FSM model. This includes communication, etc.

The Project Excellence Model and the model by Belassi and Tukel (1996) do not provide the subsystems of monitoring and controlling as well as the feedback process. They also do not depict the interrelationships between the factors within a ‘systems process’ as provided in the models. Although the models do highlight interesting points it does not follow the management cycle, which is necessary to show the interrelationships between the subsystems. This provides the main drawback for the application of these models in this research as applying the CSFs into them would not provide the most crucial CSFs in the case study projects. Therefore, the FSM model was chosen to be applied in this research. However, the FSM model should be checked for its applicability to construction projects, which is the topic of the following Subsection 4.5.3.

4.5.3 Applicability of FSM Model to construction projects

The CSFs relating to construction projects are reviewed to check its feasibility with the FSM model components and project attributes. The CSFs described in the literature applied to construction are summarized in Table 4-9. Although these CSFs are divided largely by the party in the project responsible for that CSF, they are easily subdivided into other components or attributes.

The CSFs relating to construction are listed and compared to the components and project attributes of the FSM model. The comparison is made between construction CSF literature, particularly for the Gulf region, and each of the components of the FSM model below:

Goals and objectives component

Unrealistic contract duration and requirements imposed is comparable to the clear realistic objectives subcomponent in the FSM model. No mention is made of the strong business case/ sound basis subcomponent, maybe due to ‘lack of interest’ of the project team as it may be considered a strategic decision versus an operational one.

Performance monitoring component

Quality assurance/control is similar to the effective monitoring/control subcomponent of the FSM model. The consultant was mentioned more in this regard as the projects are largely traditionally procured contracts. However, there was no mention in the literature in the region of planned close down/review/acceptance of possible failure; it seems for no reason other than a foresight on the part of the authors since the studies used questionnaires with responses provided. This is one of the problems of this type of questionnaires.

Table 4-9 Comparison of CSFs in FSM with construction literature

Components of FSM/ Project attributes	Critical success factors from literature	As related in construction literature	Literature from construction
Goals and objectives	Clear realistic objectives	Unrealistic contract duration and requirements imposed	Sambavisan and Soon (2006); Faridi and El-Sayegh (2006); Odeh and Battaineh (2002)
	Strong business case/sound basis for project		
Performance monitoring	Effective monitoring/control	Quality assurance/control (consultant)	Sambavisan and Soon (2006); Odeh and Battaineh (2002)
	Planned close down/review/acceptance of possible failure		
Decision-maker(s)	Support from senior management	Slow decisions making (owner)	Alaghbari et al. (2007); Sambavisan and Soon (2006); Faridi and El-Sayegh (2006)
		Excessive bureaucracy/uncooperative owner (late in approving design documents)	Faridi and El-Sayegh (2006); Assaf and Al-Hejji (2006); Odeh and Battaineh (2002)
		Slow to give instructions (consultant)	Sambavisan and Soon (2006)
		Owner personality	Zaneldin (2006); Odeh and Battaineh (2002)
		Termination of work	Zaneldin (2006)
		Suspension of work	Zaneldin (2006)
	Competent project manager	Poor site management	Alaghbari et al. (2007); Assaf and Al-Hejji (2006)
		Contract management (consultant)	Sambavisan and Soon (2006)
		Unavailability of the construction/project management group for the project	Faridi and El-Sayegh (2006)
	Strong/detailed plan kept up to date	Improper and inadequate planning	Sambavisan and Soon(2006); Faridi and El-Sayegh (2006); Zaneldin (2006); Odeh and Battaineh (2002)
		Inadequate progress review	Faridi and El-Sayegh (2006)
		Planning errors	Zaneldin (2006)
		Conflicts encountered with sub-contractors' schedule in project execution	Assaf & Al-Hejji (2006)
	Realistic schedule	Unrealistic contract duration and requirements imposed	Sambavisan and Soon(2006); Faridi and El-Sayegh (2006); Odeh and Battaineh (2002)
	Good leadership	Unsuitable leadership style of construction/project manager	Faridi and El-Sayegh (2006)
	Correct choice/past experience of project management methodology/tools	Construction methods	Sambavisan and Soon(2006); Faridi and El-Sayegh (2006); Odeh and Battaineh (2002)
		Type of project bidding and award	Assaf and Al-Hejji (2006)
		Type of construction contract	Assaf and Al-Hejji (2006)
		Unavailability of incentives for contractor to finish ahead of schedule	Assaf and Al-Hejji (2006)
		Ineffective delay penalties	Assaf and Al-Hejji (2006)
Transformations	Skilled/suitably qualified/sufficient staff/team	Lack of consultant's site staff experience (managerial and supervisory personnel)	Alaghbari et al. (2007)
		Construction mistakes and defective work	Alaghbari et al. (2007); Sambavisan and Soon (2006); Faridi and El-Sayegh (2006); Zaneldin (2006)
		Shortage of site labour and manpower	Alaghbari et al. (2007); Sambavisan and Soon (2006) ; Faridi and El-Sayegh (2006); Assaf and Al-Hejji (2006); Odeh and Battaineh (2002)
		Low labour productivity	Alaghbari et al. (2007); Sambavisan and Soon (2006); Faridi and El-Sayegh (2006); Odeh and Battaineh (2002)
		Poor skills and experience of labour	Alaghbari et al. (2007); Faridi and El-Sayegh (2006)
		Lack of subcontractor's skills	Alaghbari et al. (2007)
		Lack of contractor's staff (and poor qualification)	Alaghbari et al. (2007); Assaf and Al-Hejji (2006)
		Subcontracting problems	Zaneldin (2006)
		Delay caused by contractor	Zaneldin (2006)
		Contractor not well organized	Zaneldin (2006)
		Bad quality of contractor's work	Zaneldin (2006)

Components of FSM/ Project attributes	Critical success factors from literature	As related in construction literature	Literature from construction
Communication	Good communication/feedback	Lack of coordination (between parties)	Alaghbari et al. (2007); Faridi and El-Sayegh (2006); Odeh and Battaineh (2002)
		Preparation and approval of drawings	Sambavisan and Soon (2006); Faridi and El-Sayegh (2006); Assaf and Al-Hejji (2006); Odeh and Battaineh (2002)
		Lack of (or bad) communication between the parties	Sambavisan and Soon (2006); Faridi and El-Sayegh (2006); Zaneldin (2006); Odeh and Battaineh (2002)
Environment	Political stability	Poor economic conditions (currency, inflation rate, etc.)	Alaghbari et al. (2007)
		Changes in laws and regulations	Alaghbari et al. (2007); Sambavisan and Soon (2006); Zaneldin (2006); Odeh and Battaineh (2002)
	Environmental influences	Lack of materials (and quality) in the market	Alaghbari et al. (2007); Sambavisan and Soon (2006); Faridi and El-Sayegh (2006); Assaf and Al-Hejji (2006); Odeh and Battaineh (2002)
		Poor or unforeseen site conditions (location, ground, etc.)	Alaghbari et al. (2007); Sambavisan and Soon (2006); Faridi and El-Sayegh (2006); Zaneldin (2006); Odeh and Battaineh (2002)
		Problems with neighbours	Sambavisan and Soon (2006); Odeh and Battaineh (2002)
		Lack of equipment and tools in the market and failure	Alaghbari et al. (2007); Sambavisan and Soon (2006); Faridi and El-Sayegh (2006); Odeh and Battaineh (2002)
		Poor weather conditions	Alaghbari et al. (2007); Sambavisan and Soon (2006); Faridi and El-Sayegh (2006); Assaf and Al-Hejji (2006); Odeh and Battaineh (2002)
		Transportation delays & permits	Alaghbari et al. (2007); Faridi and El-Sayegh (2006)
		External work due to public agencies (roads, utilities, public services)	Alaghbari et al. (2007)
		Obtaining permit/approval from the municipality/different government authorities	Faridi and El-Sayegh (2006)
	Past experiences (learning from)	Lack of working knowledge of owner	Alaghbari et al. (2007)
		Lack of consultant site experience	Alaghbari et al. (2007)
	Organizational adaptation/culture/structure	Waiting time for approval of tests, QA/QC and inspection	Sambavisan and Soon (2006); Faridi and El-Sayegh (2006)
		Waiting time for sample/materials approval	Faridi and El-Sayegh (2006); Odeh and Battaineh (2002)
		Inappropriate overall organizational structure linking to the project	Sambavisan and Soon (2006)
Boundaries	Project size/level of complexity/number of people involved/duration		Belassi and Tukel (1996)
Resources	Adequate budget	Financial problems of contractors and owners (delayed payments, financial difficulties and economic problems)	Alaghbari et al. (2007); Sambavisan and Soon (2006); Faridi and El-Sayegh (2006); Zaneldin (2006); Assaf and Al-Hejji (2006); Odeh and Battaineh (2002)
		Low price of contract due to high competition	Zaneldin (2006)
		Changes in material and labour costs	Zaneldin (2006)
		Estimating errors	Zaneldin (2006)
	Sufficient/well allocated resources	Shortage of materials on site	Alaghbari et al. (2007); Odeh and Battaineh (2002)
		Delay in delivery of materials to site	Alaghbari et al. (2007); Faridi and El-Sayegh (2006); Odeh and Battaineh (2002)
		Equipment and tool shortages on site	Alaghbari et al. (2007); Odeh and Battaineh (2002)
	Training provision		
	Proven/familiar technology		

Components of FSM/ Project attributes	Critical success factors from literature	As related in construction literature	Literature from construction
	Good performance by suppliers/contractors/consultants	Absence of consultant's site staff	Alaghbari et al. (2007)
		Supervision too late and slowness in decision making (consultant)	Alaghbari et al. (2007); Odeh and Battaineh (2002)
		Incomplete documents (by consultant)	Alaghbari et al. (2007); Faridi and El-Sayegh (2006); Odeh and Battaineh (2002)
		Design error due to unfamiliarity with the local conditions, environment, and the materials	Faridi and El-Sayegh (2006); Odeh and Battaineh (2002)
		Mistakes and discrepancies in contract documents	Sambavisan and Soon (2006); Zaneldin (2006); Assaf and Al-Hejji (2006); Odeh and Battaineh (2002)
		Subcontractor's incompetence	Sambavisan and Soon (2006)
		Poor contractor supervision and site management	Sambavisan and Soon (2006); Faridi and El-Sayegh (2006); Odeh and Battaineh (2002)
		Inadequate contractor experience	Sambavisan and Soon (2006); Faridi and El-Sayegh (2006); Odeh and Battaineh (2002)
		Contract management (consultant)	Sambavisan and Soon (2006); Odeh and Battaineh (2002)
		Poor control of site resources allocation (contractor)	Faridi and El-Sayegh (2006)
		Delay in subcontractor's work	Faridi and El-Sayegh (2006)
		Accidents	Zaneldin (2006)
Continuity	Risk addressed/assessed/managed		
Other	User/client involvement	Owner interference	Sambavisan and Soon (2006); Odeh and Battaineh (2002)
		Delay caused by owner	Zaneldin (2006); Odeh and Battaineh (2002)
	Different viewpoints (appreciating)		
	Project sponsor/champion		
	Effective change management	Contract modifications-Change orders and variations (replace and add new works to the project; change in specifications)	Alaghbari et al. (2007); Sambavisan and Soon (2006); Faridi and El-Sayegh (2006); Zaneldin (2006); Assaf and Al-Hejji (2006); Odeh and Battaineh (2002)
		Major disputes and negotiation	Sambavisan and Soon(2006); Odeh and Battaineh (2002)
		Materials type and specification change during construction	Faridi and El-Sayegh (2006); Odeh and Battaineh (2002)

Decision-makers

There were many issues stated in the construction literature that were within the support from senior management subcomponent of the FSM model. These were largely negative issues and stressed the owner. These included slow decision making, excessive bureaucracy, uncooperative owner, slow instructions (mainly from consultant), owner personality, termination of work and suspension of work. It was noticeable the presence of the owner in all these negative responses, and highlights the client role. This topic will be further discussed in Chapter Five.

The subcomponent of competent project manager in the FSM model relates to issues stated in the construction literature of poor site management, problems of contract management (by consultant) and unavailability of the construction/project management team for the project. The construction literature referred to provide several issues in relation to the strong/detailed plan kept up to date subcomponent of the FSM model. Issues included improper and inadequate planning, inadequate progress reviews and planning errors. Furthermore, the construction literature adds conflicts encountered with subcontractors' schedules, which may be due to the lack of qualified subcontractors.

The realistic schedule subcomponent in the FSM model was replicated from the construction literature with unrealistic contract duration and requirements imposed. The unsuitable leadership style of the construction/project manager is equivalent to the good leadership subcomponent of the FSM model. The difference was in the positive and negative perspectives between the FSM model and the construction literature.

Transformations

The skilled/suitably qualified/sufficient staff/team subcomponent of the FSM model seems to be a problem as provided in the construction literature. The problems stated included shortages of labour and manpower, labour productivity and poor skills and experience of labour. Other problems stated were the lack of consultants' site staff and experience in both a managerial and supervisory capacity. Other problems included lack of subcontractor skills and problems caused by them as well as lack of qualified contractors' staff, delays caused by them and poor quality of work.

Communication

The FSM model provides one subcomponent in communication which is good communication/feedback. The construction literature problems included lack of coordination between the parties and problems with preparation and approval of drawings. Furthermore, the lack of, or bad communication between the parties was cited as a problem.

Environment

The political stability subcomponent of the FSM model that was comparable to the construction literature were poor economic conditions such as currency and inflation rates and changes in laws and regulations. The environmental influences subcomponent was comparable to the construction literature where there were problems related to lack of materials, equipment and tools and their subsequent failure. Other problems stated in this regard included poor or unforeseen site conditions and problems with neighbours. Furthermore, there were problems related to transportation delays, external work of public agencies (e.g. roads and other public service utilities) and problems of obtaining permits and approvals from various authorities.

The past experiences (learning from) subcomponent of the FSM model was comparable to the construction literature where problems were stated due to lack of owner working knowledge and lack of consultant site experience. It is noticeable that the owner's lack of knowledge is problematic, a topic further reviewed in Chapter Five. The organizational/adaptation/culture/structure is comparable to the construction literature where the main problems were created by the waiting for approvals for tests, samples, and inspections, among others. Furthermore, another main problem stated is the inappropriate overall structure linking the project.

Boundaries

This particular component had no direct comparison to the construction literature. Again, this is believed to be related to the problems of survey questionnaires where the respondent is rather limited to responses provided. Despite that, there are comparables such as unreasonable durations.

Resources

Responses from the construction literature for the adequate budget subcomponent of the FSM model included financial problems of contractors and owners including delayed payments and financial difficulties. Other problems in this regard included low price of contract due to high competition and changes in material and labour costs as well as estimation errors. For the sufficient/well allocated resources the construction literature cited problems of shortage of materials on site and delays in delivery of materials as well as equipment and tool shortages on site.

It was noticeable the lack of comparable factors from the construction literature to the training provision and proven/familiar technology subcomponents of the FSM model. The training provision is an issue that has been plaguing the construction industry, and in particular in developing countries where temporary labour is the standard, and therefore, it may have been viewed as of little significance. The proven/familiar technology subcomponent may have simply been viewed as insignificant as construction projects are viewed as ‘low technology’ with respect to other industries. Furthermore, the construction literature may have studied ‘small’ projects which do not have a ‘high technology component’.

Unlike, the previous two subcomponents, there was much from the construction literature comparable to the good performance by suppliers/contractors/consultant subcomponent of the FSM model. There were many problems cited involving the consultants, contractors and subcontractors. Problems relating to the consultant included absence of site staff, slow decision making by supervisors, incomplete documents and discrepancies, design errors due to unfamiliarity with the local environment, mistakes in documents and poor contract management. Problems relating to the contractor included inadequate experience, poor control of site resources and accidents. The main problem relating to subcontractors was incompetence.

Continuity

The single subcomponent is risk addressed/assessed/managed in the FSM model. The lack of comparable factors in the construction literature may be attributable to the lack of educated staff where it is evident that there are risks of lack of material and skilled labour, which are faced and resolved in an intuitive manner rather than a systematic manner. Thereby, it would not be considered ‘significant’.

Other

These are subcomponents that were not directly placed in any component in the FSM model. Fortune and White (2006) state that these may be fit in the main components of the FSM model where as an example the project sponsor/champion fits well in the Decision-maker(s) model and the effective change management can fit in the transformation component. However, each will be discussed as presented by the authors.

In the user/client involvement subcomponent the construction literature cites problems of owner interference and delays caused by the owner. It is noted again that the owner’s role in the project is significant. No comparable factors were provided from the construction for the different viewpoints or for the project sponsor/champion subcomponents of the FSM model. This is due largely to the fact that these are already incorporated in the main components of the model and are a repetition.

The final subcomponent in the FSM model is effective change management. Comparable factors from the construction literature cite problems from contract modifications, change orders and variations including changes in material types and specifications during construction. The construction literature cites major disputes and negotiations resulting from changes.

The previous comparison of the FSM model and the construction literature is limited to the Gulf region. The general body of CSF literature provides an even better fit with the FSM model as it incorporates more components such as risk assessment and boundaries of the projects. This is attributed to the difference in levels of research where it is scarce in the Gulf region.

It is found that there is a good fit between the CSFs in the construction literature and the components and project attributes of the FSM model. It is thereby concluded that the components of the FSM model is applicable, and thereof the model itself is applicable. This indicates that the FSM model is robust and can be applied to construction projects.

4.6 Summary of CSFs

The definitions of projects and mega-projects are provided from the literature and defined for the research. The characteristics of mega-projects are provided form the literature and defined for the research. The CSF literature has been reviewed highlighting both the importance and problems of CSFs in the literature. Various definitions are provided differentiating between factors, criteria and success.

Assumptions for the research are made as well as the perspective of the project managing entity is established. The need for a framework showing interrelationships between CSFs is established and several frameworks are reviewed. Three ‘systems’ models placing a framework around CSFs have been presented, described and critiqued. The Formal System model was chosen for application to the case study projects. This choice is justified in that it follows the general management phases, something which is found to be of necessity. Additionally, the FSM model provides a "systems view" and is dynamic. The FSM model components are compared to those from the construction literature emanating from the area to test its suitability for application in construction projects in Dubai. It was found to be suitable when comparing CSFs to the main components of the model. Therefore, this model will be used to apply the case study projects for the purpose of highlighting the most critical success factors affecting the case study projects within the context of the research. The following chapter presents the philosophical position of the research as well as methods and research design.

CHAPTER 5 RESEARCH DESIGN AND METHODOLOGY

5.1 Introduction

Research is a systematic investigation to increase the sum of knowledge (Fellows and Liu, 2003). Marshal and Rossman (2006) define research as a systematic inquiry to provide a better understanding of a phenomenon and/or change a social circumstance. In order to study a phenomenon, researchers are expected to employ suitable methodologies defining how the research shall be conducted. Furthermore, specific research techniques (i.e. methods) fitting the methodology and phenomenon under study should be used (Silverman, 2001).

Research methodology is the framework associated with a particular set of paradigmatic assumptions that is used to conduct research (O'Leary, 2004). *Research methodology is informed by what we know philosophically and its applications affects what we come to know* (Smyth and Morris, 2007). "The principles and procedures of logical thought processes applied to a scientific research" refers to what is known as "research methodology". Although the term methodology means different things to different people, and as any other concept, its meaning is continually evolving, what is important to understand is that research methodology deals with the methods for creating knowledge about the world and the interpretation of this knowledge in light of the ontological epistemological positions (Reich, 1994).

Details of research methodology and design are provided in this chapter. The chapter initiates with the epistemological debate within the project management research and establishes the position taken in this research. The various research approaches are reviewed and the selection of a multiple case study approach is justified. The following section identifies the most appropriate methods that should be adopted for this study and argues the appropriateness and possible problems. Methods of data collection and analysis are described to incorporate the 'replication logic', which addresses issues of validity and reliability within the cases studies. The qualitative nature of the data and its analysis requires that the research meet rigour and replicability requirements. The research methods are detailed and the overall research design is discussed.

5.2 Ontology

Ontology is 'about the theory of social entities and is concerned with what there exists to be investigated' (Walliman, 2006). Ontology deals with the nature of the things we know about the world or the nature of the world. A central ontological question is: do we know things about the real world, or is our knowledge a reflection of our manipulation of the world? (Reich, 1994).

Two theoretical positions in ontology are objectivism and constructionism (Walliman, 2006; Bryman, 2008). Objectism is 'the belief that social phenomena and their meanings have an existence that is not dependent on social actors' as they are 'facts that have an independent existence'. Constructionism is 'the belief that social phenomena are in a constant state of change because they are totally reliant on social interactions as they take place' (Walliman, 2006). The main questions at the ontological level concern the nature of social entities. Should social entities be considered as objective entities or should they be regarded as social constructs built up from the 'perceptions and actions of social actors'? (Bryman, 2008).

The project management body of knowledge has been governed by a 'natural sciences' tradition (Cicimil et al., 2006). Project actors and managers have been viewed as 'implementers' whose role is limited to issues of control of time and cost and content of a pre-planned scope of work to achieve project objectives. Their wider role is marginalized as social and political actors in complex arrangements of projects (Clegg and Ross-Smith, 2003 c.f. Cicimil et al., 2006). This view assumes rationality, universality and objectivity. It also assumes that individuals have the capacity to collect, analyse and communicate information, resolve problems in project work, and make value-free decisions. This implies they are 'skilful technicians' with certain expectations of behaviour, traits, knowledge and responsiveness to complexity (Cicimil et al., 2006). This perspective is challenged by several researchers (Clegg and Ross-Smith, 2003; Wood, 2002; Flyvberg, 2001, c.f. Cicimil et al., 2006) who view that actor's responses are based on skills which have become 'reflexive and intuitive' and is important.

With the past literature providing guidance, prescriptions and best practices, the rate of failures of projects in terms of achieving the traditional objectives of time, cost and quality continue. With this in mind the main driving question in this research is do we understand construction at all? (Clarke et al., 2003). To begin to answer this question for the structurally complex mega construction projects with high uncertainty and time constraints (Cicimil et al., 2006); an alternative methodology to the 'objectivist' culture pervasive in the project management literature is required. Therefore, this research uses a constructionist approach. This research deals with the perspectives of subjects at a point in time in the context described in Chapter One. It is not independent of the actors within the social entity being investigated. The research topic of communication in mega construction projects cannot be considered otherwise since communication is recognized as a process of relating (Chia, 2002 c.f. Cicimil and Marshall, 2005) and the understanding that 'organization' is a result of individuals interacting together through complex processes of relating (Stacey, 2003 c.f. Cicimil and Marshall, 2005).

5.3 Epistemology

Epistemology is concerned with "how we know things and what we can regard as acceptable knowledge in a discipline" (Walliman, 2006). Epistemology deals with the relation between humans and their knowledge, and is a philosophical branch that deals with the theory of knowledge. Typical epistemological questions are: What can we know? How do we know? What is truth? Is there *a priori* knowledge, and if so, of what? (Bryman, 2008; Walliman, 2006).

A particular issue in epistemology is the questions of whether the world can and should be studied according to the same 'principles, procedures and ethos as the natural sciences' (Bryman, 2008). Epistemology can be divided into two main parts: (1) that of a natural science methods use in the study of social sciences (positivism), and; (2) that which is contrary to positivism (referred to as interpretism, anti-positivism or phenomenology) (Walliman, 2006; Flick, 2006; Bryman, 2008). Interpretism is defined as the 'recognition that subjective meanings play a crucial role in social actions', which aims to reveal interpretations and meaning (Walliman, 2006).

Bryman (2008) states the difficulty in defining the precise guidelines of positivism since it is used differently by different authors. Another philosophical position close to positivism is realism, which shares a belief that the natural and social sciences can and should use the same approaches to collection of data and to explanation. Additionally, realism shares the view that ‘there is a reality that is different to our description of it’ (Bryman, 2008).

The research subject is communication and information management in mega construction projects, which are complex (e.g. Bertelsen, 2003 and Baccarini, 1996). Communication (e.g. Dainty et al., 2006) and complexity (Sinha et al., 2001) are multi-faceted concepts and neither has a universally accepted definition. This suggests that there may be underlying dimensions that cannot be ‘tapped’ by use of the conventional deductive approach (Phua and Rowlinson, 2004). Furthermore, it is accepted that when ‘pre-existing theoretical frameworks are likely to be fragmented or rudimentary’ an inductive approach that captures tacit knowledge and causal relationships is useful (Partington, 2000; p. 99 c.f. Phua and Rowlinson, 2004). As an exploratory study in communication in a complex setting, this research takes the interpretive position epistemologically. Subjective matters play a major role in the research. The issues dealt with in the research are ‘soft’ issues and the questions guiding the research were exploratory in nature and were subject to interpretation of the data. The causal links developed formed the basis for the interpretation of findings. A systematic approach was used with due consideration of validity concerns.

5.4 Methodological issues in project management research

Research methodology plays a key role in generation of knowledge on projects and their management (Smyth and Morris, 2007). Smyth and Morris (2007) argue that progress in developing the knowledge base for research and practice is weak, and thereby, practice is weak if the epistemological base is weak. A particular problem they state is the assumption that general patterns in project management can be identified, which has ‘explanatory power’. Applicability is contingent upon context, and while the importance of context is acknowledged, epistemologically context is overlooked in the selection of research methodology. Project management and its bodies of knowledge have been subject to a paradigm reflecting an ‘execution’ view of the discipline while omitting reference to definitional stages. The project management literature and bodies of knowledge are epistemologically associated with positivism, seeking general explanations and practical solutions disregarding context (Smyth and Morris, 2007).

The general literature divides research methodologies into two distinct approaches showing the 'extreme' positions rather than where they may be employed (Bryman, 2008; Walliman, 2006; Long and Godfrey, 2004; Long et al., 2000). These divisions are described, among others, as positivist-interpretivist, objective-subjective, hard-soft and qualitative and quantitative. Fitzgerald and Howcraft (1998) provide a model showing this divide, which is redeveloped in Table 5-1. This table shall be used to elaborate on the positioning of this research. However, as noted by many authors, this division is not 'rigid' as many research projects employ methods from both extremes (Bryman, 2008; Walliman, 2006; Bryman and Bell, 2003; Wilson and Natale, 2001; Long et al., 2000)

The main debates of philosophical positioning are most evident at the methodology level at the divide between quantitative and qualitative. The quantitative is commensurate with traditional, positivist, experimental or empiricist paradigm. The qualitative is commensurate with constructivism, naturalist, interpretive, postpositivist or postmodern paradigms. This distinction is stated as futile since there is an 'interaction between conceptual inquiry and empirical fact-finding' whereby the ability to handle both throughout research and move from one to the other may be required (Wilson and Natale, 2001).

Long et al. (2000) state that philosophically the positioning of research is not as clear as referred to ontologically and epistemologically. Whether reality is objective and external to the individual or subjective and 'cognitively constructed' on an individual basis are extremes. Epistemologically, knowledge can be seen objectively (theoretically accessible to all) or subjectively (dependent on individual experiences). They add that observations of objects involves personal perspectives which constitutes a 'parametric' dependence (i.e. observations are taken from a certain standpoint). This then allows observations from different positions.

Table 5-1 'Soft' versus 'hard' research dichotomies as summarised by Fitzgerald and Howcroft (1998) c.f. Blismas (2001) within the Information Sciences

Soft	Hard
Ontological Level	
Relativist Belief that multiple realities exist as subjective constructions of the mind. Socially-transmitted terms direct how reality is perceived and this will vary across different languages and cultures.	**Realist** Belief that external world consists of pre-existing hard, tangible structures which exist independently of an individual's cognition.
Epistemological Level	
Interpretivist No universal truth. Understand and interpret from research's own frame of reference. Uncommitted neutrality impossible. Realism of context important.	**Positivist** Belief that world conforms to fixed laws of causation. Complexity can be tackled by reductionism. Emphasis on objectivity, measurement and repeatability.
Subjectivist Distinction between the researcher and research situation is collapsed. Research findings emerge from the interaction between researcher and research situation, and the values and beliefs of the researcher are central mediators.	**Objectivist** Both possible and essential that the researcher remain detached from the research situation. Neutral observation of reality must take place in the absence of any contaminating values or biases on the part of the researcher.
Emic/Insider/Subjective Origins in anthropology. Research orientation centres on native/insider's view, with the latter viewed as an appropriate judge of adequacy of research.	**Etic/Outsider/Objective** Origins in anthropology. Research orientation of outside researcher who is seen as objective and the appropriate analyst of research.
Methodological Level	
Qualitative Determining what things exist rather than how many there are. Thick description. Less structured and more responsive to needs and nature of research situation.	**Quantitative** Use of mathematical and statistical techniques to identify facts and causal relationships. Samples can be larger and more representative. Results can be generalised to larger populations within known limits of error.
Exploratory Concerned with discovering patterns in research data and to explain/understand them. Lays basic descriptive foundation. May lead to generation of hypotheses.	**Confirmatory** Concerned with hypothesis testing and theory verification. Tends to follow positivist, quantitative modes of research.
Induction Begins with specific instances which are used to arrive at overall generalisations which can be expected on the balance of probability. New evidence may cause conclusions to be revised. Criticised by many philosophers of science, but plays an important role in theory theory/hypothesis conception.	**Deduction** Uses general results to ascribe properties to specific instances. An argument is valid if it is impossible for the conclusion to be false if the premises are true. Associated with theory verification/falsification and hypothesis testing.
Field Emphasis on realism of context in natural situation, but precision in control of variables and behaviour measurement cannot be achieved.	**Laboratory** Precise measurement and control of variables, but at expense of naturalness of situation, since real-world intensity and variation may not be achievable.
Idiographic Individual-centred perspective which uses naturalistic contexts and qualitative methods to recognise unique experience of the subject.	**Nomothetic** Group-centred perspective using controlled environments and quantitative methods to establish general laws.
Axiological Level	
Relevance External validity of actual research question and its relevance to practice emphasised, rather than constraining the focus to that researchable by 'rigorous' methods.	**Rigour** Research characterised by hypothetico-deductive testing according to the positivist paradigm, with emphasis on internal validity through tight experimental control and quantitative techniques.

Long et al. (2000) state that adequacy of method is rooted in assumptions the researcher holds about the nature of the object of the research. This relates to the ontological, epistemological and methodological nature of society and social science of which perspectives fall within the range of quantitative (highly objective approach) to qualitative (highly subjective approach). The authors add that most research falls within the range, and thereby, do not fit neatly within categories since more often than not researchers 'borrow useful constructs from a variety of perspectives'. This in turn gives way to a 'mixed-methods' research (Bryman, 2008).

This research was found unsuitable for the use of mixed methods. The exploratory nature of the research favoured a highly subjective approach. Additionally, due to the nature of the phenomenon under study, it did not lend itself to the use of quantitative methods. There was no need for a preoccupation with measurements.

There are three main reasons for the preoccupation with measurement in general. The three main reasons for this preoccupation are:

- measurements may highlight 'fine differences' in characteristics of people.
- measurement provides a 'consistent device' to make distinctions. This should be consistent over time and should not be influenced by the researcher.
- measurement acts as a basis for 'more precise estimates of the degree of relationship between concepts' (Bryman and Bell, 2003).

Davies (2007) warns that a common mistake in qualitative data analysis is to treat the data as a 'survey', and thereby, being tempted to describe and 'add up' what respondents have said in the conversations. The author continues to warn that most times the results are bad. First, the sample gathered does not allow reliable conclusions to be drawn as in 'surveys'. Secondly, and following from the first reason, is the risk of missing the opportunity of delivering interpretive finding from the data (i.e. exploring) is high. The exploration should concentrate on respondents' interaction with their social settings, people's perspectives, etc.

Smith (2003) calls for a different set of constructs for assessment of qualitative research. This is supported by other authors such as Guba and Lincoln (1994). All the constructs that are proposed do not provide 'measurement' as of importance. Smith (2003) calls for qualitative research to be judged by criteria appropriate to it. Some principles for a assessing the quality of qualitative research includes sensitivity to context and data, rigour, commitment, transparency and coherence as well as impact and importance.

From the argument stated above and the exploratory nature of the research a mixed method approach was not favoured or used for several reasons. The first reason is that a high level of detail or precision is not required for this research. The purpose of the research is to develop theory without a need for precise measurements of the relatedness of concepts or themes that may develop. Secondly, through the coding process for each code, a text is placed relating to that code. In this process the same text may be placed in a different code at the same time. There are two problems that arise as a result: (1) quantifying becomes less reliable, and thereby, renders measures as a 'misguidance', and (2) the coding is performed by the researcher where 'subjective' placement of texts is made, and thereby, measurement may reflect only the subjective judgment of the researcher. Thirdly, concentrating on 'measurements' would distract the researcher from exploring the data and delivering interpretive findings. Fourthly, measurements usually imply a 'deductive' approach to the research, whereas the research was 'highly' inductive. Lastly, the quality of exploratory qualitative research is judged by criteria where 'measurement' is not necessarily an important factor.

5.5 Methodology

Methodology is concerned with questions such as how is research planned and executed? How are theories created and tested? How are tests interpreted? As a general rule, research methodologies can be broadly classified into two distinct approaches. They are the scientific empirical tradition and the naturalistic phenomenological modes (Punch, 2005). These two approaches have come to be synonymous with quantitative and qualitative research methods, respectively (Bryman, 2008). From the data presentation perspective, quantitative data is mainly numbers. On the other hand, qualitative data is data that is mainly words, sounds or images (Punch, 2005). In addition, the qualitative approach is also supported by action research or the case study method.

Quantitative and qualitative researches differ with respect to their epistemological foundations as well as in other respects. Table 5-2 shows the main differences between the two research strategies in terms of the connection between theory and research, epistemological and ontological considerations as provided by Bryman and Bell (2003).

Table 5-2 Main Differences between Quantitative and Qualitative Research Strategies [Redeveloped from Bryman and Bell (2003)]

	Quantitative	Qualitative
Principal orientation to the role of theory in relation to research	Deductive; testing of theory	Induction; generation of theory
Epistemological orientation	Natural sciences model, in particular positivism	Interpretivism
Ontological orientation	Objectivism	Constructionism

The above indicates a strong distinction between qualitative and quantitative research. Both have different characteristics in terms of data and the techniques required for their analysis. The shortcomings of the 'hard' quantitative (positivist) analysis may not be appropriate when studying 'subjective' issues difficult to quantify and collect (anti-positivist), which account for the 'soft' personal data (Walliman, 2005). However, a mixture of quantitative and qualitative research may be used within certain limits (Walliman, 2005; Blaxter et al., 2006, Bryman and Bell, 2003).

In this research the data collection was based on semi-structured interviews. The data was, therefore, narratives and not numbers. Additionally, the research was inductive for the purpose of developing theory. The epistemological orientation is interpretive. The ontological orientation is constructionsim. The research collection methods and analysis favoured a qualitative approach, which was used in this research and which is described in the following sections. Bryman (2008) adds:

While it is useful to contrast the two research strategies, it is necessary to be careful about hammering a wedge between them too deeply.

5.5.1 Quantitative research

Quantitative research methods usually involve large randomised samples, more application of statistical inference, and few applications of cases demonstrating findings (Blaxter et al., 2006). The objective of quantitative research is to determine the relationship between one thing (an independent variable) and another (a dependent or outcome variable) in a population (Glesne and Peshkin, 1992). Quantitative research designs are either descriptive or experimental. A descriptive study establishes only associations between variables. An experiment establishes causality (McQueen and Knussen, 2002; Blaxter et al., 2006).

Strengths of Quantitative Approach

The main strengths of this approach lie in precision and control (Blaxter et al., 2006) and the generalizability of findings (Glesne and Peshkin, 1992; Blaxter et al., 2006). Precision is reached through quantitative and reliable measurement and control is achieved by sampling and design. Furthermore, hypotheses are tested via a deductive method and the use of quantitative data to allow statistical analysis (Blaxter et al., 2006). Generalizability is achieved from the precision provided by measurement and statistical analysis of samples (Sapsford, 1999; Bryman and Bell, 2003; Blaxter et al., 2006).

Limitations of Quantitative Approach

The key limitation of the quantitative approach is that the results provide less detail on human behaviour, attitudes and motivation (Silverman, 2000; Bryman and Bell, 2003). Quantitative methods may not be suitable to the *complexity, embedded character and specifity of real-life phenomena* (Gilham, 2000b). Although response of opinions and perceptions can be converted into digitised results, it mainly leaves no meaning to the researchers. Accordingly, many researchers are concerned that the quantitative approach makes it difficult to generate theory (Silverman, 2000). Table 5-3 provides some criticisms of quantitative research.

Table 5-3 Some criticisms of quantitative research [Developed from Silverman (2000)]

1- Quantitative research can amount to a ‘quick-fix’, involving little or no contact with people or the ‘field’
2- Statistical correlations may be based upon ‘variables’ that, in the context of naturally occurring interaction, are arbitrarily defined
3- After-the-fact speculation about the meaning of correlations can involve the very common-sense processes of reasoning that science tries to avoid
4- The pursuit of ‘measurable’ phenomena can mean that unperceived values creep into research by simply taking on board highly problematic and unreliable concepts such as ‘delinquency’ or ‘intelligence’
5- While it is important to test hypotheses, a purely statistical logic can make the development of hypotheses a trivial matter and fail to help in generating hypotheses from data

5.5.2 Qualitative Approach

Qualitative research is generally defined as research that *uses qualitative methods in gathering and analysis of the data, that is, visual and verbal (conceptual or thematic) rather than numerical data manipulation* (Long and Godfrey, 2004). Its aim is to understand underlying reasons for informants' feelings, perceptions or experiences of a phenomenon (Gilham, 2000b). Qualitative research strives for in-depth (Bryman and Bell, 2003), holistic understanding of phenomenon from different perspectives bounded by the context or setting within which is studied (Long and Godfrey, 2004). Qualitative research can take many forms and there are a variety of methods for conducting this type of research (Silverman, 2001; Bryman and Bell, 2003).

Strengths of qualitative approach

Qualitative research is best used for depth, rather than breadth, of information (Bryman and Bell, 2003; Yin, 2003b). While quantitative surveys are an outstanding medium for gathering a breadth of information regarding "How many?" or "How much?", qualitative research is the best research method for discovering underlying motivations, feelings, values, attitudes, and perceptions (Yin, 1994).

Limitations of qualitative approach

The primary limitation is that, unlike quantitative research, the findings are not statistically projectable to the population under study (Blaxter et al., 2006). Due to the "specifity" of elements in one group or organization, generalization from one to another is suspect (Gilham, 2000). This limitation is created by two facts: recruiting is rarely completely representative (Bryman and Bell, 2003); and, the very nature of qualitative research necessitates small sample sizes (Voss et al., 2002). Furthermore, qualitative research is context-specific, and thereby, relevance of theory is not known until data is gathered and analyzed, which requires a more inductive approach (Gilham, 2000b).

5.5.3 Quantitative versus Qualitative

Consideration of research methods are not clear-cut as may seem at first glance (Bryman, 2008). There are many ways to categorize research methods. However, the methods may be interrelated and at times interdependent (Long et al., 2000). The most important factor in the choice of methodology and research methods is that it is a "close fit" with the questions of the research and its aims and objectives (Gilham, 2000b).

Quantitative research is often contrasted with qualitative research. The distinct characteristics of both research approaches support researchers to make appropriate decisions on designing new research in the initial stage. Table 5-4 lists some common characteristics of both research approaches.

Quantitative research may be viewed as a research strategy that emphasizes quantification in the collection and analysis of data (Punch, 2005) and qualitative research can be viewed as a research strategy that usually emphasizes words rather than quantification in the collection and analysis of the data (Blaxter et al., 2006). However, there is more to differentiate the two research strategies that lie deeper than the face of it (Bryman, 2008).

The nature of this research and the aims, objectives and questions do not lend itself to a quantitative approach. The research also is of an exploratory nature and is inductive, where the nature of what we investigate is firmly engrained in human behaviour, something that is more interpretive than anything else. The data collected are largely words and descriptions of processes. This research, therefore, uses a qualitative approach.

Table 5-4 Comparison of quantitative and qualitative research

Quantitative	Qualitative	Author
Objective	Subjective	Blaxter et al. (2006); Bryman and Bell (2003)
Hard	Soft	Siverman (2000); Bryman and Bell (2003)
Seeks the facts/causes of social phenomena	Concerned with understanding behaviour from actor's own frames	Blaxter et al. (2006); Glesne and Peshkin (1992)
Literature review must be done early in study	Literature review may be done as study progresses or afterward	
Tests theory	Develops theory or tests the theory	Bryman and Bell (2003)
One reality: focus is concise and narrow. Seeks consensus, the norm.	Multiple realities: focus is complex and broad. Seeks pluralism, complexity	Blaxter et al. (2006); Glesne and Peshkin (1992)
Assumes a stable reality	Assumes a dynamic reality	Blaxter et al. (2006)
Reduction, control, precision	Discovery, description, understanding, shared interpretation	Blaxter et al. (2006);
Measurable	Interpretive	Blaxter et al. (2006); Glesne and Peshkin (1992); Merriam (2002); Bryman and Bell (2003)
Report statistical analysis.	Report rich narrative, individual interpretation.	Blaxter et al. (2006); Glesne and Peshkin (1992)
Basic element of analysis is numbers	Basic element of analysis is words/ideas.	Blaxter et al. (2007); Merriam (2002)
Component analysis	Search for patterns	Glesne and Peshkin (1992)
Reliable: hard and replicable data	Valid: real, rich, deep data	Blaxter et al. (2006)
Researcher is separate: detached and impartial	Researcher is part of the process: partiality	Glesne and Peshkin (1992); Bryman and Bell (2003)
Researcher provides objective portrayal	Researcher provides emphatic understanding	Glesne and Peshkin (1992); Merriam (2002)
Removed from the data: the 'outsider' perspective	Close to the data: the insider perspective	Blaxter et al. (2006); Glesne and Peshkin (1992); Bryman and Bell (2003)
Context free	Context dependent	Glesne and Peshkin (1992)
Begins with hypotheses and theories	Start with research questions. End with hypotheses and grounded theory	Glesne and Peshkin (1992)
Reasoning is logistic & deductive	Reasoning is dialectic & inductive	Blaxter et al. (2006); Glesne and Peshkin (1992)
Establishes relationships, causation	Describes meaning, discovery	Glesne and Peshkin (1992)
Primacy of method	Primacy of subject matter	Glesne and Peshkin (1992)
Outcome-oriented	Process-oriented	Blaxter et al. (2006); Glesne and Peshkin (1992); Merriam (2002)
Generalizable: multiple case studies	Ungeneralizable: single case studies	Blaxter et al. (2006); Glesne and Peshkin (1992)
Particularistic	Holistic	Blaxter et al. (2006); Bryman and Bell (2003)
Obtrusive and uncontrolled measurement	Naturalistic and uncontrolled observation	Blaxter et al. (2006); Bryman and Bell (2003)
Strives for generalization	Strives for uniqueness (contextualization)	Glesne and Peshkin (1992); Bryman and Bell (2003)
Designs: descriptive, correlation, quasi-experimental, experimental	Designs: phenomenological, grounded theory, ethnographic, historical, philosophical, and case study.	Blaxter et al. (2006); Merriam (2002)
Survey	Case study	Silverman (2000)
Abstract	Grounded	Silverman (2000)
Value-free	Political	Silverman (2000)
Fixed	Flexible	Silverman (2000)

5.6 Research design

5.6.1 Research purposes

Research is conducted for three main purposes, which are:

- to explore phenomena (exploratory). When very little is known about something (Singleton, Jr. et al., 1993; Voss et al., 2002), exploratory research is suitable.
- to describe a phenomena (descriptive). Descriptive research describes a phenomenon. It is more structured than exploratory research, focused on fact-finding and focuses on a few dimensions of a 'well defined entity', measuring them systematically and precisely (Singleton, Jr. et al., 1993; Voss et al., 2002).
- to examine and formally to test relationships among variables (explanatory). Explanatory research is used to test relationships and to seek answers to problems and hypotheses, where the difference with explanatory research is in the scope of the description. Descriptive research seeks information about isolated variables and explanatory research seeks the relationship between the variables (Singleton, Jr. et al., 1993; Voss et al., 2002).

Exploratory research is highly unstructured (Singleton, Jr. et al., 1993), which has given all case studies a notorious reputation (Yin, 2003a). Fieldwork and data collection are initiated prior to the final definition of research questions and hypotheses following intuitive paths where the goal may be to develop theory (Yin, 2003b). It is probably the most difficult for a novice researcher, as there are no pre-described independent and dependent variables (Singleton, Jr. et al., 1993).

On the contrary, descriptive and explanatory research are highly structured and carefully planned with a complete strategy before the start of data collection (Singleton, Jr. et al., 1993; Voss et al., 2002). Descriptive research has descriptions as their main objective where a descriptive theory covers scope and depth of an object rather than an expression of cause and effect. The "theory" of what needs to be described should be stated ahead of time, subject to review and debate to later serve as the design for the study (Yin, 2003a). Explanatory research is more suitable for designing and performing causal case studies where the analysis can take advantage of pattern-matching techniques (Voss et al., 2002; Yin, 2003a).

Voss et al. (2002) differentiate the divisions among the general purpose research strategies in a different way and match the research purpose with methods or strategies. These are stated as divided as a hierarchy. The authors state that the outcome of one purpose strategy is the basis for following purpose strategies. These are presented in Table 5-5. As can be seen there are many similarities with the previous divisions provided by Singleton, Jr. et al. (1993). Theory building is similar to descriptive research and theory testing and extension/refinement are similar to explanatory research purpose.

Table 5-5 Matching research purpose with methods [Developed from Voss et al. (2002)]

Purpose	Research question	Research structure
Exploration Uncover areas for research and theory development	Is there something interesting enough to justify research?	In-depth case studies Unfocused, longitudinal field study
Theory building Identify/describe key variables Identify linkages between variables Identify "why" these relationships exist	What are the key variables? What are the patterns or linkages between variables? Why should these relationships exist?	Few focused case studies In-depth field studies Multi-site case studies Best-in-class case studies
Theory testing Test the theories developed in the previous stages Predict future outcomes	Are the theories we have generated able to survive the test of empirical data? Did we get the behaviour that was predicted by the theory or did we observe another unanticipated behaviour?	Experiment Quasi-experiment Multiple case studies Large-scale sample of population
Theory extension/refinement To better structure the theories in light of the observed results	How generalizable is the theory? Where does the theory apply?	Experiment Quasi-experiment Case studies Large-scale sample of population

This research guided by its questions, is placed entirely as an exploratory research undertaking. The research sets out to explore how processes are applied in practice in mega construction projects in Dubai. It also attempts to find out the critical CSFs and how they interrelate. Additionally, it attempts to explore the processes and the relationship with complexity, uncertainty and ambiguity. All these are of an 'exploratory' nature, where the independent and dependent variables are not clear from the start of the research. The questions for the interviews were semi-structured to allow for tangents that may develop to be explored. Overall, the research was not highly structured or focused and was 'open' for exploration.

5.6.2 Research design

The purpose of research design is to connect the empirical data to the study's initial questions, and thereof, to the conclusions and findings (Yin, 2003b). Another purpose of research design is to avoid "anecdotalism" and provide sound explanations (Silverman, 2000). Walliman (2006) provides the relationship between methodology, strategy and data collection and analysis. Despite criticism of the "qualitative/quantitative" dichotomy (Silverman, 2000; Bryman and Bell, 2003), this research follows the distinction. Section 5.9 shall address the choice of research methods.

This investigation falls within the engineering and construction management research. Engineering and construction management research can be defined as systematic process of discovering, acquiring, and using knowledge to solve a problem of theory or practice in any subject related to the field of engineering and construction management (Bennett, 1996). The purpose of this section is to provide the form or forms of research relevant to conduct of this investigation to answer the research questions indicated in Chapter One.

There are a number of different approaches to research. There is also a difference in the degree of scientific method adhered to in carrying out the research (Fellows and Liu, 2003; Bryman and Bell, 2003). For instance, in the physical sciences, it is much easier to have rigid control over an experiment to formulate a hypothesis, design a rigorous research project, control all variables, and look for the answer (Yin, 2003b; Blaxter et al., 2006). A sample of different research strategies used for empirical research is shown in Table 5-6. An additional research method is action research, which shall be referred to separately.

The research strategies that may be employed are commonly categorised as shown in Table 5-6 displays the conditions for various research strategies. 'What', 'Why' and 'How' questions are likely to favour the use of survey and case study forecast strategies.

Table 5-6 Types of research questions and research strategies to use [Developed from Yin (2003b)]

Strategy	Form of research question	Require control over behavioural events?	Focuses on contemporary events?
Experiment	how, why	Yes	Yes
Survey	who, what, where, how many, how much	No	Yes
Archival Analysis	who, what, where, how many, how much	No	Yes/ No
History	how, why	No	No
Case Study	how, why	No	Yes

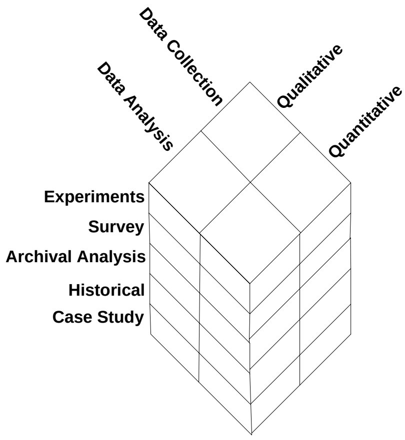
A common misconception is that the various research strategies should be arranged hierarchically (Silverman, 2000; Yin, 2003). Thus, some scientists are taught that case studies are appropriate for the exploratory phase of an investigation; that surveys are appropriate for the descriptive phase; and that experiments are the only way of developing explanations for inquiries (Yin, 2003). Yin (1994) believes that this hierarchical view of research strategies is incorrect. Experiments with an explanatory motive have certainly always existed. In addition, the development of causal explanations has long been a serious concern of historians, reflected by the sub field known as historiography. Finally, case studies are far from being only an exploratory strategy. Some of the best and most famous case studies have been both descriptive and explanatory.

More than one strategy can be used, such as case study and historical (Yin, 2003). Each provides an alternative logic and way for the collection and analysis of the data (Yin, 2003; Walliman, 2005). Figure 5-1 provides a diagram depicting the relationship between methodology and research strategies. Each has advantages and disadvantages. However, each research strategy can be used for all three purposes in science, namely, exploratory, descriptive, or explanatory (Walliman, 2005; Yin, 1994). The more appropriate view of these different strategies is a pluralistic one. What distinguishes each strategy is not this hierarchy, but other conditions. These consist of the following (Walliman, 2005; Yin, 1994):

- the type of research question posed
- the extent of control an investigator has over actual behaviour events
- the degree of focus on contemporary as opposed to historical events

Bennett (1991) suggested that an additional condition for choosing an appropriate research strategy was the current state of knowledge of variables involved. The first and most important condition for differentiating among the various research strategies is to identify the type of research question being asked (Silverman, 2000; Bryman and Bell, 2003; Yin, 2003).

Figure 5-1 Relationship between methodology, strategy and data collection and analysis [Developed from Walliman (2006)]



The case study is preferred in examining contemporary events, especially when the relevant behaviour of the phenomenon being studied cannot be manipulated, contrary to experiments (Yin, 2003). The case study's unique strength is its ability to deal with a full variety of evidence like documents, artefacts, interviews and observations (Voss et al., 2002; Yin, 2003). Additionally, case studies are not constrained by rigid rules, which can lead to new and creative insights, development of new theory and have high validity with practitioners (Voss et al., 2002).

Experiment strategy

The experimental strategy is characterized by manipulation, measurement and control with the aim of demonstrating cause and effect (Bowling, 2002; McQueen and Knussen, 2002). Blaxter (2006) point to the difficulty of choosing the 'control' variable in order to exclude all 'confounding variables'. Black (1999) states that experimental research is 'ideal'. However, he adds that when it comes to human activity in real situations experiments may either be impossible or introduce problems 'intrinsic to their configuration'. Quasi-experiments are introduced in these situations, which hold the same principles and logic, but are not as ‘rigorous’ (Yin, 1994; Black, 1999). Shipman (1997) adds that quasi-experiments have the all the characteristics of experiments except that they are dependant on self-selection or administrative decisions for determination of who takes part. Bryman and Bell (2003) add that the use of ‘the experiment strategy in qualitative research is rare in business and management research due to the difficulty of achieving the requisite level of control required in organizations’.

An experimental strategy was not used in this research for the following reasons:

- this research is exploratory in nature as the questions of the research indicate
- the settings are organizations in which there is no control over activities in the research
- the research questions themselves required that the researcher not control events, but to seek information on how processes are performed in mega construction projects

Surveys strategy

Surveys are used to provide a view of a section of a population at a particular point in time with the intent of generalisation of findings. Longitudinal measurements may also be performed at several different times (Marshall and Rossman, 2006). Surveys attempt to achieve discoveries about a society by studying small samples of it. Survey strategies are the most commonly used in social science research (McQueen and Knussen, 2002).

Surveys rely on standardization. The strategy is to collect the same information from the sample cases (Sapsford, 1999; Aldridge and Levine, 2001). The whole point is to get consistent answers to consistent questions. Questions are asked requiring precise answers, which may also be provided. Furthermore, during interviews the questions are asked in the same way for each interview. That is to standardise the questionnaire to become a measuring device (Sapsford, 1999).

Yin (1994) states that a survey strategy is suitable when the form of research questions are who, what, where, how many and how much and there is no control required over behavioural events and focusing on contemporary events. A wide variety of methods can be used in systematic evaluation of the problems and needs of a target group but they vary in their complexity, costs and diagnostic accuracy. They include resource inventory, use analysis, social indicator analyses, surveys and structured groups.

The survey strategy has some strong advantages as shown in Table 5-7. However, the survey strategy was not used in this research for several reasons. These include:

- The research goal does not require obtaining quantitative data on the problem nor was it studying a certain population (Marshall and Rossman, 2006).
- The exploratory nature of the research problem is not appropriate for a survey strategy (Marshall and Rossman, 2006) as the research was studying information and process flows, which surveys do not capture well.
- The research examines complex social patterns and intricate patterns of interaction where surveys are of little value (Marshall and Rossman, 2006).
- The research did not start with independent and dependent variables to study cause and effect, which is the main strength of survey research (Blaxter et al., 2006).
- The research did not attempt to standardize the questions (Sapsford, 1999) and allowed the researcher to follow any interesting tangents that respondents raised during the interview.

Table 5-7 Advantages and disadvantages of surveys

Description	Author
Advantages	
May aim at representation and provide generalized results	Blaxter et al. (2006); Bryman and Bell (2003)
Easy to administer and may not require any fieldwork	Blaxter et al. (2006)
Easily replicated	Blaxter et al. (2006); Bryman and Bell (2003)
Can provide a lot of data quickly	Blaxter et al. (2006)
Disadvantages	
The data become the focus of the research with a loss of linkage to wider theories and issues	Blaxter et al. (2006)
The researcher may not be in a position to check the understandings of the respondent to questions asked. Issues of truthfulness and accuracy are thereby raised.	Blaxter et al. (2006)
Relies on breadth rather than depth for its validity.	Blaxter et al. (2006)
Degree of inference required between cause and effect of independent and dependent variables	Bryman and Bell (2003)

Archival analysis strategy

Yin (1994) provides that an archival analysis strategy should be employed where the research questions are of the who, what, where, how many and how much forms and do not require control over behavioural events. This strategy is advantageous when the goal is "to describe incidence or prevalence of a phenomenon or when it is to be *predictive* about certain outcomes" (Yin, 2003). This strategy was found unsuitable as the research questions were of an "exploratory" nature rather than a "descriptive" one.

History strategy

Yin (1994) advises that a history strategy is suitable when the forms of the question are how and why and there is no control over behavioural events required and does not focus on contemporary events. The historical method's distinct contribution is in dealing with the "dead" past, where no person is alive to recount occurrences and researchers have to rely on documents and artefacts as main sources of evidence (Yin, 2003). It is particularly for this reason that this strategy was not used as it had no relevance to the research of ongoing mega construction projects.

Action research

Action research generally involves the active participation of the researcher in the study (Fellows and Liu, 2003). It also requires the collaboration and contribution of participants in the investigation, which are commonly referred to as subjects. Action research may be defined as *a kind of collective, self-reflective enquiry undertaken by participants in social relationship with one another in order to improve some condition or situation with which they are involved* (Berg, 2007).

Action research was not used in this research for several reasons, which are:

- The level of participation required by the researcher would not be allowed by the case study projects.
- The research problem was not to answer or resolve a particular issue (Berg, 2007), but it was rather to explore communication and information issues in mega construction projects.

- The level of participation by the group under study was not possible due to the severe time constraints of the individuals in the groups in the case study projects.
- There is a level of trust required to be developed prior to start of this type of research (Fellows and Liu, 2003), which was not possible in this research.
- Following from the point above, action research is usually performed by consultants brought in to the organization where there is essentially a level of trust.

Case study research

The definition of the case study method varies (Berg, 2007). Table 5-8 provides several definitions for the case study method.

Table 5-8 Definition of case study approach

Definition	Author
A method involving systematically gathering enough information about a particular person, social setting, event, or group to permit the researcher to effectively understand how the subject operates or functions	Berg (2007)
Is an approach capable of examining simple or complex phenomenon, with units of analysis varying from single individuals to large corporations and business; it entails using a variety of lines of action in its data-gathering segments, and can meaningfully make use of and contribute to the application of theory	Yin (2003)
An attempt to systematically investigate an event or a set of related events with the specific aim of describing and exploring this phenomenon	Bromley (1990) c.f. Berg (2007)
In-depth, qualitative studies of one or a few illustrative cases	Hagan (2006) c.f. Berg (2007)
… is an approach to social research and embodies several methods with the aim being to discover something about the unique nature of the case	McQueen and Knussen (2002)
… an in-depth investigation of a case	Hamel et al., 1993

The case study approach was deemed the most appropriate method to be used in this research for the following reasons:

- The case study method is largely used for exploration (Yin, 2003), which allowed flexibility in investigating communication and information processes in mega construction projects in great depth. Case studies would allow enough information to be systematically gathered about the organizations to provide insight into its processes (Berg, 2007), which would be a necessary feature of the research. Voss et al. (2002) add that the case study method lends itself to exploratory investigations where the variables are still unknown and the phenomenon not understood which was the case in this research.

- The case study method provides a holistic perspective (Blaxter et al., 2007) of communication and information processes, which was necessary to be captured in the research.
- The case study method is not just suitable for answering how and why questions (Yin, 2003) but are also suitable for development of new theory and ideas (Voss et al., 2002). The exploratory nature of the research in investigating communication and information in mega construction projects would end up with the development of new theory or ideas. There were no propositions but rather questions to be answered throughout the research.
- Voss et al. (2002) citing Meredith (1998) state that the case study method allows for a *relatively full understanding of the nature and complexity of the complete phenomenon*. This was an essential feature for this research as it required an understanding of the complex nature of communication and information processes in mega construction projects.
- In the case study approach several methods may be used to produce an overall view of the organization (Fellows and Liu, 2003; Bryman and Bell, 2003; Davies, 2007). This was found favourable since several methods would provide for triangulation (Yin, 2003; Fellows and Liu, 2003; Davies, 2007). In this research data included interviews, documents provided by the case study projects and observation.
- Voss et al. (2002) citing Meredith (1998) state that one of the strengths of case research is that the phenomenon may be studied in its natural setting where meaningful and relevant theory may be generated from the understanding gained from observation of actual practice. This was deemed essential for the research in order to capture actual communication and information processes used in mega construction projects.

5.7 Case study strategy

5.7.1 Case study design

The purpose of the case study design was to capture the communication and information processes and the factors influencing it in mega construction projects in Dubai and how these factors reduced complexity. The questions developed throughout the research guided the investigation. Justification for the use of the multiple-case approach is provided in this section.

5.7.2 Single and multiple cases

There is a variety of choices in conducting case study research. When there are fewer case studies there is a greater opportunity for more in-depth observation (Voss et al., 2002). Single cases may provide the opportunity to study several contexts within the case (Mukherjee et al., 2000 c.f. Voss et al., 2002). However, single case studies have limitations. The first involves the limitation of generalizability of the *conclusions, models or theory developed from one case study*. Other limitations include risks of *misjudging of a single event, and of exaggerating easily available data* (Voss et al., 2002). Use of multiple case studies enhances external validity and assists in reduction of observer bias (Voss et al., 2002). Yin (2003) states that multiple-case studies are *considered more compelling, and the overall strategy is therefore regarded as more robust*.

Yin (2003) states that the single-case design is justifiable when it represents critical testing of theory; rare or unique circumstances, or; rationale cannot be justified by multiple cases. When undertaking multiple-case research, each case should serve a purpose in answering the questions of the research where Yin (2003) states that the cases should provide similar (literal replication) or contrasting (theoretical replication) results. Two or three cases would be literal replication, whereas six or ten cases would be theoretical replication. Multiple-cases are generally used to follow replication logic, similar to that in experiments (Yin, 2003). This research was designed to follow the "replication logic" through the use of a multiple-case approach of two cases (literal replication) due to the difficulty in getting permission to research ongoing mega construction projects in Dubai.

5.7.3 Cross-case analysis

Each of the case study projects was analyzed separately as designed in the planning phase of the research, ensuring that the context of each case was retained. The cross-case comparison and analysis served to provide a cross-check of findings to the questions developed in the research. This was particularly relevant when performing the cross-case analysis for the most critical CSFs in mega construction projects in Dubai. The cross-case analysis enhances external validity, reduction of bias and regarded as more robust (Voss et al., 2002; Yin, 2003). Additionally, the research was designed with consideration of the "replication logic" stated by Yin (2003). The result of the cross-case analysis is refinement of findings in response to the questions developed during the research.

Yin (2003) states that "replication logic" should not be confused with "sampling logic" for multiple-case research. A mistaken analogy is to consider multiple cases similar to multiple respondents in a survey or multiple subjects in an experiment. This confusion results in one of the criticisms of case study research, which is that findings cannot be generalized (Gillham, 2000; Bryman and Bell, 2003). However, case study research should not be viewed in "statistical terms" as samples of a population. The aim of this case study research was not generalizability of findings to the population, but to develop theory through the patterns and themes that developed from the data.

Yin (2003) states that multiple-case studies, where applicable, have the possibility of direct replication, and analytic conclusions may arise from even two cases, which would be stronger than from a single-case. Furthermore, arriving at common conclusions from multiple-cases, where contexts are likely to differ, would expand the external generalizability of the findings than from a single case. However, multiple case design would be selected which are believed to be literal replications, thereby requiring prior knowledge of outcomes and focusing on *how and why the exemplary outcomes might have occurred* (Yin, 2003).

In this research the critical CSFs were first found for each individual case and then compared across cases to identify the most critical CSFs in mega construction projects in Dubai. Each of the CSFs were analyzed for each case and compared across cases to verify the findings or refine them. This logic is further clarified in Chapter Ten.

5.8 Data Collection Methods

5.8.1 Principles of data collection

The main purpose of collecting data is to provide evidence for the research study (Gillham, 2000; Yin, 2003). Yin (2003) provides three principles for data collection whenever possible in case study research. These are:

- Use of multiple sources of evidence
- Creating a case study database
- Maintaining a chain of evidence

The use of multiple sources shall be discussed in the following section. The creation of the case study base and maintaining the chain of evidence shall be discussed in Chapter Ten.

5.8.2 Methods of data collection

Data collection methods are specific research techniques. The usefulness of technique depends on their "fit" with the theories and methodologies of the research and the hypothesis being tested and/or research topic (Silverman, 2001). The techniques employed may be quantitative such as statistical correlations or qualitative such as observations (Silverman, 2001; Fellows and Liu, 2003).

There are many different ways of collecting data. Which method or combination of methods that should be applied will depend upon the research topic (Silverman, 2001; Yin, 2003) and the nature of the research (Marshall and Rossman, 2006). Bryman and Bell (2003) state that the *different approaches to data analysis and collection highlight the diverse nature of qualitative research within management and business*. The subsequent paragraphs outline some common data collection methods in the engineering and construction management context. Yin (2003) provides six main sources of evidence that may be used for case studies as well as their strengths and weaknesses. These six sources of evidence are generally supported by Gillham (2000), Silverman (2001) and Marshall and Rossman (2006) although other authors provide other methods such as audio and video recording (Silverman (2001). Table 5-9 summarises the data collection methods as provided by Yin (2003).

Table 5-9 Six sources of evidence: strengths and weaknesses [Developed from Yin (2003)]

Source of Evidence	Strengths	Weaknesses
Documentation	o Stable – can be reviewed repeatedly o Unobtrusive – not created as a result of the case study o Exact – contains exact names, references, and details of an event o Broad coverage – long span of time, many events, and many settings	o Retrievability – can be low o Biased selectivity – if collection is incomplete o Reporting bias – reflects (unknown) bias of author o Access – may be deliberately blocked
Archival Records	o [Same as above for documentation] o Precise and quantitative	o [Same as above for documentation] o Accessibility due to privacy reasons
Interviews	o Targeted – focused directly on case study topic o Insightful – provides perceived causal inferences	o Bias due to poorly constructed questions o Response bias o Inaccuracies due to poor recall o Reflexivity – interviewee gives what interviewer wants to hear
Direct Observations	o Reality – covers events in real time o Contextual – covers context of event	o Time consuming o Selectivity – unless broad coverage o Reflexivity – event may proceed differently because it is being observed o Cost – hours needed by human observers
Participant Observations	o [Same as above for direct observations] o Insightful into interpersonal behaviour and motives	o [Same as above for direct observations] o Bias due to investigator's manipulation of events
Physical Artifacts	o Insightful into cultural features o Insightful into technical operations	o Selectivity o Availability

In this research study, some of the methods outlined in Table 5-9 could not be practically applied. These included archival records, participant observation and physical artefacts. The reason these methods of data collection were not practical is that from the author's knowledge of the construction industry, project management is unwilling to provide historical data of their projects to anyone outside of those given the authority within the project. Participant observation required the researcher to be active within the project (Silverman, 2001; Yin, 2003), which the researcher could not be given the research duration. Data collection using the physical artefacts method was ruled out for the same reason as the archival records.

The data collection methods that would be practically applicable were documentation, interviews and direct observation. These were practical as these methods would not be "obtrusive" to the project as the researcher would interview based on a preset schedule agreed with the respondents beforehand. Direct observations would be made within the time the researcher was present at the case study project sites and without “bothering” anyone. The researcher was unsure at the start whether or not the project management would provide documents for use in the research. However, some documents were provided from both case study projects in the form of quality control manuals, organization charts as well as other documents.

Documentation

Travers (2001) states that a lot can be learned about the world through documents, something that qualitative researchers have always known. Texts of all kinds form a crucial part of everyday life, where modern societies interact through mediation of various kinds of text (Travers, 2001). However, Fellows and Liu (2003) argue that documents are produced, used and interpreted by people, and thereby, like other data have subjective aspects that should be considered in their use. This is confirmed by Atkinson and Coffey (1997, p. 47) c.f. Fellows and Liu (2003) who state that “…. we cannot treat records – however ‘official’ – as firm evidence of what they report.” Even construction project records such as valuation of variations, delay claims and final accounts are usually an outcome of negotiations (Fellows and Liu, 2003).

Interview

There are several types of interview questions that are provided in the literature (e.g. Fellows and Liu, 2003; Bryman and Bell, 2003; Yin, 2003). General agreement is on three types as shown in Table 5-10, which also highlights the main aims, advantages and disadvantages of each type.

Other types of interviews such as focus groups (Bryman and Bell, 2003) were not considered due to the difficulty of gathering a group of people at the same time in fast-track mega construction projects. The main differences between the three main types are the constraints placed on the respondents and interviewers (Fellows and Liu, 2003). Closed or close-ended questions are those where the respondent is asked to answer from a set of pre-selected answers. The goal is standardization of both questions and answers. This is easier to be completed by respondents and liable to provide a higher return of answered questionnaires. It also produces standardized data for statistical analysis. Even though closed questions are more difficult to write, they may be more reliable and consistent over time. However, it means that the project objectives are clearly thought through in the questionnaire and that the respondents are known and choices of responses are known in advance.

Table 5-10 Main types of interviews, aims, advantages and disadvantages

Type of interview	Aim	Author
Closed Structure		
	Advantages	
	Easy to process answers	Bryman and Bell (2003); Smith and Osborne (2003)
	Easier to show relationship between variables & make comparisons between respondents	Bryman and Bell (2003);
	May clarify the meaning of a question from availability of answers	Bryman and Bell (2003);
	Easy for interviewers and/or respondents to complete	Bryman and Bell (2003);
	In interviews , reduce the possibility of variability answers	Bryman and Bell (2003);
	Investigator has control over what takes place in the interview	Smith and Osborne (2003)
	Interview is reliable as same format is used with each respondent	Smith and Osborne (2003)
	It is first to administer	Smith and Osborne (2003)
	Disadvantages	
	Always the possibility of respondents giving different answer then provided & thereby	Bryman and Bell (2003);
	Fixed answers should be mutually exclusive in order not to cause confusion for respondents.	Bryman and Bell (2003);
	Difficulty of provider exhaustive answers, & may have long lists of answers	Bryman and Bell (2003);
	Validity may be jeopardized if there is variation in interpretation of question amongst respondents.	Bryman and Bell (2003);
	Initiation of respondents if category of answer is not available.	Bryman and Bell (2003);
	Difficulty to establish report between respondent & interviewer (i.e. no personal feel to it)	Bryman and Bell (2003);
	Does not allow unravelling of complex or ambiguity in respondent's opinion	Smith and Osborne (2003)
	Can also become tilted because of asking questions in some format & sequence to all respondents.	Smith and Osborne (2003)
Open-ended Structure		
	Advantages	
	Respondents answer in their own terms	Bryman and Bell (2003);
	Allows unusual responses to be provided	Bryman and Bell (2003);
	Questions de not suggest answer, and therefore, level of knowledge and understanding of respondent can be tapped and salience of issues can be explored	Bryman and Bell (2003);
	Useful for exploration of new areas where researcher has limited knowledge	Bryman and Bell (2003);
	Useful for generation of fixed choice format answers	Bryman and Bell (2003); Gillham (2000)
	Disadvantages	
	Time-consuming for interviewers	Bryman and Bell (2003);
	Coding of answers time consuming	Bryman and Bell (2003);
	Require greater effort from respondents, which may provide lower response rates	Bryman and Bell (2003);
	Possibility of variability between interviewers in recording answers. Transcription also time consuming and costly	Bryman and Bell (2003);
Semi structured		
	Advantages	
	Interview process is flexible and simple	Gillham (2003)
	Allows following interesting tangents that may develop.(to go in novel ways)	Smith and Osborne (2003)
	Facilitates report / empathy	Smith and Osborne (2003)
	Allows interviews to	
	Disadvantages	
	Transcription is lengthy, tedious and expensive	Bryman and Bell (2003); Fellows and Liu (2003)
	Reduced control of interview by investigator	Bryman and Bell (2003); Fellows and Liu (2003)
	Time - consuming to carry out	Smith and Osborne (2003)
	Difficult to analyze	Smith and Osborne (2003)

Open or open-ended questions are those where the respondent answers what he wishes as a response to a question. These types of questions allow respondents to answer in their own words. This is most useful where interest is on gathering unanticipated results or in learning how the respondents see the answer to the question. However, some respondents are not willing or able to provide a written response to a survey question. They are also very difficult to compare and interpret the data.

Semi-structured questions are neither fully fixed nor fully free. The interviewer generally starts with some defined questions but is ready to pursue interesting tangents as they develop. This is used where a respondent is interviewed for a short period of time, an hour for example, and the interviews may remain open ended and assuming a conversational manner. However, the interviewer is more likely to be following a certain set of questions (Bryman and Bell, 2003; Gillham, 2000; Oishi, 2003; O’Leary, 2004; Yin, 1994).

The semi-structured interview was chosen as the most appropriate for the research for several reasons:

- Time limitations with the busy individuals at construction projects.
- The requirement to probe into interesting tangents that may develop.
- The open-ended nature of some of the questions.

A list of the interview questions is provided in Appendix 1 and Appendix 2. The development of the questions were intended to get a comprehensive overview of the project organization, process of work, systems used and human interaction. The questions were carefully drafted to capture as much as possible within approximately one hour interviews. The questions were provided to the supervisors of the research and some colleagues for review. This was an iterative process with the final outcome as aforementioned. Some room was left to probe interesting tangents that may arise at each interview. This was important since respondents may raise interesting topics that should be explored. The general questions developed and the logic behind the choice of questions is provided in Appendix 2.

An interview may be structured (where the researcher asks clearly defined questions) or unstructured, to allow some of the questioning to be led by the responses of the interviewee. To be specific, structured data is organised and can be produced by closed questions. Unstructured data is relatively disorganised and can be produced by open questions. Sometimes it is a better idea to use a videotape recorder to record the interview, if the interviewee has consented to do so.

There are advantages and limitations to adopting the interview method. The greatest value lies in the depth and detail of information that can be secured. It far exceeds the information obtained from telephone and mail surveys. During the interview, the interviewers have more control and opportunities to improve the quality of information acquired. However, such a data collection method has a certain level of limitations and drawbacks. The primary concern regarding the downside of this method would be the cost. The costs of a particular interview may range from a few dollars to a few hundred dollars. A huge amount of money could be spent if the research requires interviews that spread across regions or nations. However, interviews provide more rapid results than observation, which is very time consuming. The interview study provides a “deeper” understanding than variable-based quantitative studies (Silverman, 2007).

Direct observation

Direct or non-participant observation refers to a researcher not getting involved in the group activities but remaining a passive observer (Davies, 2007). Bryman and Bell (2003) provide various types of non-participant observation methods, including structured (or systematic), structured and simple observation. In structured observation the researcher establishes rules to guide in what to look for and why and how to record the observations. In contrast, in unstructured observation, the aim is to record as much detail as possible of the behaviour of the participants to develop a narrative account of it. In simple observation, the researcher has no influence over the situation being observed.

Field notes have been advocated to complement other data collection methods as Strauss (1987) c.f. Fellows and Liu (2003) states that researchers must be “…. fully aware of themselves as instruments for developing that grounded theory". Schatzman and Strauss (1973) c.f. Fellows and Liu (2003) advise segregation of field notes into observational notes, theoretical notes and methodological notes. Observational notes are to contain little interpretation; theoretical notes are attempts to derive meaning from observational notes, and; methodological notes concern how the field work is carried out.

Despite the many problems associated with observation including problems interpreting meaning, problems of memory, the gap between stated and actual behaviour (Bryman and Bell, 2003) and selectivity of observations, taking field notes is vital for any research (Fellows and Liu, 2003). Research based on observation as the main source of data is time consuming (Silverman, 2007). Therefore, within this research observations and field notes were taken as complementary to the main data collection method through interviews. The field notes were used to corroborate data from interviews. For example, where statements were made regarding relationships between staff, the researcher observations during the time on site would confirm this statement. Additionally, some things that were not stated during interviews were stated "off record". These were recorded daily in order not to forget it. The field notes were also used as data during the analysis, although it is not considered as ethnography (Travers, 2001).

Physical Artefact

This type of evidence is a physical or cultural artefact. They could be a technological device, tool, instrument or other physical evidence. This is used extensively in anthropological research (Yin, 2003). This source of evidence was not considered for this research. Due to the nature of the research artefacts would not have assisted in answering the questions of the research.

5.9 Triangulation

Patton (1987) c.f. Yin (2003) provides four types of triangulation. These are:

- data triangulation – triangulation of data sources
- investigator triangulation – triangulation among different 'evaluators'

- theory triangulation – triangulation of perspectives to the same data set
- methodological triangulation – triangulation of methods

The purpose of data triangulation is to collect data from multiple sources aimed at corroborating the same fact or phenomenon (Yin, 2003; Silverman, 2001) and there is convergence (Yin, 2003) as shown in Figure 5-2. Use of multiple sources of evidence does not constitute data triangulation if convergence of the data is not achieved (Yin, 2003) as shown in Figure 5-3. Multiple sources of evidence achieving data triangulation addresses construct validity concerns since it essentially provides measures of the same phenomenon (Yin, 2003).

Triangulation involves comparison of different kinds of data and/or methods to check whether they corroborate one another (Silverman, 2006). However, the term has been used more broadly by Denzin (1970; 310) in reference to an approach that uses “multiple observers” and theoretical perspectives as well as different sources of data and methods. Deacon, Bryman and Fenton (1998) refer to triangulation as a process of cross-checking findings derived from both quantitative and qualitative data.

In the research data triangulation is of main concern. Data is provided from various sources to achieve data convergence. Triangulation was achieved through: (1) interviews with various people; (2) documents from each project; (3) cross-case analysis, and; (4) observations and field notes.

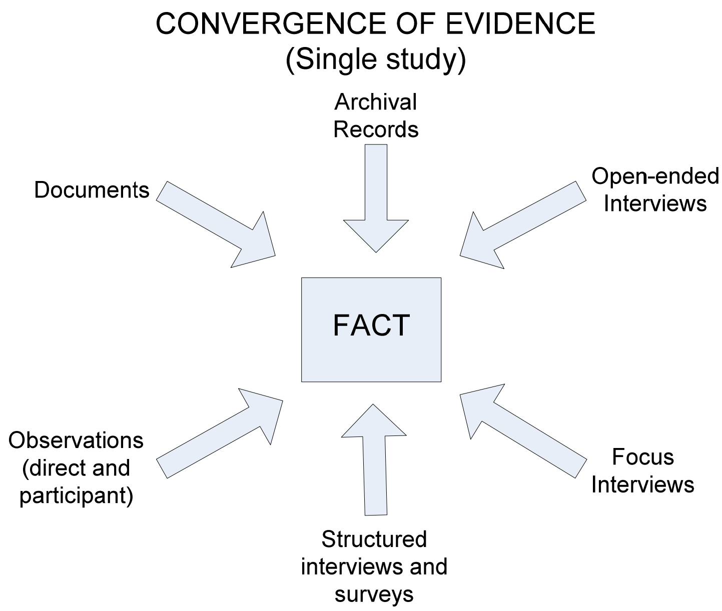


Figure 5-2 Convergence of multiple sources of evidence [Developed from Yin (2003)]

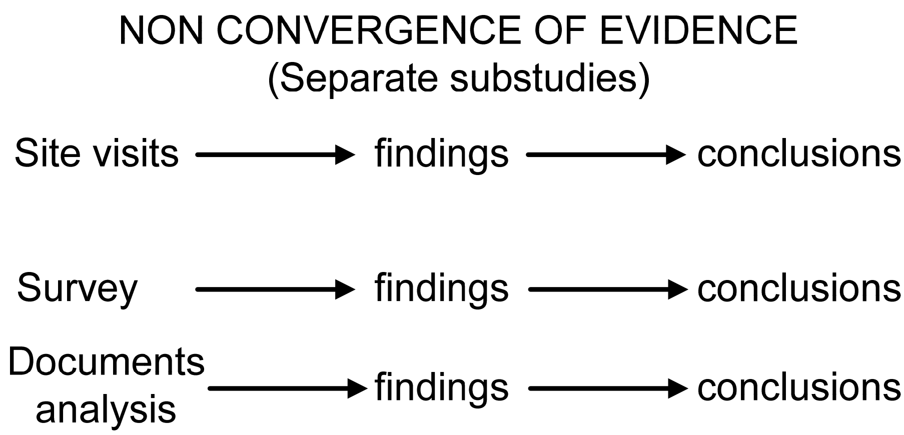


Figure 5-3 Nonconvergence of multiple sources of evidence [Developed from Yin (2003)]

Triangulation in this research was achieved in several ‘levels’. The first level, each interview was transcribed and checked for any contradictions in statements. The second level involved cross-checking between responses of informants in each of the case studies. The third level involved cross-checking with other sources of data including observations made and field notes. Documents also were used as another source of data, but it was largely to check the formal processes described by informants against the official procedures and quality control to confirm their convergence. The fourth level was the cross-case analysis, which included cross-checking responses of informants in each case study. This included cross-checking documents to find the similarities and differences between them. Having achieved triangulation, the next main issue is the validity of the research.

5.10 Validity of the research

The main criteria for evaluation of research studies are as follows:

Construct Validity: *concerned with establishment of correct operational measures for the concepts of the research.*

Internal Validity: *concerned with the conclusions of causal relationships and how strongly these are confirmed.*

External Validity: *concerned with the extent the research findings can be generalized.*

Reliability: *concerned with whether the results of the research are repeatable.*

(Bryman and Bell, 2003; Yin, 2003)

Yin (2003b) provides four measures of validity of qualitative research. Authors such as LeCompte and Goetz (1982) and Kirk and Miller (1986) c.f. Bryman and Bell (2003) have advocated the use reliability and validity measurements to qualitative research. However, from the perspective of some researchers, these measures are viewed as applicable to quantitative research and not to qualitative research. Some qualitative researchers propose that qualitative research should be judged or evaluated using different criteria than those used for quantitative research (Bryman and Bell, 2003; Marshall and Rossman, 2006). The logic is that reliability and measurement validity are essentially concerned with adequacy of measures. Internal validity is concerned with the soundness of findings which specify a causal connection, which is a concern mainly in quantitative research. External validity is concerned with sample representativeness, which may be applicable to qualitative research, but is more concerned with sampling procedures that generate a representative sample, a concern that is more applicable to quantitative research (Bryman and Bell, 2003).

Lincoln and Guba (1985) c.f. Bryman and Bell (2003) propose alternative terms and methods for the evaluation of qualitative research prosing trustworthiness as a criterion of judgement of the quality of the research. Table 5-11 shows the terms used in quantitative research and those proposed for qualitative research. Bryman and Bell (2003) state that the unease of Guba and Lincoln (1994) with the simple application of reliability and validity is the presupposition that 'a single absolute account of social reality is feasible' (i.e. there are no absolute truths about the social world). They argue that there may be more than one account to the social world being studied. Furthermore, the positivist view of reliability is set on the assumption of an unchanging world, which could be replicated in contrast with the qualitative / interpretive assumption that the social world is 'continuously being constructed' (Marshall and Rossman, 2006).

Table 5-11 Differences between quantitative and qualitative constructs and their requirements [Developed from Yin (2003b) and Bryman and Bell (2003)]

Terms for evaluation of quantitative research	Requirements of construct	Terms for evaluation of qualitative research	Requirements of construct
Internal validity	Establishment of causal relationship	Credibility	How believable are the findings?
External validity	Establishment of domain to which research findings are generalizable	Transferability	Do the findings apply to other contexts?
Reliability	Demonstration that operations of the research may be repeated with same results	Dependability	Are the findings likely to apply at other times?
Construct validity (Objectivity)	Establishment of correct operational measures for concepts under study	Confirmability	Has the investigator allowed his or her values to intrude to a high degree?
		Ecological validity	Are social scientific findings applicable to people's everyday, natural social settings?
		Authenticity	Set of issues concerning wider political impact of research.

Yin (2003) provides that other concepts have been offered, such as those by the General Accounting Office (1990), including trustworthiness, credibility, confirmability and data dependability. Hammersely (1992) c.f. Bryman and Bell (2003) advocates the use of validity and proposes the use of relevance as an important criterion. The relevance criterion assesses the importance of the research topic and its contribution to the literature in the field. Bryman and Bell (2003) add ecological validity as another criterion, which is concerned with the applicability of research findings to people's everyday, natural social setting.

Internal validity is described as the establishment of causal relationships (Fellows and Liu, 2003) whereas the aim of credibility is demonstration that the manner the study was conducted in ensures the subject was identified correctly and described (Marshall and Rossman, 2006). The issue of generalizability is addressed by external validity (Yin, 2003b). However, transferability is the argument that findings will be useful to others in similar situations and with the same questions, which largely rests on subsequent research (Marshall and Rossman, 2006). Reliability requires demonstrating that procedures used in the research may be repeated to achieve the same result (Fellows and Liu, 2003), whereas dependability requires accounting for changing conditions in the phenomenon under study (Marshall and Rossman, 2006). Construct validity (sometimes referred to as objectivity) establishes that correct operational measures are used for the concept being studied (Bryman and Bell, 2003). Confirmability seeks to obtain confirmation of research findings which is done by establishing that logical inferences and interpretations of the researcher make sense and responds to concerns of natural subjectivity of the research (Marshall and Rossman, 2006).

Guba and Lincoln (1994) c.f. Bryman and Bell (2003) suggest an additional criterion to be used in evaluating qualitative research. This criterion is authenticity, which is concerned with the wider political impact of research. The criteria include fairness, ontological authenticity, educative authenticity, catalytic authenticity and tactical authenticity. However, this criterion will not be used in this research.

Yin (2003b) states that the logic of causal relationships is not applicable to descriptive or exploratory studies, which is the case in this research. However, internal validity may be extended to making inferences. Questions to be asked are the correctness of the inference made, convergence of evidence, and how tight they are. In this research the points of view of the proposed constructs are found useful and are used in the validation of the research. In validation, confirmability was found crucial in this research in choosing participants for the validation of research findings, which is discussed in the Chapter Ten.

The evaluation of research findings includes achieving project aims and objectives and answering the propositions of the research. The research aims, objectives and questions are provided in Table 5-12 below. This will be discussed further in Chapter Ten.

Table 5-12 Research aims, objectives and questions

Objectives	Questions
Objective 1 To review the literature surrounding critical success factors, communication and information management, information management systems, change, socio-technical systems and human factors to identify the factors critical to communication and information management.	Develop questions to be asked
	Provide guidance for research analysis
	Provide background for themes that developed
Objective 2 To review models that place a framework around Critical Success Factors (CSFs) to provide guidance for analyzing, investigating and establishing the CSFs that are most critical in mega construction projects in Dubai.	What are the most crucial CSFs in the case study projects?
Objective 3 To establish the organization and work process within the case study projects from the perspectives of the main parties involved in order to map key communication and information flows.	How are construction communication processes performed?
Objective 4 To construct a new theoretical model framework for communication and information management systems in order to provide a practical way of understanding key formal and informal processes and interactions within mega construction projects in Dubai.	Follows from Objective 3 and adds- How are construction processes performed in practice capturing the formal and informal components to perform the tasks required to transform and produce the project?
	What is the role of top management in construction projects and what characteristics are required for effective communication and which party is most crucial in its establishment?
	What are the characteristics of the 'collection' of individuals conducive to effective communication?
Objective 5 To verify and validate the model and the conclusions and recommendations of the research within the context of the case study projects explored in order to ensure its relevance to both researchers and practitioners.	Verify and validate the model and guidelines

5.11 Research case studies

Research population

The population for purpose of this research is restated from Section 4.2.2:

- Projects of value above 1 Billion US Dollars.
- Projects having various elements: e.g. buildings, landscape, etc.
- Projects providing an 'engineering' achievement within the context of Dubai
- Projects that are 'novice' and of an experimental character.

- o Projects complex in terms of risk, uncertainty and methods.
- o Projects that are, thereby, difficult to control.

Both case study project characteristics incorporate all of the above.

Research sample

The research sample was to be from the population aforementioned. However, due to accessibility problems, the research was to be performed on projects where all parties agree to participate in the research. The case study projects were provided through ‘acquaintances’. This is referred to as “convenience” sampling, and is valid as long as the sample has the same characteristics as that of the population. The summary of the sample are as follows:

- o Case study projects were initially intended to be used for in-depth research. However, due to time constraints and the extent of the work, 2 cases were found sufficient.
- o Case study projects were from the population
- o Case study projects involved all parties and staff and were largely accessible
- o Case projects were provided through friends (i.e. convenience sampling)

5.12 Interview Structure

A main concern during the research design phase is the questions to be asked. Prior to developing the interview questions, the literature was reviewed for advice in their development. In Table 5-13 a list of advice is provided from the literature concerning developing questions for interviews. The list of questions and justification for each question is provided in Appendix 1 and Appendix 2.

5.13 Analysis of the data

5.13.1 Grounded Theory

Grounded theory is “theory that was derived from data, systematically gathered and analyzed through the research process”. In this method, “data collection, analysis, and eventual theory stand in close relationship to one another” (Strauss and Corbin, 1998; p. 12). Grounded theory in essence is directed at theory building rather than theory testing (Fellows and Liu, 2003). However, Brymann and Bell (2003) state that grounded theory is sometimes used to imply that the researcher has grounded his theory in the data.

Table 5-13 Advice on developing questions for interviews

Advice on constructing questions		Author
General Rules		
1	Interview should be geared to answering research questions	Bryman and Bell, 2003; Silverman, 2007
2	Decide exactly what it is you want to know and ask questions accordingly	Bryman and Bell, 2003
3	Place yourself in the position of the respondent and reflect on how you would answer	Bryman and Bell, 2003; Davies, 2007
Specific Rules		
1	Questions should be written avoiding ambiguous terms such as 'often' and 'regularly' as frequency measures	Bryman and Bell, 2003; Davies, 2007
2	Avoid long questions	Bryman and Bell
3	Avoid 'double-barrelled' questions	Bryman and Bell
4	Avoid very general questions as they lack a frame of reference to specific issues	Bryman and Bell
5	Avoid leading questions	Bryman and Bell, 2003; Smith and Osborn, 2003; Davies, 2007
6	Avoid questions that are in reality asking two questions	Bryman and Bell
7	Avoid questions that are positively or negatively polarized	Bryman and Bell, 2003; Silverman, 2007
8	Use existing questions if possible	Bryman and Bell
9	Questions must be clear and easy to answer	Davies, 2007; Fellows and Liu, 2003
10	Exclude inessential questions	Davies, 2007
11	Structure questions elegantly and efficiently	Davies, 2007
12	Ensure that respondents have appropriate knowledge to enable them to answer question	Bryman and Bell, 2003; Smith and Osborn, 2003; Davies, 2007
13	Ensure that questions are not making excessive demands on the time and patience of respondents	Davies, 2007
14	Flow of questions should be 'natural'	Davies, 2007
15	Use open, not closed, questions (if require respondent to open-up)	Smith &Osborn,2003

Novice researchers are usually uncertain and confused during the analysis of the data when using grounded theory. The differences that exist between the approaches of Glaser and Strauss usually cause this uncertainty (Heath and Cowley, 2004). There is a difference between reading about grounded theory and learning *about the process of researching through learning in the process of carrying out the research* (Heath and Cowley, 2004).

Although there are adaptations to grounded theory, the most variation in the literature is between Glaser and Strauss (e.g. Heath and Cowley, 2004; Bryman and Bell, 2003). Glaser (1978) developed the grounded theory explaining theoretical sampling and coding and use of theoretical memos in detail (Heath and Cowley, 2004). Strauss and Corbin (1990) provided analytical techniques as well as guidance (Heath and Cowley, 2004). Criticisms of the analytical techniques included the rigidity introduced not intended for grounded theory (Keddy et al., 1996) and holding the emergence is problematic (Robrecht, 1995 c.f. Heath and Cowley, 2004). The main source of divergence is cited as methodological rather than of ontological and epistemological aspects (Heath and Cowley, 2004).

The main variations between Glaser and Strauss on methodological aspects are in the process of theory generation with different emphasis on induction, deduction and verification and also in the form that theory should take (Heath and Cowley, 2004). Heath and Cowley (2004) state that Glaser (1978, 1992) views induction as the key process while moving from data to empirical generalization and on to theory. This is shown in Figure 5-4. Heath and Cowley (2004) continue to state that Strauss and Corbin (1990) claim that in the original theory inductive aspects were "overplayed". In their new perspective deduction and verification "dominate analysis" and maintain that induction should not be overemphasized. This is shown in Figure 5-5. However, they modify their perspective as shown in Figure 5-6 by emphasizing deduction followed by validation and elaboration rather than deduction followed by verification.

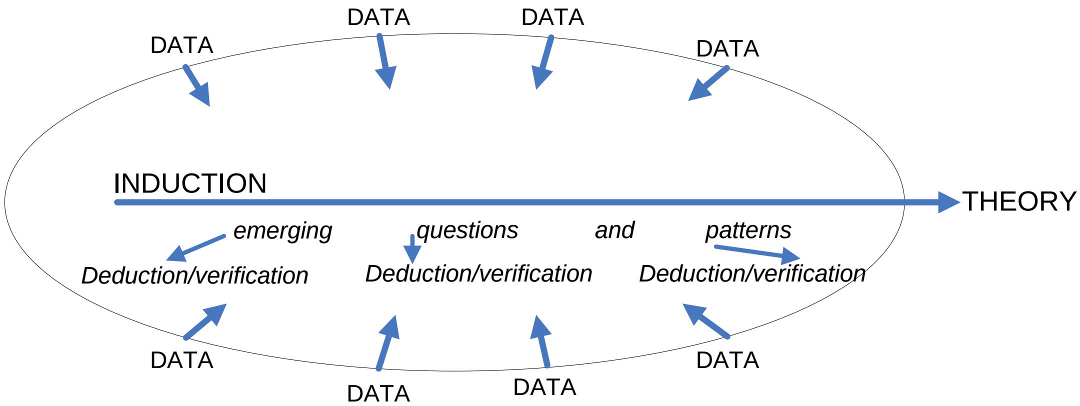


Figure 5-4 Glaser (1978, 1992) place of induction, deduction and verification in grounded theory analysis [Developed from Heath and Cowley (2004)]

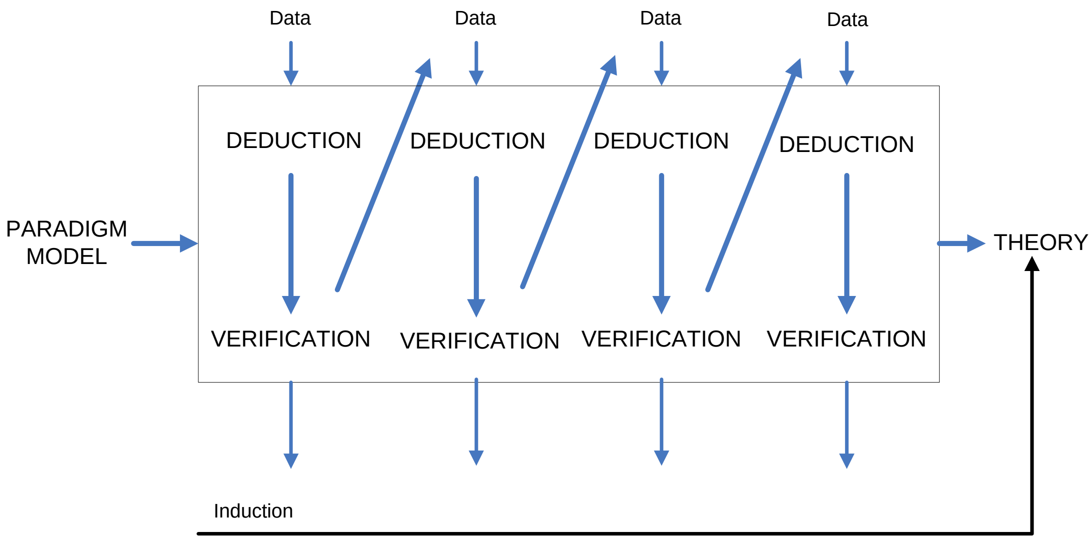


Figure 5-5 Strauss (1987), Strauss and Corbin (1990) place of induction, deduction and verification in grounded theory analysis [Developed from Heath and Cowley (2004)]

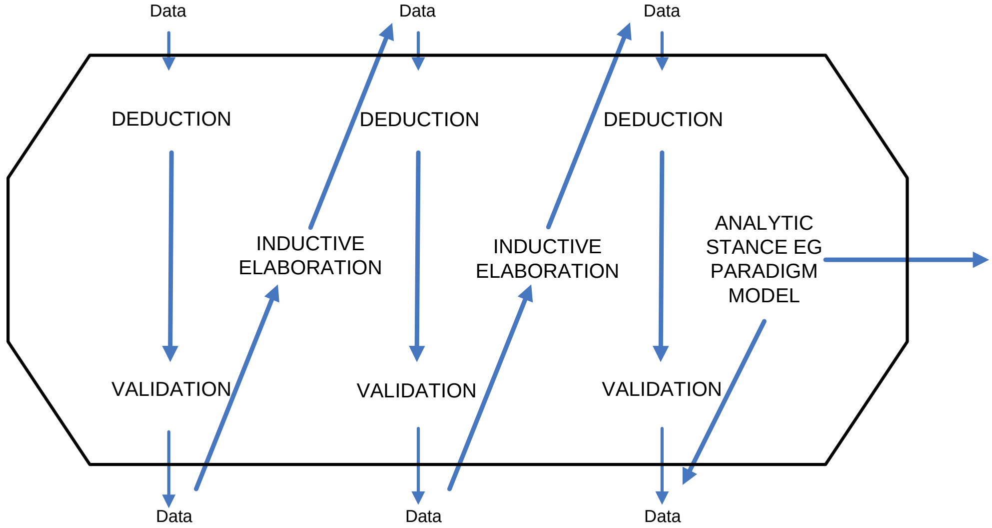


Figure 5-6 Strauss (1987), Strauss and Corbin (1990) place of induction, deduction and verification in grounded theory analysis [Developed from Heath and Cowley (2004)]

Some authors have criticized Strauss and Corbin's (1990) new approach of grounded theory (e.g. Robrecht, 1995 c.f. Heath and Cowley, 2004) stating that the approach can take the research away from the data to reflect prior knowledge in addition that "forced questioning" will result if verification involves looking for data rather than at it. Heath and Cowley (2004) state that there are a range of positions to take balancing deduction and validation while using the researcher's own expertise with induction and creating ideas from data. Table 5-14 provides the two variations in data analysis between Strauss and Corbin and Glaser.

Table 5-14 Data analysis: Glaser and Strauss compared [Developed from Heath and Cowley (2004)]

	Strauss and Corbin	Glaser
Initial coding	*Open coding* Use of analytic technique	*Substantive coding* Data dependent
Intermediate phase	*Axial coding* Reduction and clustering of categories (paradigm model)	Continuous with previous phase Comparisons, with focus on data, become more abstract, categories refitted, emerging frameworks
Final development	*Selective coding* Detailed development of categories, selection of core, integration of categories	*Theoretical* Refitting and refinement of categories which integrate around emerging core
Theory	Detailed and dense process fully described	Parsimony, scope and modifiability

Other authors criticize this debate altogether. Seale et al. (2004) state that the "analytical" view of "coding" procedures in grounded theory provides for a direct relationship between observations and codes expressing them. The data is broken down into parts and reconnected through axial or selective coding, which assumes that theory emerges after categorization rather than through it. This results in an "infinite" number of ways to reconnect data which favours "interrogating" the data rather than "interpreting" it. Seale et al. (2004) add that headings should aid interpretation. They should not be isolated "codes" but "related concepts connected to and informed by a more complex and holistic account".

Selden (2005) adds that a weakness of grounded theory is related to theoretical sensitivity where "conceptualizations do not emerge from data". The author states that the source of conceptualization is the researcher which is dependent on his/her knowledge of scholarly material; otherwise the novice researcher would be most effective. Although knowledge is not a prerequisite of creativity, "the proximity to the participant level carries the risk of reformulating known details". Seale et al. (2004) criticizes the sensitizing concept of grounded theory since data cannot be organized without a degree of conceptualization and concepts have to be grounded in some sort of data referred to. It is, therefore, claimed "it is not a case of fitting concepts to data, nor of fitting data to concepts, since neither can exist independently of the other". In the relation between grounded theory and preconceptions, Selden (2005) criticizes both Glaser and Strauss. Strauss seems to have lacked consideration to consequences. Glaser on the other hand stresses lack of prejudice but does not acknowledge preconceptions.

This has resulted in the criticism that grounded theory is at base a “positivist” epistemology (Seale et al., 2004; Selden, 2005). This creates a tendency to investigate events rather than mechanisms. During the coding procedure, data may be disconnected from its context. Context and relations are disconnected during coding incidents, reducing the viability of examination of themes (Selden, 2005). Seale et al. (2004) argues that categorization depends on “idealized cognitive models”, which are idealized and often metaphorical and holistic constructions rather than accurate representation of the world. Categories may assist classification and ordering of observations but regard to individual, idiosyncratic and shared attributes should be considered. In essence, meanings are attached to observations in terms of specific contexts and purposes. Meaning is created, not “discovered” (Seale et al., 2004).

Selden (2005) states that grounded theory analysis procedures have been exaggerated and getting too embroiled in the procedures is counterproductive. This is further confirmed by Glaser 1998) c.f. Heath and Cowley (2004) who states that researchers should stop talking about grounded theory and get on with doing it. Heath and Cowley (2004) recommend that novice researchers adhere to the principle of constant comparison, theoretical sampling and emergence and search for the balance between interpretation and data that would produce a grounded theory. It is insinuated that individuals develop their own understandings of grounded theory by practicing it as each individual has a different cognitive style.

Selden (2005) provides four warnings in the use of grounded theory. The first is not to get too caught up in the coding procedures (Heath and Cowley, 2004) and forget that the purpose is to develop grounded theory. The second is to avoid a break from context in the coding procedures as when incidents are coded the context and relations are broken, and may thereby, result in disconnectedness achieving ‘notes without a melody’. The third is to avoid the far polar positions between Glaser and Strauss and Corbin in the level of knowledge of the subject area under investigation prior to start of the research. Selden (2005) recommends a midpoint between the two positions, where prior to the start of research, there is a logical requirement for a ‘pre-understanding’ of the subject area under investigation, which does not contrast with the inductive nature of grounded theory. The fourth is avoiding production of everyday knowledge (i.e. ‘trivial pursuit’). Selden (2005) states that the researcher, and not the data, generates theory with the purpose of advancing from everyday to scholarly knowledge. To achieve this, the researcher needs to avoid being tied down by reformulations of interviewee statements.

In the research we shall use the features of the grounded theory in terms of coding and analyses taking into account the advice provided by Selden (2005) and Heath and Cowley (2004). Their advice was invaluable in providing the researcher with confidence to use grounded theory without getting stalled by the analytical procedures or the ongoing debate between the two main grounded theory philosophies. The procedures performed in the research are described in chapter Ten.

5.13.2 Analysis and coding by inductive or deductive methods

Denzin and Lincoln (1998) state that the quantity of qualitative data can be daunting. The design of qualitative research can be seen as analytic and involves data reduction, which is an essential aspect of data analysis. The choice of framework, research questions, samples, cases and methods have a ‘focusing’ and bounding function where some variables, relationships and data may be ruled out and others selected for attention. They state that qualitative designs are not off-the-shelf patterns but are normally custom built, revised and “choreographed”.

There is merit in inductive and deductive approaches. Inductive approaches work well when the terrain is unfamiliar, complex and where the intent is exploratory and descriptive. Deductive approaches are appropriate where the researcher has a prior acquaintance with the setting, has available firm concepts and takes an explanatory or confirmatory stance. Qualitative research aims to describe and explain a pattern of relationships, where we may start with these relationships, deductively or we gradually reach them, inductively. Both inductive and deductive are legitimate paths to take (Denzin and Lincoln, 1998).

Analysis will be undifferentiated and disjointed until the researcher is acquainted with the setting, which is a point acknowledged by grounded theory, whether it is for inductive or deductive approaches. Analysis starts during the first site visits for typical inductive approaches, where field notes, observations and interviews are made. The following level is coding and memo writing (Denzin and Lincoln, 1998).

The analysis in the research is based on an inductive rather than a deductive approach. This was a natural outcome of the exploratory qualitative nature of the research. The questions were rather 'generic' to probe the interesting tangents that may develop during the interviews. The 'exact' data that would be provided was unknown. Therefore, an inductive approach to analysis was required. The following subsections describe and coding and categorizing terms in the analysis.

5.13.3 Coding and categorizing

In grounded theory, coding of data is performed as it is collected. There are different levels of coding including open, axial and selective coding. Open coding is the process where data is divided into small pieces, examined, conceptualized and categorized. This is very basic coding and unlikely to provide us with analytical concepts. Axial coding follows open coding and puts together the data in various ways by relationships between categories. This is the second level where there is more awareness of the content of what is stated. Selective coding follows by selecting the core category and relating it to other categories whilst validating the relationship and adding categories that require further refining. This is the third level where development of analytical themes is the main concern. The various types of coding are simply different levels of coding performed at various phases in the analysis (Bryman and Bell, 2003).

Bryman and Bell (2003) provide steps and considerations in coding. These are provided as follows:

- Code as soon as possible
- Read through your initial set of transcripts, field notes, documents, etc.
- Do it again
- Review your codes
- Consider more general theoretical ideas in relation to codes and data
- Any one item or data can and often should be coded in more than one way
- Do not worry about generating what seems to be too many codes

- Keep coding in perspective

Coding

Coding is defining what the data is about. In quantitative data preconceived codes are applied to the data. In qualitative data codes are created by what the researcher sees in the data, and thereby, emerge as analysis of the data is ongoing (Smith, 2003). The coding process may lead the researcher to areas and research questions that were not expected. Grounded theory encourages following the leads provided by the coding process in lieu of pursuit of previously designed research problems.

The procedure of coding, particularly by Strauss, tends to be a laborious exercise that may stifle creativity (Selden, 2005). Seale et al. (2000) add that the coding procedure stresses the relationship between observations and codes. This “analytic” view breaks down the data into parts only to struggle to reconnect them. The advice of Selden (2005) and Heath and Cowley (2004) in regards to avoid getting too embroiled in coding procedures have been considered in the research.

Categorizing

A category is defined as the selection of certain codes as significant in abstracting common themes in several codes into an analytical concept. The researcher during his analysis raises the conceptual level from description to more abstract theoretical levels. The researcher then attempts to define the properties of the category, its conditions and its relations to other categories.

Axial coding

Axial coding treats each category as an axis around which the researcher develops relationships and the dimensions of the category. The purpose of axial coding is to bring the data back together after having divided the data up into little pieces through line-by-line coding.

Coding in the research

The analysis of the data was performed in three phases. Figure 5-7 shows these phases. The first phase was performed after the coding of the data. The first phase was to find the most crucial CSFs in the case study projects. There were two main reasons for this. First, it is established that CSFs are interrelated, and thereby, the most crucial CSFs would narrow the focus of the research and provide the most important issues. Second, the most crucial CSFs would maintain the context of the research analysis, something the grounded theory is criticized for (Seale et al., 2000).

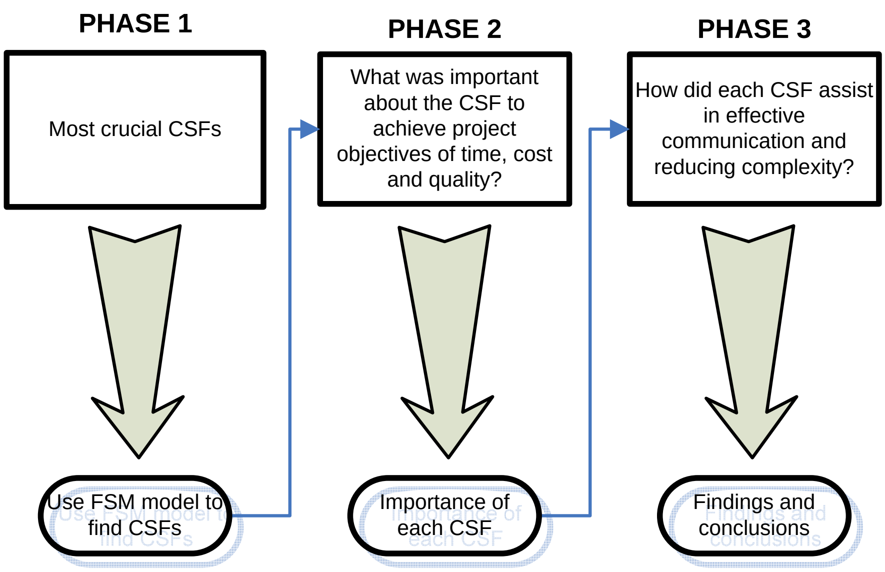


Figure 5-7 The coding process for phases 2 and 3.

The second phase builds upon the first phase results by asking what is so important regarding each of the most crucial CSFs for achievement of the project management objectives of time, cost and quality. The three most crucial CSFs found were communication, top management support and effective change management. Each was analyzed using the data gathered for the research. Following the analysis for each case, a cross-case analysi was performed.

The third phase built upon the second phase results. The question to ask was how each CSF assisted in establishing effective communication and information management in the case study projects as well as reducing complexity. The interrelationships between the three CSFs were analyzed. The common issue that developed between them was the formal and informal communication and processes. It was found that formal and informal communication and processes were important and had their functions in the case study projects.

Formal and informal processes were found to be complementary where the advantages and disadvantages were reversed where the advantage of one was a disadvantage of the other and vise versa. It was also found that each had different capabilities for reducing complexity issues. The hybrid model was developed showing formal and informal construction processes in the case study projects and interplay between them. Furthermore, it was found that client staff and individual characteristics of the project team members were important to achieve effective communication and reducing complexity. These charcteristics have been found to be guidelines forming a framework for the use of the hybrid model.

Use of software for analysis

The use of software for data analysis can save time and assist in management of larger samples. Software can lead to greater efficiency by mechanization of tedious tasks such as searching and copying text segments (Kelle and Laurie, 1995). Additionally, the use of software can make the analysis more rigorous and transparent by systematizing procedures, which enable the researcher to codify exactly how they want to analyze their data (Conrad and Reinarz, 1984). Furthermore, software for textual analysis frees up the researcher to perform more creative and analytic tasks by allowing the researcher to 'juggle' the data and explore relationships between different categories more thoroughly (Lee and Fielding, 1995).

The preliminary analysis of data was made during the interview process. However, it could not be completed until all transcripts had been typed and inserted into QSR NVivo for analysis. Coding is an iterative process that changes continuously. There is no "exact" method to perform the coding of the research data. However, the closest method was to use cross-coding and attempt to capture relations between coded items, which was generally used in the research. The coding tree from the QSR NVivo program is shown in Figure 5-8. Further description is provided in Chapter Ten.

Figure 5-8 Coding tree from NVivo

Tree Nodes

Name	Sources	References	Created On	Created By
Trust	0	0	3/25/2008 3:55 PM	T.A.H.B.
Other	25	100	3/25/2008 4:00 PM	T.A.H.B.
Intra-organizational	8	17	3/25/2008 3:57 PM	T.A.H.B.
Inter-organizational	11	29	3/25/2008 3:59 PM	T.A.H.B.
Individual	14	30	3/25/2008 3:57 PM	T.A.H.B.
Things Not Done Well	1	1	3/25/2008 5:30 PM	T.A.H.B.
Resources	16	49	3/25/2008 6:18 PM	T.A.H.B.
Process Related	20	84	3/26/2008 5:40 PM	T.A.H.B.
Other	12	47	4/17/2008 11:10 PM	T.A.H.B.
Management Related	18	66	3/25/2008 6:40 PM	T.A.H.B.
IMS	16	52	4/6/2008 11:49 PM	T.A.H.B.
Design Related	16	50	3/25/2008 8:42 PM	T.A.H.B.
Contractor Related	15	36	3/25/2008 8:36 PM	T.A.H.B.
Consultant Related	14	23	3/25/2008 8:43 PM	T.A.H.B.
Client Related	15	27	3/26/2008 6:12 PM	T.A.H.B.
Changes	20	61	3/25/2008 5:51 PM	T.A.H.B.
Things Done Well	0	0	3/25/2008 5:29 PM	T.A.H.B.
Other	25	114	3/26/2008 7:01 PM	T.A.H.B.
Management	20	93	3/25/2008 5:41 PM	T.A.H.B.
Design Related	8	14	3/25/2008 6:04 PM	T.A.H.B.
Contractor Related	12	28	3/25/2008 8:35 PM	T.A.H.B.
Consultant Related	12	17	3/26/2008 5:34 PM	T.A.H.B.
Client Related	12	23	3/26/2008 6:11 PM	T.A.H.B.
Achievements	14	45	3/25/2008 5:55 PM	T.A.H.B.
Suggestions for Change	0	0	3/25/2008 12:19 PM	T.A.H.B.
Process of Work	22	40	3/25/2008 12:25 PM	T.A.H.B.
Other Suggestions	19	44	3/25/2008 12:27 PM	T.A.H.B.
Organization	23	36	3/25/2008 12:22 PM	T.A.H.B.
IT	21	43	3/25/2008 12:24 PM	T.A.H.B.
Human Resources	19	25	3/25/2008 12:24 PM	T.A.H.B.
Communication & Info	23	48	3/25/2008 12:22 PM	T.A.H.B.
Project	1	1	3/25/2008 4:32 PM	T.A.H.B.
Quality & Rework	25	75	3/25/2008 4:33 PM	T.A.H.B.
Objectives	25	27	3/25/2008 4:36 PM	T.A.H.B.
Management	23	129	3/25/2008 5:22 PM	T.A.H.B.
History	17	35	3/25/2008 5:27 PM	T.A.H.B.
Complexity	20	60	3/25/2008 4:35 PM	T.A.H.B.
Changes	20	63	3/25/2008 4:34 PM	T.A.H.B.
Process	0	0	3/25/2008 12:11 PM	T.A.H.B.
Informal Process	23	78	3/25/2008 12:14 PM	T.A.H.B.
Formal Process	24	108	3/25/2008 12:12 PM	T.A.H.B.
Complexity	20	49	3/25/2008 12:15 PM	T.A.H.B.

Tree Nodes

Name	Sources	References	Created On	Created By
Change Process	22	49	3/25/2008 12:15 PM	T.A.H.B.
Organization	0	0	3/25/2008 12:05 PM	T.A.H.B.
Staff	26	192	3/25/2008 12:10 PM	T.A.H.B.
Management Adaptabi	17	90	3/25/2008 5:31 PM	T.A.H.B.
Informal	25	90	3/25/2008 12:09 PM	T.A.H.B.
Formal	24	97	3/25/2008 12:09 PM	T.A.H.B.
Effectiveness	26	126	3/25/2008 12:10 PM	T.A.H.B.
Culture	26	239	3/25/2008 12:08 PM	T.A.H.B.
Mini-cases-Examples	0	0	3/25/2008 4:11 PM	T.A.H.B.
Quality	19	44	3/25/2008 9:05 PM	T.A.H.B.
Management Related	14	38	3/25/2008 6:43 PM	T.A.H.B.
Information Flow	20	49	3/26/2008 5:37 PM	T.A.H.B.
Design Related	15	22	3/25/2008 6:02 PM	T.A.H.B.
Contractor Related	7	9	3/25/2008 8:38 PM	T.A.H.B.
Client Related	7	7	3/25/2008 6:13 PM	T.A.H.B.
Adaptability	12	30	3/25/2008 6:02 PM	T.A.H.B.
IMS	0	0	3/25/2008 4:14 PM	T.A.H.B.
Uses of IMS	24	69	3/25/2008 4:16 PM	T.A.H.B.
Requirements of IMS	22	76	3/25/2008 4:16 PM	T.A.H.B.
Programs	20	31	3/25/2008 4:15 PM	T.A.H.B.
Problems	21	71	3/25/2008 4:18 PM	T.A.H.B.
Genral Description of Co	0	0	3/25/2008 4:26 PM	T.A.H.B.
Human Factors	18	69	3/25/2008 4:28 PM	T.A.H.B.
General Descriptions	19	88	3/25/2008 4:30 PM	T.A.H.B.
Culture in Dubai	19	51	3/25/2008 4:27 PM	T.A.H.B.
Description of Parties	0	0	3/25/2008 4:19 PM	T.A.H.B.
Management Team	25	132	3/25/2008 4:21 PM	T.A.H.B.
Contractor	20	80	3/25/2008 4:21 PM	T.A.H.B.
Consultant	19	49	3/25/2008 4:20 PM	T.A.H.B.
Client	20	84	3/25/2008 4:20 PM	T.A.H.B.
Communication & Inform	0	0	3/25/2008 4:00 PM	T.A.H.B.
Other	19	34	3/25/2008 8:56 PM	T.A.H.B.
Methods	2	3	3/25/2008 4:07 PM	T.A.H.B.
Phone	12	18	4/13/2008 6:22 PM	T.A.H.B.
Meetings	19	35	3/25/2008 9:37 PM	T.A.H.B.
IMS	19	70	3/25/2008 9:32 PM	T.A.H.B.
Face to Face	21	46	3/25/2008 9:33 PM	T.A.H.B.
Email	24	54	3/25/2008 9:32 PM	T.A.H.B.
Information	23	90	4/6/2008 11:50 PM	T.A.H.B.
Informal	26	87	3/25/2008 4:08 PM	T.A.H.B.
Formal	24	80	3/25/2008 4:08 PM	T.A.H.B.

Tree Nodes

Name	Sources	References	Created On	Created By
Effectiveness	26	103	3/25/2008 4:10 PM	T.A.H.B.

5.15 Summary

This chapter has provided a general literature review of methodologies. The basic research methodologies have been outlined. The methodology chosen for the research has been described and justified. The research methods have been described and those used were justified. Validity, reliability and replicability have been reviewed as well as triangulation. Grounded theory has been described and the two main variations thereof have been critically reviewed. Data analysis, coding and cross coding has been described. The logic behind development of the questions for the semi-structured interviews has been presented.

The application of the requirements of the research methods and data analysis is presented in Chapter Ten. The following chapter provides the application of the FSM model into the case study projects for the purpose of identifying the most critical CSFs in mega construction projects in Dubai.

CHAPTER 6 CSFs IN THE CASE STUDY PROJECTS

6.1 Introduction

This chapter aims at capturing the crucial CSFs for mega construction projects in Dubai, due to its particulars stated in the research context in Chapter One. From the literature review in Chapter Two, a dynamic model providing a framework for CSFs was identified and justified for use in construction projects. This FSM model shall be applied to the case study projects for analysis of the crucial CSFs. The outcome of this analysis (i.e. crucial CSFs) shall be subject to further investigation in following chapters, incorporating themes developing from the coding and analysis process. The coding process was performed separately as a separate exercise to check its convergence with the CSFs and to relate the themes to them. Questions are developed to guide the research analysis for each of the crucial CSFs.

6.2 Cross-case analysis of CSFs in case study projects

There are nine main components in the FSM model with a few additional CSFs that remained separated, which were combined under the heading “other” for simplification as shown in Figure 6-1. Under each main component come several CSFs. The number of CSFs are large as well as the range and variety of CSFs.

Both case study projects were considered successful by respondents. The CSFs as shown in the discussions and analysis in Appendix 3 for each of the case study projects indicate that CSFs are not all crucial. The CSFs for each case study project is presented for each component within the discussions in this section. In order to find the most crucial CSFs in the case study projects there are several criteria that shall be used in the cross-case analysis. These are summarized as follows:

- The CSFs that were present in one case study and not the other shall be eliminated. Since both projects are considered successful, then the CSFs in one and not the other justifies eliminating it as a crucial CSF.
- The CSFs that were considered as crucial in both case study projects but were on an equal footing on it shall be eliminated. The logic is that if both projects

worked within the same conditions, and both were considered successful, then the comparison loses its meaning and there is no need to study it further.

- The CSFs that are available in both case study projects but not stated in the CSF literature emanating from the region as one of the top ten critical CSFs shall be eliminated. The most critical CSFs from the literature from the region are provided in Table 6-1.

Each of the components and CSFs for the case study projects shall be compared and discussed. The most important components and CSFs resulting from the cross case analysis shall be chosen for further scrutiny.

Figure 6-1 Components and subcomponents of FSM model

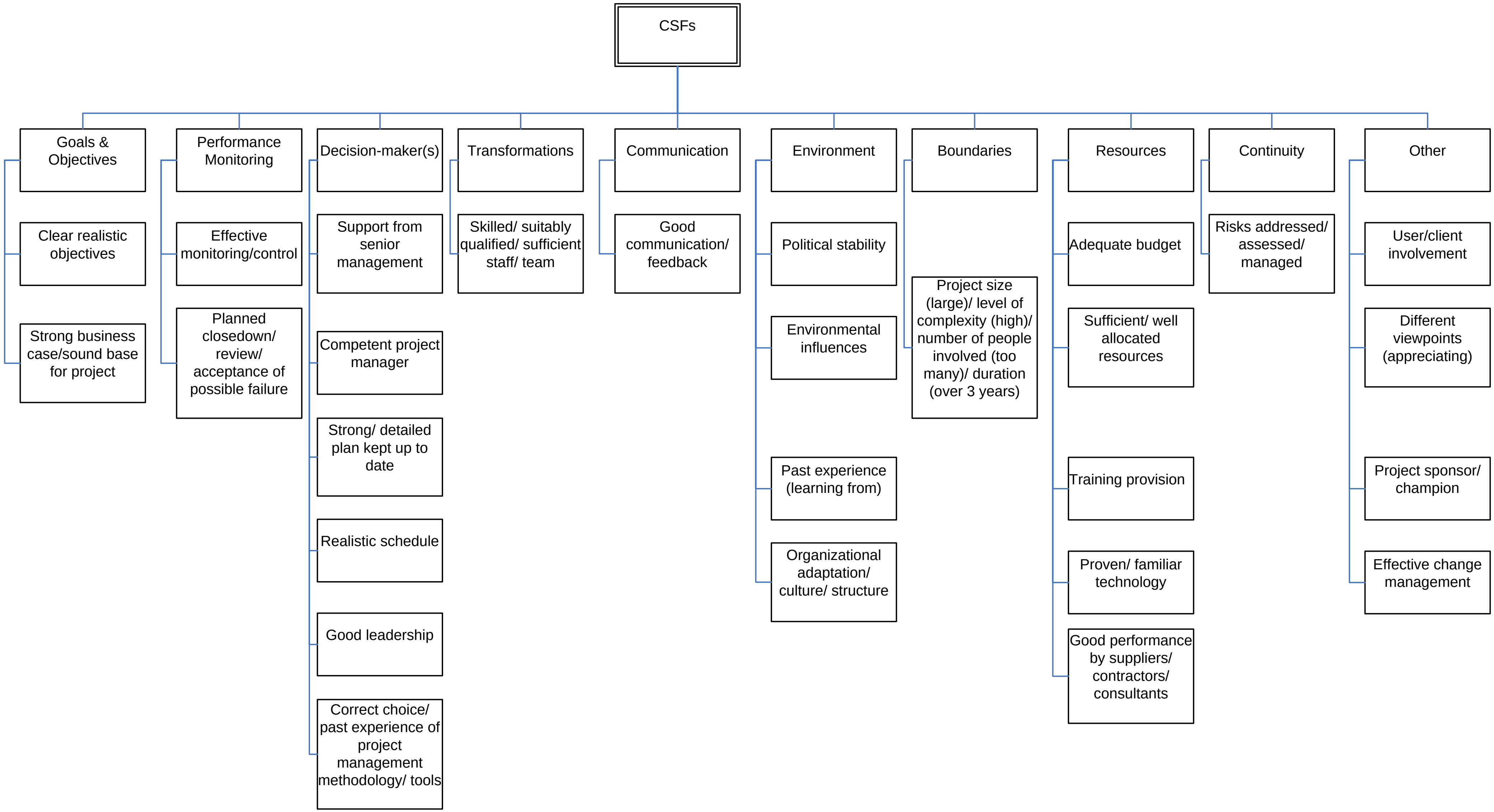


Table 6-1 The most critical factors as described in the construction literature in the Middle East region

Components of FSM/ Project attributes	Critical success factors from literature	As related in construction literature	Literature
Decision-maker(s)	Support from senior management	Slow decisions making (owner)	Alaghbari et al. (2007); Sambavisan and Soon(2006); Faridi and El-Sayegh (2006)
		Excessive bureaucracy/uncooperative owner (late in approving design documents)	Faridi and El-Sayegh (2006); Assaf and Al-Hejji (2006)
	Competent project manager	Poor site management	Alaghbari et al. (2007); Assaf and Al-Hejji (2006)
	Strong/detailed plan kept up to date	Improper and inadequate planning	Sambavisan and Soon(2006); Faridi and El-Sayegh (2006); Zaneldin (2006)
		Conflicts encountered with sub-contractors' schedule in project execution	Assaf and Al-Hejji (2006)
	Good leadership	Unsuitable leadership style of construction/project manager	Faridi and El-Sayegh (2006)
	Correct choice/past experience of project management methodology/tools	Type of project bidding and award	Assaf and Al-Hejji (2006)
		Type of construction contract	Assaf and Al-Hejji (2006)
		Unavailability of incentives for contractor to finish ahead of schedule	Assaf and Al-Hejji (2006)
		Ineffective delay penalties	Assaf and Al-Hejji (2006)
Transformations	Skilled/suitably qualified/sufficient staff/team	Shortage of site labour and manpower	Alaghbari et al. (2007); Sambavisan and Soon(2006) ; Faridi and El-Sayegh (2006); Assaf and Al-Hejji (2006)
		Low labour productivity	Alaghbari et al. (2007); Sambavisan and Soon(2006); Faridi and El-Sayegh (2006)
		Poor skills and experience of labour	Alaghbari et al. (2007); Faridi and El-Sayegh (2006)
		Lack of contractor's staff (& poor qualification)	Alaghbari et al. (2007); Assaf and Al-Hejji (2006)
Communication	Good communication/feedback	Preparation and approval of drawings	Sambavisan and Soon(2006); Faridi and El-Sayegh (2006); Assaf and Al-Hejji (2006)
Environment	Environmental influences	Lack of materials (& quality) in the market	Alaghbari et al. (2007); Sambavisan & Soon(2006); Faridi & El-Sayegh (2006); Assaf & Al-Hejji (2006)
		Poor weather conditions	Alaghbari et al. (2007); Sambavisan & Soon(2006); Faridi & El-Sayegh (2006); Assaf & Al-Hejji (2006)
		Obtaining permit/approval from the municipality/different government authorities	Faridi & El-Sayegh (2006)
Resources	Adequate budget	Financial problems of contractors and owners (delayed payments, financial difficulties and economic problems)	Alaghbari et al. (2007); Sambavisan and Soon(2006); Faridi and El-Sayegh (2006); Zaneldin (2006); Assaf and Al-Hejji (2006)
	Good performance by suppliers/contractors/consultants	Mistakes and discrepancies in contract documents	Sambavisan and Soon(2006); Zaneldin (2006); Zaneldin (2006); Assaf and Al-Hejji (2006)
	Effective change management	Contract modifications-Change orders & variations (replace and add new works to the project; change in specifications)	Alaghbari et al. (2007); Sambavisan and Soon(2006); Faridi and El-Sayegh (2006); Zaneldin (2006); Assaf and Al-Hejji (2006);

6.2.1 Goals and objectives component of FSM model

The CSFs resulting from the application of the data is provided in Table 6-2 below for each case study project.

Table 6-2 Summary of analysis for CSFs in goals and objectives component

Component of FSM / project attributes	Critical Factor	Project 1	
		Taken account of	**Comments**
Goals and objectives	Clear realistic objectives	yes	The project requirements were clear to all. This is shown from the response to question no. 3 of the interviews. However, the majority found that the task is difficult but not impossible.
	Strong business case/ sound basis for project	yes	The project seemed to provide a haven for families from the entire region. It offered a vast range of new things in entertainment, which are not available.
		Project 2	
	Clear realistic objectives	yes	The project requirements were clear as shown from the responses to question no. 3 of the interviews. Additionally, they found the requirements reasonable. Unlike Project 1, the complexity was less.
	Strong business case/ sound basis for project	yes	The development is largely for resale as properties at this time were selling quickly and for large sums. It catered to the requirements of the booming property market in Dubai.

The goals and objectives component in the FSM model is not considered as warranting further scrutiny. The first reason for this is that in both projects the project management objectives were clear to all respondents. However, the author is of the view that the project management success criteria (i.e. time, cost and quality) is well known, and becomes a fact of life, to anyone who has worked in construction projects. The second reason is that the strong business case for the project was present in both case study projects. The third reason is that it was not considered as one of the most critical CSFs in the literature as described in Table 6-1.

6.2.2 Performance monitoring

The CSFs resulting from the application of the data to the performance monitoring component in the FSM model is provided in Table 6-3 below for each case study project.

Table 6-3 Summary of analysis for CSFs in performance monitoring component

Component of FSM / project attributes	Critical Factor	Taken account of	Comments
		Project 1	
Performance monitoring	Effective monitoring/ control	yes	The cost and time were closely monitored by the project management team with the SPMs leading the control for each section of the project.
	Planned close down/ review/ acceptance of possible failure	no	There were no plans for close down at the time of interviews.
		Project 2	
	Effective monitoring/ control	yes	There were many meetings for the control of the project. Additionally, the budget was closely monitored.
	Planned close down/ review/ acceptance of possible failure	no	There were no plans made for closedown and there were complaints that no one had thought about this. It was stated that they were too busy completing the job and forgetting about this part.

The performance monitoring component in the FSM model is not considered for further scrutiny due, firstly, to the fact that both case study projects had effective monitoring and control systems in place. The second reason is that in both case studies the planned close down and review was not mentioned except by a few of the respondents who stressed that the people responsible should start to think about that. However, the reason it was not mentioned may have been due to the stage the projects were during conduct of the research interviews. Project 1 was at the beginning of the finishing stage and Project 2 was at the completion of structures phase. The third and final reason is that the performance monitoring component and the CSFs within this component are not included in the most critical CSFs in the literature as seen in Table 6-1.

6.2.3 Decision maker(s) component of FSM model

In summary, the CSFs most important for the success of the projects in the Decision Maker(s) component were attributed to client and top management. The attitude of the client was critical to establish a collaborative attitude in the project and establish the culture. The knowledge of the clients of the construction process made their decisions faster and with more awareness to make correct decisions.

The decision-maker(s) component in the FSM model warranted further exploration due to the many statements made by respondents describing the client and top management and their effect on the case study projects. Furthermore, the management styles were different making both cases study projects on unequal footings. The concentration will be on top management support. Additionally, the CSF, particularly owner attitude, is stated as one of the most critical CSFs as shown Table 6-1 from the literature in the area. The CSFs resulting from the application of the data to the performance monitoring component in the FSM model is provided in Table 6-4 below for each case study project.

Table 6-4 Summary of analysis for CSFs in decision-maker(s) component

Component of FSM / project attributes	Critical Factor	Project 1: Taken account of	Project 1: Comments
Decision-maker(s)	Support from senior management	yes	The foreign partner of the joint venture was physically present at site, including the President and several vice presidents.
		yes	The top management of the main contractors were supportive of their project managers in the project.
		no	The top management of the main consultant was not as supportive of their project manager as the client would have liked. The project manager of the main consultant was left largely on his own, except for some technical assistance from the Head Office.
	Competent project manager	yes	The project managers in the project were very competent and had worked in projects of a similar nature. This is the case for all the project leaders in the majority of the parties in the project. The only incompetence was stated as those of the smaller contractors.
	Strong/detailed plan kept up to date	yes	A plan was formulated at the start of the project and was continuously monitored and updated through weekly meetings between the planners and the contractors and the WPMs. This included major changes made to the project. Any discrepancies were followed up.
	Realistic schedule	no	The original schedule was not realistic had the project been performed in its original state, which was cast-in-situ and block work. It was the changes that were suggested by the contractors and accepted by the client that had made the duration more realistic.
	Good leadership	yes	The project managers for the construction management team as well as the parties had good leadership skills. This is except for some of the smaller contractors who were led by the construction management team.
	Correct choice/ past experience of project management methodology/ tools	no	The project management route chosen was not tried and that created a lot of uncertainty for all that came on board. However, it did prove successful.
		Project 2	
	Support from senior management	yes	The board of the client was in support of the project but were not hands on as much as in project 1. The CEO of the project management firm was the same for the client.
		yes	The top management of the main contractors were supportive of their project managers in the project.
		yes	The top management of the main consultant was supportive of their Resident Engineer. Any staff could receive any assistance at any time. Additionally, the top management was closely following up activities on site.
	Competent project manager	yes	The project leaders in the project were competent and had worked in similar projects. This is the case for all the parties in the project.
	Strong/detailed plan kept up to date	yes	A plan was formulated at the start of the project and was modified to incorporate the changes made to the project. The planner had weekly meetings with each of the main contractors to maintain the plan and follow up any delays.
	Realistic schedule	yes	The original schedule was realistic in regards to the cast-in-situ design of the project.
	Good leadership	yes	The project leaders of all the parties had good leadership skills.
	Correct choice/ past experience of project management methodology/ tools	yes	The project management route seemed a good choice for the project. It was also

6.2.4 Transformation component in FSM model

In the transformation component of the FSM model, the ten highest ranked CSFs in the literature shown in Table 6-1 included shortage of manpower, low labour productivity, poor skills and experience and lack of contractor's staff and qualifications. As stated previously, there was a severe shortage of manpower in Dubai due to the amount of construction and legislature. In both case study projects this problem was recognized and overcome. However, it was the contractors who proposed changes that overcame this problem, and which was duly accepted by the client. This was proposed by the contractors because they are the ones that face the problems stated. It is accepted in the literature that precast elements for buildings provide advantages in regards to reduced manpower requirements and enhancement of quality. The CSFs resulting from the application of the data to the transformation component in the FSM model is provided in Table 6-5 below for each case study project.

Table 6-5 Summary of analysis for CSFs in transformation component

Component of FSM / project attributes	Critical Factor	Project 1	
		Taken account of	Comments
Transformations	Skilled/ suitably qualified/ sufficient staff/ team	yes	The management teams in the project were stated as qualified and sufficient in numbers. However, there was a problem regarding the quality of junior staff and skilled labour was a big problem in Dubai.
		Project 2	
	Skilled/ suitably qualified/ sufficient staff/ team	yes	The management teams in the project were stated as qualified and sufficient in numbers. However, for the smaller contractors there was a problem regarding the quality of the staff. Additionally, skilled labour was a big problem in Dubai.

Both projects were even handed when it came to this component in the model. This is despite being stated as one of the most crucial CSFs in the literature emanating from the area. Therefore, this component is not considered for further scrutiny, although it is believed that effective change management is part of the transformation process. However, to maintain the FSM model components, they shall be treated separately in the analysis.

6.2.5 Communication component in FSM model

Although the FSM model provides communication as one of the CSFs, it is not visible in the model. This may be that it is intangible or included in all facets of the FSM model. In Table 6-1 the literature concerning the U.A.E. and neighbouring countries provides that the most critical factor is preparation and approval of drawings.

Inherently inclusive in this process are RFIs. Communication involves many facets, and thereby, will be discussed separately showing the processes in both case study projects and how communication was successful despite the fact that the formal process was long and difficult and respondents pointed this. The CSFs resulting from the application of the data to the communication component in the FSM model is provided in Table 6-6 below for each case study project.

Table 6-6 Summary of analysis for CSFs in communication component

Component of FSM / project attributes	Critical Factor	Project 1	
		Taken account of	**Comments**
Communication	Good communication/ feedback	yes	The client was on site and hands on in the project. Although, there was some criticism regarding over involvement of the client, the majority found that this assisted the project tremendously.
		Project 2	
	Good communication/ feedback	yes	The Project Director and CEO of the client were continuously meeting as observed by the researcher. Additionally, the Project Director and his team were continuously meeting and maintained an open door policy for all.

Communication was considered critical by all respondents. It is considered as one of the most crucial CSFs in the literature performed in the area. Additionally, both projects had different communication systems and were thereby not on equal footings. Furthermore, the surfacing of informal communication as of criticality warranted further investigation, analysis and scrutiny.

6.2.6 Environment component of FSM model

The environment component in the FSM model included Authorities, main developers, boards of directors, contractors, consultants, suppliers, staff and legislature. From Table 6-1 it is seen that the literature in this part of the world shows that the most critical factors in the environment component included poor weather conditions, lack of materials and its quality in the market and obtaining approvals from the relevant authorities. Regarding weather conditions, there was a legislature passed that advised working hours in hot weather and which was strictly enforced. This was something out of the control of anyone. It is therefore supposed to be incorporated in the planning for any project in the region.

Materials were a problem in Dubai in general. The vast majority of materials were imported following approval of the consultant and client. The formal approval process was lengthy and time consuming. This will be shown in the formal approval process in following sections for both case study projects. This is a logistics problem that needs to be resolved for timely completion of projects because without materials the project would stagnate. In Project 1 the logistics was performed by the construction management team and a system was established with a freight forwarder to provide timely service in shipping for all imported material. This was quite successful. In Project 2 the logistics was performed by the main contractors supervised by the project management team. Again, this was successful because due consideration was given to the logistics.

Approvals of Authorities were a problem in Dubai. There were two main parts to the approvals. The first is approval of construction drawings, whereby approval of some major changes had to be approved prior to construction. The second is inspections by Authorities at certain junctions in the construction project. This was faced by both case study projects, especially in approvals of changes in the method of construction of the structures. This process is time consuming, particularly since the Authorities were stretched with the amount of ongoing construction. Additionally, the changes had to be approved by the consultant and then go to the relevant Authorities which then review and approve the same. The approved construction drawings by the Authorities are used during inspections. This did impact the time in both case study projects. However, it did not cause any substantial delays since the changes actually caused a reduction in the time for construction and as such the delay was absorbed.

In the FSM model the organization structure and culture is stated as one of the critical success factors. In Project 2 this was duly considered from the design phase and it was clear that the procurement route is the project management route. However, in Project 1, the procurement route had been changed from a traditional main contractor route to a construction management route at the start of construction. It is therefore not possible for such a change in procurement route to have been considered fully prior to the start of the project. Despite this sharp change in procurement route the organization was described as effective by the vast majority of respondents and the project was considered successful due to the organization.

Balle (1996) views the association of organization with organizational structure as puzzling. First, the organizational structure tells very little about how or what work actually happens. It just shows who is what in the organization and is important for those having a career in it. Secondly, people are clever and establish their own channels of information, resources and allies-what may be termed as a power base. In this regard, the organization chart is misleading and tells very little.

Balle (1996) adds that an organization is a system and not a structure. It is composed of interdependent people who rely on one another for work, and this interdependency is dynamic, constantly adjusting itself. It is not as a chart would make it appear. Walker and Shen (2002) iterate this point by stating that each project will typically experience several structures during its life cycle.

This critical success factor was not considered fully in Project 1 and despite that it worked. This is not a coincidence but was largely due to several factors. These factors included the clear goals and objectives of the project, the client's persistence in completing the project to the objectives and the client's and project management team in establishing a collaborative attitude in the project. The clear goals and objectives stressed and reinforced by the client and management team kept all involved focused on achieving them. Therefore, all other matters paled in the face of achieving the project goals and objectives. The client's genuine interest to complete the project was clearly felt throughout the project organization. Being proactive, the client provided evidence of his intent which was reflected on the actions of project staff.

It is therefore concluded that the organization itself is not a critical factor. It is the clear goals and objectives of the project that made staff focus on the task at hand and find ways to achieve them. The client again plays a major role in establishing the clarity of the goals and objectives required of the project and reinforce them through their actions throughout the construction process. The organization may be adapted to suit the project requirements if the project management maintain versatility in this regard. Additionally, the people in the project played a major role for the success of the project. This will be discussed further in the human aspects section.

The CSFs resulting from the application of the data to the environment component in the FSM model is provided in Table 6-7 below for each case study project.

Table 6-7 Summary of analysis for CSFs in environment component

Component of FSM / project attributes	Critical Factor	Project 1	
		Taken account of	Comments
Environment	Political stability	yes	Political stability in Dubai as seen by the heavy investment that was attracted to the city.
	Environmental influences	yes	Any influences on the project were dealt with swiftly. There was a team for dealing with environmental influences that arose.
	Past experience (learning from)	yes	It was very evident that the management team had used their past experience to deliver the project, despite the new management method used in the project.
	Organizational adaptation/ culture/ structure	no	The project contract was initially to be a traditional main contract but was changed to a construction management team for the client to reduce the cost. The organization was a matrix structure that fit the requirements of the project but was rather loose. A cooperative culture was built with the contractors since the main contractor CEO and the President of client knew each other previously. This was not the case with the consultant.
		Project 2	
	Political stability	yes	Political stability in Dubai as seen by the heavy investment that was attracted to the city.
	Environmental influences	yes	Any influences were taken care of quickly.
	Past experience (learning from)	yes	It was evident that the project team used their previous experience in completing the project.
	Organizational adaptation/ culture/ structure	yes	The project management structure fit well with the project complexity and division of the project. Although portions were awarded to main contractors, it was negotiated and this established a culture of cooperation in the project.

In both case study projects, the environment was the same. Both were developers taking areas from main developers and both were building the infrastructures of the areas they were developing. Hence, both projects were affected by the main developers and the Authorities. Since both projects were working within the same environmental conditions, this component did not warrant further investigation.

6.2.7 Boundaries component of the FSM model

The CSFs resulting from the application of the data to the boundaries component in the FSM model is provided in Table 6-8 below for each case study project.

Table 6-8 Summary of analysis for CSFs in boundaries component

Component of FSM / project attributes	Critical Factor	Project 1	
		Taken account of	Comments
Boundaries	Project size (large)/ level of complexity (high)/ number of people involved (too many)/ duration (over 3 years)	yes	The project size was large, the level of complexity high, the number of people large but duration of construction of the project was less than 2 years.
		Project 2	
	Project size (large)/ level of complexity (high)/ number of people involved (too many)/ duration (over 3 years)	yes	The project was divided into smaller portions each headed by an SPM. This made each section of the project smaller with fewer people involved. Additionally, complexity was not high for the project. The duration was less than 3 years and was sufficient for the project.

Both case study projects were mega construction projects, despite Project 1 being more complex than Project 2. Both projects had large numbers of involved and their durations were similar. Both projects were similar in nature. Therefore, this component is considered not to warranty further investigation.

6.2.8 Resources component of the FSM model

From Table 6-1 it is shown that in this region of the world the critical factors affecting construction projects include financial problems of the owner and contractor and mistakes and discrepancies in the construction documents. There were no financial problems in both case study projects. This is largely due to the client knowledge of the construction process as stated previously. The clients understood clearly that to achieve the project objectives funds had to be available for the project. Additionally, they were aware that contractor financial problems would be detrimental to the project. Therefore, it was evident that reputable contractors in good financial standing were chosen for construction. Also, both clients were aware that they needed to pay the contractors in a timely manner for work performed in order not to stagnate their work due to financial difficulties. Additionally, both clients were interested in resolving financial issues related to changes or claims quickly and fairly in order to avoid any claims and outstanding financial issues.

The clients in both case study projects were fully aware of the effect on the project from discrepancies in the project documents. This again is a result of the client knowledge of the construction process. The client in Project 2 had a less complex project and thereby did not face a severe problem in this regard. However, Project 1 which was more complex faced a severe problem due to discrepancies in the construction documents due to late changes in the design phase by the client and the early freezing of design by the client in order to start construction. The result was discrepancies in the construction documents that had to be resolved during construction.

As the above statement points out, the push-push attitude was crucial in resolving the discrepancies and coordination of the project whilst construction was ongoing. This attitude is made possible by the cooperative environment in both case study projects. This attitude actually made communication in the projects very good. Here it is important to note that the responses stressed the importance of informal communication and relations versus the formal communication system. This is based largely on trust. However, the importance of the formal communication system was also stressed as required to maintain a historical record. There was awareness that all modes of communication are required and each had its importance and was used in different situations for different purposes. This will be discussed further in Chapter Seven.

In the Resources component of the FSM model, training is stated as one of the critical factors. In both case study projects there was no formal training offered during project construction. It is most probably due to the nature of construction projects where they are temporary ventures (Emmitt and Gorse, 2003). Additionally, and due to the same reason, trained resources are required. However, in both projects on the job training was performed such as the case in Project 1 where skilled masons were mixed with semi- and unskilled labour for training on the go. However, this was done informally.

In summary, the client awareness of the importance of resources and the logistics of those in charge made these critical success factors strengths for the projects. Additionally, the client attitudes in both projects made possible the good communication in the project by establishing a cooperative culture in the project and trust. In both case study projects the clients encouraged informal communication between the parties and staff.

The CSFs resulting from the application of the data to the resources component in the FSM model is provided in Table 6-9 below for each case study project. The resources component in the FSM model is decided to not require further investigation due to several reasons. The first reason is that both case study projects had adequate resources considering that both projects had labour problems. This is despite lack of sufficient manpower being one of the most critical CSFs in the literature in the area as seen in Table 6-1. Additionally, the parties in the project performed well and both used familiar technology. However, neither case study project provided training. Therefore, both case study projects were similar.

Table 6-9 Summary of analysis for CSFs in resources component

Component of FSM / project attributes	Critical Factor	Project 1	
		Taken account of	**Comments**
Resources	Adequate budget	yes	The budget for the project seemed to be sufficient and no complaints were voiced regarding insufficient funds.
	Sufficient/ well allocated resources	yes	The resources were sufficient but not abundant as a strict budget was maintained.
	Training provision	no	No training provision was made for any of the staff. What was required was trained professionals.
	Proven/ familiar technology	no	The project was managed in a system that was new in Dubai. Additionally, the construction management team was developed by the client mainly from the main contractors in the project, which was also something new.
	Good performance by suppliers/ contractors/ consultants	yes	The performance of the main contractors was described as excellent. However, there were problems with the smaller contractors whom they had to push.
		Project 2	
	Adequate budget	yes	The budget for the project seemed to be sufficient and no complaints were voiced regarding insufficient funds.
	Sufficient/ well allocated resources	yes	The resources were sufficient but not abundant as a strict budget was maintained.
	Training provision	no	No training provision was made for the project. It was expected that the staff would be qualified.
	Proven/ familiar technology	yes	The project was managed by a project management firm, which was part of the client group of companies. The method has been tried and tested in Dubai and was not new.
	Good performance by suppliers/ contractors/ consultants	yes	The main contractors were chosen carefully by the client. Their performance was described as very good.

6.2.9 Continuity component of the FSM model

The CSFs resulting from the application of the data to the continuity component in the FSM model is provided in Table 6-10 below for each case study project. As stated previously, Project 1 had changed procurement route just before the start of construction. Thereby, Project 1 had not assessed the risks properly. A case in point is the fact that the consultant contract was not modified to suit the new requirements. However, this did not seem to affect the outcome of the project. Therefore, this component is not to be investigated further.

Table 6-10 Summary of analysis for CSFs in continuity component

Component of FSM / project attributes	Critical Factor	Project 1	
		Taken account of	**Comments**
Continuity	Risks addressed/ assessed/ managed	no	The risks were not assessed well in the design phase and early construction phase. It is evident from the change in procurement route in the project and also from the main changes that occurred during project execution that caused the realization of the schedule.
		Project 2	
	Risks addressed/ assessed/ managed	yes	The risks were assessed well for the project at the design stage, which the same project management firm was involved in. The procurement route was not changed, despite the main changes that occurred during the execution of the project.

6.2.10 Effective change management CSF

In both case study projects there were major changes in the design of the construction projects. In the FSM model, effective change management was placed as a CSF in other items which did not exactly fit in the model. However, the author is of the opinion that effective change management is part of the transformation process and forms part of the performance and monitoring system since changes is where more transformation and monitoring and control is required. The CSFs resulting from the application of the data to the “other” (remaining CSFs) component in the FSM model is provided in Table 6-11 below for each case study project.

Communication and iteration of information is an aftermath of any change. In the case study projects there were major changes. Despite that both case study projects were viewed as successful. Change is stated as one of the main causes of project failure in the literature (e.g. Chua et al., 2002). As such the research will focus on this process. Particular focus will be on RFIs and submittals, particularly drawings, as these are considered one of the most crucial CSFs in the area as seen from Table 6-1.

The RFI and submittals process for both projects shall be presented in the following chapter. It will be seen that the formal systems in both projects are complex and lengthy. It is even a worse case scenario when a change occurs. In addition to this, one can imagine if a revision is required and may have to go through the formal process several times. It is therefore clear that good information management should be present in any venture, but in particular when a change occurs.

Effective change management warranted further analysis and investigation due to several reasons. The first is that both case study projects underwent major changes during construction and both were considered successful. This is despite the fact that the literature considers change as one of the major reasons for project failure as seen in Table 6-1. This warranted further investigation into why change in the case study projects did not negatively affect the projects. Figure 6-2 highlights the three crucial CSFs from the cross-case analysis performed. Table 6-12 provides the three most crucial CSFs and questions to guide the research analysis.

Table 6-11 Summary of analysis for CSFs in "other" component

Component of FSM / project attributes	Critical Factor	Project 1	
		Taken account of	Comments
Other	User/client involvement	yes	The client was hands on in the project. Additionally, the vice president of operations for the client was on site. Many of the changes were made by either them or the ultimate operators of certain portions of the project.
	Different viewpoints (appreciating)	no	Viewpoints of the operator were considered but end users were not considered since they were not on board at the time. However, the operator kept making changes because they could not envision the project on paper despite their agreement to the designs. Additionally, the project team was not established at the start to consider any of their viewpoints.
	Project sponsor/ champion	yes	The client placed his top management on site to ensure that the project ran smoothly. The owner of the foreign firm of the joint venture was continuously on visiting the project.
	Effective change management	no	The formal change management system was lengthy and was not suitable for the complexity of the project and the duration. It was stated by the majority that the change management system was sidetracked unofficially to get things done.
		Project 2	
	User/client involvement	no	The client was involved in regards to progress and budget and the main design. However, the users were not involved as it was largely a development for sale to the public.
	Different viewpoints (appreciating)	no	Viewpoints of end users were not considered since they were largely unknown. The users were largely people who would buy the properties after completion of the project.
	Project sponsor/ champion	yes	The client board assigned one of its members to follow up the project and made a critical decision not to bid the contract but to negotiate it with one chosen contractor.
	Effective change management	yes	The change management system was lengthy but it seems it was sufficient for the project, which was not very complex. Despite that it was stated that the change process was sidetracked at times of urgency.

6.3 Importance of crucial CSFs and further questions

The most crucial CSFs in the research were generated through the FSM model rather than through surveys. The FSM model is dynamic and considers the interdependence of CSFs as well as considering projects as systems. The three most crucial CSFs, are thereby, generated from a systematic view of the project rather than solely compilation of opinions from individuals with no consideration to interdependence of CSFs or factors that affect the dynamic project systems. This is a new approach to generating CSFs for use in construction projects.

The three most crucial CSFs were generated following a cross-case analysis by the FSM model. These CSFs are a reflection of the context of the research rather that on single projects. This provides guidance as to the most important issues to concentrate on to properly manage mega construction projects in Dubai. This may result in other interdependent CSFs to "fall in place".

The most crucial CSFs are not an end in themselves for this research, although the findings are important. The question is to find out the underlying reasons for the importance of the three most crucial CSFs. Furthermore, what are the common aspects that relate these three CSFs?

Each of the CSFs raise questions to be explored. A list of the main questions to explore is provided in Table 6-12. It is prudent to analyze each of the CSFs separately with due regard to the questions raised for each. Once that is completed the common 'thread' tying the three CSFs are to be analyzed, which would provide conclusions and findings of importance.

The most crucial CSFs have been compared to the CSF literature, in particular relating to the Gulf region. It was found that the most crucial CSFs in both cases are comparable in terms of their criticality in construction projects in the area. It was found that many problems were caused by lack of communication between the parties or poor communication methods. This was one area to investigate and was found to be crucial as indicated in the introduction as well as the literature review in Chapter Three.

In the CSF literature review in Chapter Three, it was indicated that many problems are created by top management. This included slow decision-making and slow payments to contractors, among other reasons. However, the client or owner was particularly indicated as a main source of these problems.

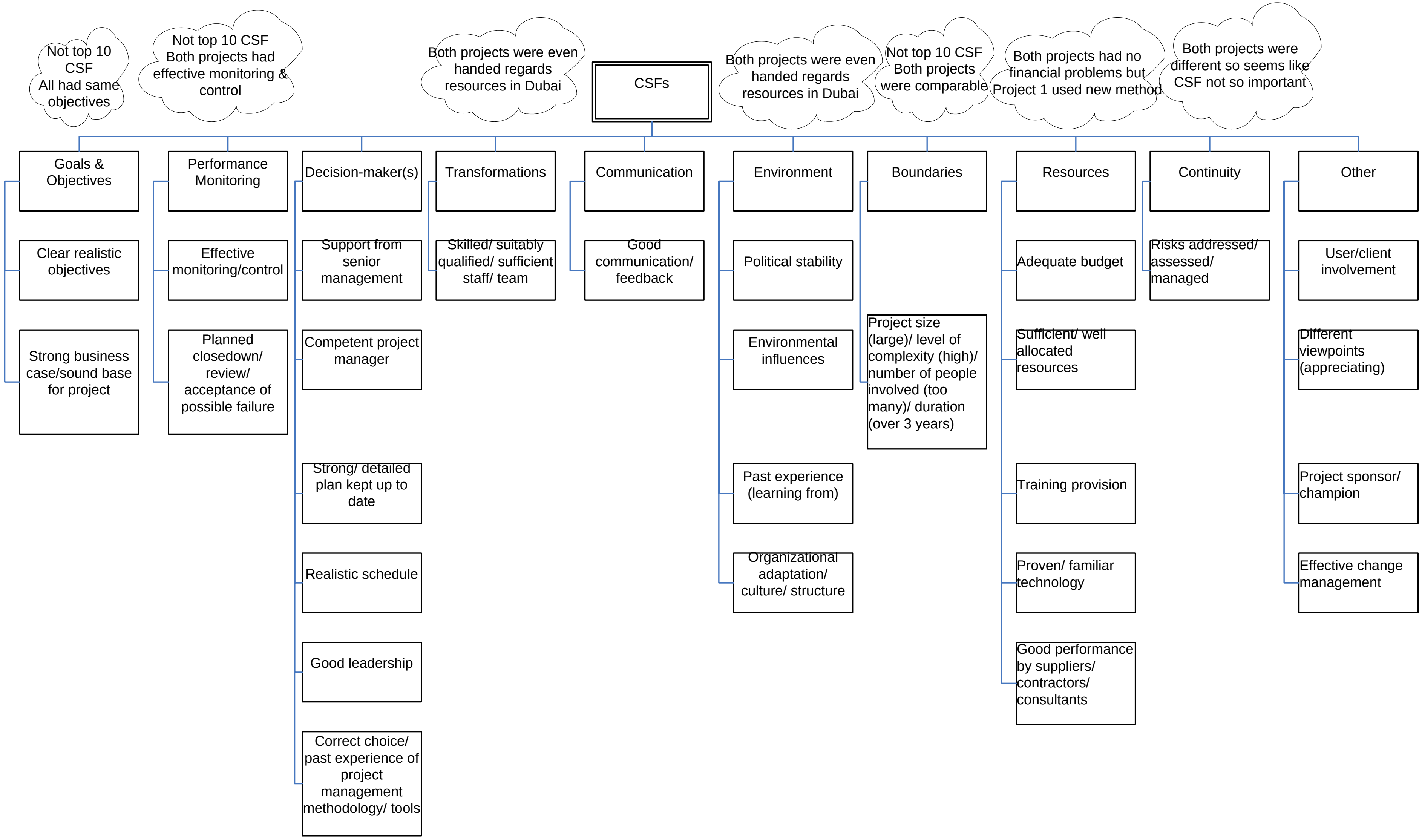
Change is mentioned as a main cause of problems in construction projects as shown in the literature review in Chapter Three. Therefore, this confirms effective change management as a crucial CSF in construction projects. The need to find a way to perform changes effectively is required as shown by the problems in construction projects.

Construction projects are shown to be very complex undertakings from the literature review in Chapter Two. If there are any solutions to problems in construction projects, they have to consider complexity issues. It is, therefore, prudent to analyze the three most crucial CSFs in consideration of complexity issues in construction projects.

Table 6-12 Further questions for analysis

CSF	Further questions raised
Communication	o What is the nature of communication and methods that are used in the case study projects? o How were communication methods perceived? o Why was communication perceived by respondents as effective?
Top management support	o What were the descriptions of top management for each of the main parties in the case study projects? o How did each of the main parties contribute to the projects and who was crucial? o Why was top management support perceived by respondents as important, particularly the client?
Effective change management	o How was change managed in the case study projects? o What work methods were used in the case study projects? o Why was the informal process perceived by respondents as important and how did it contribute to the case study projects? o Can a hybrid model for communication and information management be developed?

Figure 6-2 CSFs as provided in FSM model and most critical CSFs



6.4 Summary

The coding process in the research was performed separately from the exercise for finding the most crucial CSFs in the case study projects. Themes were developing from the coding process whilst the CSF exercise was being performed. The resulting most crucial CSFs in the case study projects assisted in focusing the direction of the research analysis where the themes that developed during the coding process was incorporated within the CSFs.

The chapter provided a method for providing the most crucial CSFs through application in the FSM model presented in Chapter Four. The chapter presented the results of each case study results but discusses the cross analysis. The application of each case study into the FSM model is provided in Appendix 3.

The cross case analysis was performed to obtain the most crucial CSFs in mega construction projects in the context of Dubai. The cross-case analysis provides the results of the analysis for each component and sub-component of the FSM model for each case study project. Following the presentation of the results for each case study, a cross-case analysis was performed where justification for choosing the most crucial CSFs is made. This exercise resulted in obtaining the three most crucial CSFs, namely:

- Communications
- Top management
- Effective change management

Each of the CSFs shall be analyzed separately and discussed in Chapters Seven to Nine in the respective order presented. The following Chapter Seven shall analyze and discuss Communication in the case study projects guided by the questions raised for the CSF.

CHAPTER 7 COMMUNICATION IN THE CASE STUDY PROJECTS

7.1 Introduction

In the previous chapter it has been established that communication is one of the most significant CSFs in mega construction projects in Dubai. In this chapter further analysis is made for communication in mega construction projects in Dubai, building on the results provided in Chapter Six. The main questions guiding the analysis in this chapter are reiterated from Chapter Six.

- What is the nature of communication and methods that are used in the case study projects?
- How were communication methods perceived?
- Why was communication perceived by respondents as effective?

This chapter analyzes communication in the cases study projects. The initial analysis is regarding modes of communication where various modes and their uses in the case study projects are identified from the data. The formal and informal modes of communication established were further analyzed from the data and the needs and uses as well as advantages and disadvantages of each were identified. The formal and informal types of communication are further scrutinized against complexity, uncertainty and ambiguity dimensions provided in the literature review in Chapter Two.

7.2 Background of communication and information management in case study projects

7.2.1 Project 1

Communication

Communication in Project 1 was largely described as good and effective. The reasons for this were stated by informants in order of perceived importance as follows:-

- Leadership skills of top management.
- The quality of the parties, particularly the client, involved and the willingness to resolve problems.
- The quality and experience of the staff in the project.
- The communication skills of the staff.
- The open door policy where anyone could go to anyone for assistance and the willingness of all to help.
- The convergence of objectives of all the people involved in the project and their interest in getting the project done.

There was little mention of the importance of the electronic information management system. This supports the perception of the staff of all parties that the construction industry is people based, which was stated clearly in the interviews. The general belief is that people are the driving force in construction projects.

This is also supported by the preferred and most effective communication method stated by the vast majority of those interviewed. The preferred method of communication was face to face communication. This was immediately followed by a phone conversation between people. This was followed by e-mails and lastly the information or document management system.

Information Management

In Project 1 there were various systems being used. It was largely divided by function. The main functions were:

- Construction
- Design
- Logistics
- Cost control

Project 1 had an electronic document management system for teh project, which Project 2 did not have. In the construction system there was a document control system called Expedition, which is a product by Primavera. The intent of the system was to be used by all parties involved in the project. This did not materialize for various reasons.

The first reason is that the system used in the project, Expedition was not the first system used. The first system used was a locally developed database. It was used for several months in the project. The next system used was ACONEX, which is a document management system marketed in the UAE. All information from the old system was entered into ACONEX over a period of time. This system was used for a period of time. However, management did not like the system and insisted on changing it. The project went back to the internally developed system. Again, the data was transferred back to the old system. Finally, management decided to use Expedition in the project. The data was transferred into Expedition. This came several months into the project. This certainly would have caused a lack of confidence in any system by the users.

The second reason is that the system was disliked by top management. Top management simply hated the system used (i.e. Expedition). Top management stated that an efficient electronic IMS should not require an 'army of people' to operate it. Furthermore, they viewed it as slow and inefficient. One comment was that if it was a good system then why does everyone carry tons of paper? This dislike of the electronic system was stated clearly during the interviews with top management. It goes without saying that this meant there was no insistence by them that all use this system and this was stated in the interviews by others. Hence, whether it was used as intended or not by anyone really did not matter.

However, top management were not the only ones who hated the system. Many people did not like the system for various reasons, including some of the reasons stated above. Few used the system as intended, if at all. The electronic IMS was intended to be a 'collaborative' tool, where all information was available in one place. However, each party to the project had their own document management system. The electronic systems were not compatible and transfer of information from one system to another was not possible. This incompatibility was stated by top management as a reason for problems with electronic IMSs in general. Even those who did use

Expedition used it mainly to track documents or make prints. There were several reasons stated for this. They are as follows:

- They did not like IT and thought it was a hindrance.
- IT kept people on their desks and did not know what was going on at site.
- They were used to working with paper and did not like reading things off the screen.
- They system was cumbersome and slow.
- IT reduced the interaction amongst people, which is perceived as important in construction.

The fourth reason for lack of use of Expedition was that it was finally used for document control only. Document control simply checked documents coming in, ensuring that all the information was correct in the documents, such as the title, revision, numbering, etc. If that was correct the documents were scanned from the hard copy submitted and downloaded into the system as a PDF file. No soft copies were accepted to be downloaded from any source. The main reasons were:

- The draft copies may not be the same as the hard copies and document control could not check the contents because they were not qualified and did not have sufficient staff.
- The signatures and received and distribution stamps and any further comments were to be incorporated as the documents went through the process in the project at every stage.
- Top management insisted that hard copies of all incoming and outgoing documents be maintained for the project. This included the official receipt of outgoing documents by those receiving it and official submittal and receipt of incoming documents.
- Hard copies were considered the “legal” document. Any discrepancies were to be compared or based on the contents of the hard copy. This may be due to legal issues of using electronic formats of documents.

The fifth reason in not using Expedition by some parties was that they had their own systems. A case in point is the main consultant and the sub-consultants who used another system called Project Web. This system was developed by the main consultant in their main headquarters in Canada. It was used during the design phase by the main consultant and all the sub-consultants for the transfer of design information on a global basis where some sub-consultants were located in other countries. The system was found suitable for the consultant teams' requirements. This system was maintained throughout the construction phase by the consultant teams. The main consultant refused to use Expedition as the main system in the transfer of information or documents since it was not suitable for their requirements and there was too much on their system to be transferred. Additionally, they would not be connected to their headquarters as well as other locations. The two systems were incompatible. It was therefore agreed that the main consultant would give limited access from Project Web to Document Control of client and construction management team. Off course, the client and construction management team gave the consultant teams access to Expedition. Any transfer of information or document had to be performed mainly between the two systems, Project Web and Expedition. This task was given to the documents controllers of both the client and construction management team and the main consultant.

The sixth reason follows from the above, as the main consultant was just one case. Document, or information management systems, whether developed internally to an organization, or bought from the market, is incompatible. They do not speak to each other as stated during some interviews. This caused several problems to the project. First, the staff of an organization that uses one system will need training to use another system. Second, even if they are trained on a new system, they still use their organization system to perform their work and any transfer of information will have to be done manually. This may be an area for further research.

Additionally, there were limitations to the use of Expedition in the project. These limitations were both hardware problems and problems with the software. The hardware problems consisted of the following:

o The system could not handle the number of people that were connected to the system. It slowed the system considerably to the extent that some stated that finding the paper from files was faster.

- The internet connection was not a land connection and was not as efficient as a land connection. Large files could not be sent and received efficiently.

Some contractors who were sending and receiving large files did so by using fttp between them and their sub-contractors, particularly those performing design related works, such as RCC steel detailing.

Expedition was used as document control also for other reasons. One of them is the fact that documents should not be changed. This was a main issue in the project and that’s why everything was transformed to PDF format. The reasons were:

- How do you control changes that may be made in the system?
- How do you track who made the changes in the documents?
- How do you know which is the correct information if anyone can change it?

These ultimately caused the management to use the system solely as an elaborate document control system.

7.2.2 Project 2

Communication

The communication in Project 2 was described as good and effective. They generally stated the reasons as follows:-

- Good management practice.
- Everyone is there to complete the work.
- The quality of staff in the project.
- The open door policy of all parties, and particularly the project management firm.
- The quality of the parties, particularly the client, involved and the willingness to resolve problems.

There was no mention of the information or document management system for the project as a whole because there was none. However, the main consultant and main contractors who did have these systems did not mention them as a reason for their success or for effective communication.

Again, the above supports the perception of the staff of all parties that construction is people based. It is further substantiated by the reliance of the project management team on meetings with all parties for planning, coordination, etc. This again reinforces the belief that people are the driving force in construction projects.

Again, this is supported by the responses where the vast majority (about 85 %) of those interviewed from all parties stated that face to face communication is the most effective means of communication. The next preferred method of communication was by phone between people. Again, this was followed by e-mails. There was no information or document management system for the project as a whole, but the main consultant and main contractors' staff where there was an information or document management system, chose it last.

The only formal (i.e. legal) communication and information transfer accepted is paper based, signed and stamped as received. This includes meetings which were minuted. All other communication methods were not contractual or "legally" recognized. However, these informal communication methods and information transfer were heavily used. In fact, these were the preferred methods of communication and information transfer as indicated by the vast majority of respondents.

Information Management

Project 2 did not have any electronic information or document control management system. The project management team ran the project the old fashion way, paperwork. This was evident in the sectaries' area, and who doubled as document controllers, where these areas were always piled with incoming and outgoing documents. The only system they used was software which was developed in house. This software was simply a log of incoming and outgoing documents.

The project management team had attempted to get ACONEX, an information or document control system available in the market to be used in the project for all parties to use. The ACONEX team had come to site and actually trained some of the project management team staff on it. However, the project management team decided otherwise. Two reasons were stated for this change of heart. The reasons were:

- The project had already started and introducing the ACONEX system at that point was decided to be counterproductive.
- The contracts made with the parties involved in the project were based on hard copies to be the sole officially accepted documents.

The project management team was vastly in favour of using such a system in future projects. This was provided the system is in place before the start of the project and that any document transfers through the system are to be considered official or contractual.

Although there was no information or document management system in place to be used by all the parties involved in the project, some of the parties used their own electronic systems. The main consultant had an electronic system called Lotus used by the main consultant staff only. The sub-consultants did not have access to this system. This system was developed in house by the main consultant in the US. The system was used by staff largely for emails and chatting with the headquarters in the US. The system did not have any documents. It seems that all projects maintained a document log that was placed on the system. The staff could access the log but could not access the documents listed in the log. It was used mainly for follow up of the project by management. Other things placed on the system were the progress photos and summaries of what is going on in each of the projects. The sub-consultants did not have any electronic system in place except for a local area network with the common software such as Microsoft and AutoCad. The main consultant staffs were largely satisfied with this system and any electronic transfers were done by email amongst themselves and with external parties. The sub-consultants similarly used email to transfer any electronic information. But the electronic transfers were considered informal and unofficial.

The main contractors also had their own electronic systems. Unlike the electronic system of the main consultant, their electronic systems were information or document management systems. The main systems that were used were called ACONEX and Project Wise which were available in the market. These systems were used only by the main contractors. The transfer of information with the sub-contractors was not done through the electronic system. It was done through data storage media handed over by hand with official hard copies as the official document.

The document control of the main contractors was divided into two parts. The first document control was close to the Project Director and were largely dealing and controlling the correspondence that was coming and going. This was largely done by the Project Director’s secretary. The other document control, and the larger of them, was under the “Technical Office” or the department that dealt with all the drawings, submittals, etc. The “Technical Office” or the design departments were sizeable in terms of staff and the equipment provided to them. They were largely concerned with all pre-site construction activities including shop drawing preparation, material submittals, method statements, etc. The Project Directors were largely not involved in these activities and just ensured that everything ran smoothly and in a timely manner. The heads of these technical departments were largely left to do their work and control their documents, which were vast and much larger than the incoming and outgoing correspondence. This was the case in two of the main contractors interviewed. The one contractor who was using ACONEX had someone operate the system. This person was incorporated as a staff member of the contractor but actually was provided by the ACONEX organization.

7.3 Importance of communication in the case study projects

The importance of communication in construction projects is recognized by respondents in both case study projects. Statements that communication was vital in any venture, and particularly construction, were made. The following sample statements were made by respondents in both projects:

I think communication is obviously one of the major success or failure factors in anything, but in particular a project like this, cause as I said earlier this is not a *factory process where we do a 100 a day and we gradually improve. We do it once and then we leave. And then we go on and do it again somewhere else with a different team.* ***Work Package Manager-Project 1***

Communication. Any success of any project or anything that you do, if you have proper communication, it will be a success. If you have a poor communication, nothing will be done. ***Resident Engineer-Project 2***

This reflects the understanding of the staff in the case study projects as to the importance of good communication and information management. It also reflects the significance that is placed on communication. Communication is made through various channels (modes), which should be considered, analyzed and conclusions drawn. The following section analyzes communication modes in the case study projects.

7.4 Modes of communication

There were several methods of communication stated by the respondents in both projects. These were face-to-face, meetings, email, correspondence and phone. Project 2 did not have an electronic information management system, which Project 1 had. Therefore, all responses regarding IMSs were made only by the respondents in Project 1. Points of view regarding the possible effects of IMSs were made by respondents in Project 2 but were excluded from this particular part. The following section provides statements to the various methods of communications used in both Projects 1 and 2.

7.4.1 Face-to-face

In both projects the responses were overwhelmingly in favour of face-to-face communication. It was perceived to be the best way of communicating and the most effective. This was considered one of the informal types of communication and was the method of choice for “resolving” problems.

7.4.2 Meetings

Meetings were considered an important part of communication. They were perceived as an important coordinating method between the parties. There are also ad hoc meetings for resolving problems. Although it was generally perceived as consuming time, it was also stated as necessary. Some of these meetings were regularly scheduled and minuted. These minutes of meeting were considered "official" documents. The ad hoc meetings were generally not minuted and were considered "unofficial".

Others perceived the meetings as a waste of time. They viewed meetings as an "old-fashion" communication method, although they stated that some meetings were important to attend. They perceived that meetings were a waste of time to listen to someone else's problems and that other communication methods would be more effective.

7.4.3 Email

Emails were used extensively in the projects. However, it was viewed as having the ability to create problems. Emails had to be managed and not all messages were necessary. It was viewed as an "unofficial" method of communicating and despite that was considered an important method of communication. Additionally, in both projects emails were not recognized as official.

7.4.4 Correspondence

Correspondence by hard copy was the officially accepted documents and communication method in both projects, despite Project 1 using an electronic database. However, in Project 1 RFIs were not considered an officially recognized form of documentation despite the fact that it went through the "official" process. Despite this fact, RFIs were considered important and essential by the contractors. It seems that the written document produced was "psychologically" important, despite their knowledge that it did not carry any weight contractually. This was mainly due to the level of control required where the responses to RFIs by consultant may cause a variation.

The type of documents that were included in the officially recognized information system included shop drawings, material submittals, minutes of meetings, inspection requests, non-conformance reports, change orders, variations, etc. Electronic copies were not considered official. Only the hard copies were considered official.

7.4.5 Phone

The telephone, particularly cell phone, was considered an important method of communication. The cell phone was considered critical because it provided mobility to the staff. Anyone could call from site to request information or advise information to anyone immediately. Again, this is considered an “unofficial” form of communication.

7.4.6 IMS

Project 1 had an electronic database, which was considered as the “officially recognized” document database for the project. However, the information posted as an electronic copy was not recognized officially. The only recognized documents were official hard copies (i.e. copies stamped and signed as received).

Additionally, there were 2 electronic systems as mentioned previously. One was used exclusively by the main consultant and the subconsultants. The other was used by all those involved in the project and authorized to use the electronic database.

7.5 Cross-case analysis of communication channels in case study projects

The case study projects used the same methods with the exception of the Electronic IMS, which the project management firm in Project 2 did not use. The following Table 7-1 summarizes the communication channels in both case study projects and differentiates between the formal and informal channels.

Table 7-1 Summary of communication channels in case study projects

Communication mode	Formal?		Remarks
	Project 1	Project 2	
Correspondence	Formal	Formal	The only formal communications in both projects are documents. In Project 1 RFIs were not recognized contractually despite these documents going through formal process.
Meetings	Informal	Informal	Only minuted meetings considered formal
Phone	Informal	Informal	
Face-to-face	Informal	Informal	
Email	Informal	Informal	
EIMS	Formal	Not used	Electronic copies not considered formal in Project 1. Parties using EIMSs in Project 2 was considered informal by contract

From the above table it is noticed that the majority of communication modes are informal. Of all the informal modes of communication face-to-face communication is the preferred method of communication and the most used. This is confirmed by Tai et al. (2009) who state that 55% of all communication in large Chinese construction projects was face-to-face with 26% for letters. There was only one channel that was considered formal and that was documents. Even then RFIs were not recognized contractually in Project 1. The following section analyzes the effectiveness and use of communication modes in the case study projects.

7.5.1 Effectiveness of and the need for different types of communication

During the interviews the interviewee attempted to capture the perceptions of respondents as to which method was found to be most effective. The vast majority of respondents perceived that informal methods, and particularly, face-to-face communication was the most effective. However, there was recognition that various methods of communication were complementary to each other. It was added that each had its use. This is in line with statements that both formal and informal communication methods were a necessity.

From statements made by respondents in the case study projects it is found that face-to-face communication is largely used to resolve problems and come up with solutions. So if there is urgency the communication method of choice is face-to-face. This is in line with other statements and the general literature that construction projects are wrought with problems.

Emails are largely used for communication that needs to be made with an explanation, be it for exploring options or for reporting on an issue. This was the choice of communication for a “trackable feel” despite the fact that it was known to be unofficial. It was also used for mass distribution to many people. However, since email is instantaneous and worldwide there are disadvantages to it, and again, it relies on the individual.

Meetings were used for coordination purposes and follow up. Meetings were many times ad hoc and informal and were seen as the communication of choice for coordination purposes. It was also the communication method for formal coordination and planning. There were always scheduled meetings for planning, coordination and follow up in both projects.

Phones, particularly cell phones, were used a lot in the case study projects. The cell phone provided staff the mobility required to move around the site but still remain in contact with anyone. For day to day construction operations and for solving things in process the cell phone was a good form of communication.

Electronic databases are used largely for historical record. This is a record of all the formal communication that has gone through the formal “official” process. This was used in Project 1 but not in Project 2. However, the results for both projects regarding communication were similar. Despite statements that there is a place in the information management system for electronic databases, the reliance was not only on the electronic IMS, it was on the human aspect. Therefore, the electronic IMS in Project 1 was used as one of the communication methods with a “larger memory”.

The need for different types of communication methods is highlighted in the following statements:

I think they all have their place, to tell you the truth. There’s a subtle thing. I mean everybody talks what’s this email, how to get this email and etiquette that and what’s texting etiquette and not texting etiquette, but I think in a construction project it’s *pretty much driven by the urgency of the problem and whether its stopping other work from being done, or if it's a contractual issue as opposed to a, you know, a commercial or financial issue as opposed to a field construction issue.* ***Consultant Engineer-Project 1***

Ways of communications depends on the type of situations we have. …. because our job, more or less, is related to sorting out problems. So depending on the type of the situation we have, this situation could be resolved in different ways. ***Resident Engineer-Project 2***

It's all effective actually. But each case has special circumstances ***Work Package Manager-Project 1***

From the above discussion and analysis the method of communication relied on several issues. These are:

- The situation that is at hand to be resolved
- The location of the problem to be resolved
- The urgency of the situation at hand
- The number of people and parties involved to resolve an issue
- The individual's preference of mode of communication

The following Table 7-2 provides a summary of the mode of communication and when each is used and its advantages and disadvantages as compiled from the data of the case study projects. It is noted that most communication methods are not recognized as the formal "official" contractually recognized process. Much of the communication was done outside of the "official" process, which are the informal methods or processes. Although informal processes are recognized in the literature, the amount of informal communication was surprising. Formal and informal processes for the project case studies shall be analyzed and discussed in the following sub-section.

7.5.2 Formal and informal communication in the case study projects

From the various statements and modes of communication in both projects there is a need to recognize that there are two types of communication. The first is the officially recognized formal modes of communication through the official process. In both case study projects the official documents were hard copy signed and stamped. The "official" process established by the client or client representative will be referred to as the "formal" communication process in the case study projects.

The second type of communication is anything outside of the officially recognized process of communication. This type of communication is not "officially" recognized. However, this type of communication played a major role in making the case study projects achieve success. This type of communication will be referred to as "informal" communication in the case study projects. This section shall analyze and discuss the formal and informal communication process in the case studies.

Formal communication

The formal communication in both projects was hard copies through the official channels of correspondence. This included meetings attended by all parties and minuted. Each project had a recognized process for document management as seen from documents collected from both case study projects. This shall be described in Chapter Eight. Following is a statement from each of the projects to the effect of formal and informal communication modes as perceived by respondents:

The contractual information is still hard copy. So, we have a document control department, they have a document control department, and it's like most projects in the world, yeah. ***Contractor Project Leader-Project 1***

On a project this size, if you don't maintain some sort of recorded dialogue, then very quickly things can get lost or misinterpreted. ***Senior Project Manager-Project 2***

Table 7-2 Modes, use and effectiveness of communication modes

Communication mode	Use of communication mode	Advantages	Disadvantages
Correspondence	o To establish historical records and fulfil contractual obligations o To maintain control	o Documents establish rights and obligations o Historical records of project established	o Slow o Always a gap between information required and provided o Does not allow small pieces of information to be passed on o Inability to handle task interdependency
Cell phone	Provides mobile communication	o Ability to resolve ongoing problems immediately o May initiate resolution to problems on site	Limited to verbal understandings
Meetings	o Coordination o Follow-up o Formal coordination and planning	o May resolve issues o May maintain coordination efforts o May provide a good control medium as participants provide their points of views o May highlight problems to come	o Larger meetings may not result in resolutions o Easy for participants to "stick" to their positions o Participants may become defensive if "criticized" o Takes valuable time from staff o No records for informal meetings and misunderstandings may develop
Face-to-face	o To resolve problems o To reflect on ideas o To transfer information o To negotiate	o Ability to use all of the senses o Resolve problems before it is contractual o May convince others of different point of view before getting engrained in a position	o May stop ideas from developing prematurely o Misunderstandings are possible if each understands statements differently
Email	o Explore options o Reporting on issues o Passing information	o Provides a traceable "feel" o Is instant o Can attach documents for clarifications	o Is instant and may cause misunderstandings o May become "stuck" in response and counter response without resolution o Keeps people "glued" to their seats and not use other communication modes
Electronic IMS	Same as correspondence	o Same as correspondence o Ability for anyone to view records	Same as correspondence

Types of formal correspondence

Since documents are the "officially" recognized mode of communication, it is important to review the types of correspondence in the case study projects. This review highlights the division of the formal documents in both case study projects. Not all types of correspondence were of concern to the project managers, leaders and directors as the case may be. In both projects there were three general types of correspondence. These are described in the following sub-sections.

Correspondence of a contractual nature

The first part is correspondence of a contractual nature, which was any letters to and from the various parties. This included anything affecting cost and time such as change orders, variations and claims. This was dealt with by top management through the Project Leader or Project Director as the case may be. There were recognized signatories for official letters from all parties. This is described in the following statements from respondents in each of the case study projects.

Whenever the email is the right form of communication, it's that, and very, very rarely, a letter. I mean all the letters that go out are under my signature, but very, very, very few of them are mine. Most of them are non controversial. ***Project Leader-Project 1***

But between (project management firm) and us the main communication is between the project manager, senior project manager and the senior resident engineer. If there is any official thing it will go through letters, but all the submittals from the contractor it will go through (project management firm) to (consultant) and then from (consultant) to (project management firm) to the contractor. So (project management firm) job is to control all the in and out transmittals. ***Project Director-Project 2***

Correspondence of a technical nature

The second part is correspondence of a technical nature, which included submittals, Requests for Information (RFIs), etc. This was left largely to the technical staff. In Project 1, this was left largely to the relevant Work Package Manager (WPM). In Project 2, this was largely left to the Senior Project Manager (SPM) of each area who in turn left it to the project manager and coordinator. Following are statements from both projects:

It's been pretty effective. With the … with the package manager being the gatekeeper of all, ummm, shop drawings … ***Project Coordinator-Project 1***

Well there's one thing that I personally do is I do not have … I don't want to see, physically, technical solutions on the way in or the way out. Those go directly to the people who are dealing with it. ***Project Director-Project 2***

Correspondence of a quality control nature

The third part is the inspections, safety and quality control, which was left largely between the consultant and the contractor. Copies of the inspections and outcomes were sent to the relevant managers (i.e. WPMs in Project 1 and SPMs in Project 2). However, Project 1 did have a QA/QC Department that was active and themselves were involved in quality control and quality assurance and did perform inspections and issued non-conformance reports and followed quality and safety related issues. The following statements describe this:

The only thing that we don't manage is the Work Inspection Requests. They go straight to the consultants so that they can be … so they can be done on the day. ***QA/QC Manager-Project 1***

Then to the contractor, except for the inspections because there's so many, and there's no point to go to (project management firm). It is issued directly from the contractor to the consultant, for also having front response. ***Senior Project Manager-Project 2***

From the data gathered from both case study projects it was found that formal communication is important. The following sub-section provides the analysis of the importance of formal communication as perceived by the respondents.

The importance of formal communication

The importance of a formal means of communications was evident in both projects. It was not the "preferred" method of communication, but nevertheless was considered a necessary "evil". The need for a history of communication was regarded a necessity to track the history of the project. It was also regarded as necessary for the control of the project. Following are some statements made by respondents in both case study projects:

the correspondence or the forms are, because you allocate number, you set the time for review, this is very, very effective in regards to controlling the flow of documents from Consultant to (project management firm) to the Contractor. It's very important to control. And this is the only way that you can do it. I mean it could be a disadvantage which takes time. ***Senior Resident Engineer-Project 2***

On a project this size, if you don't maintain some sort of recorded dialogue, then very quickly things can get lost or misinterpreted. ***Contractor Project Leader-Project 1***

The majority of responses indicated that there are problems with formal communication which are discussed in teh following sub-section.

Problems with formal communication

Based on the above statements, and the following ones, the problem with formal communication is that it takes time. Information that changes takes time to reach those needing it creating a gap that may result in errors and changes that may not be provided in time for site works to be modified. These comments are made from respondents on both projects. This is despite the fact that Project 1 had an electronic database.

Formal … that's that side of it. The other side of it is yes there's a huge amount of documentation that has to be properly transmitted from party to party and I don't think we've done that particularly well. ***Project Leader-Project 1***

The only problem with information flow is this many steps for basically this information and to reach the contractor it takes time. ***Consultant Engineer-Project 2***

The results of the slow flow of information through the formal process are that some information is late in arriving and results in problems. These problems manifest themselves in the form of performing work with old information, which then results in change and rework according to new information. Other times the problem is the information is unavailable and a decision is made to work according to what is thought best at the time in order not to delay the work. When information becomes available it is either redesigned or reworked. In both cases there is another iteration of information flow.

So at the end of the day there is something that when you need the information it's too late now because that information had to go to document control to be signed by someone. So by the time you get it it's too late and that's, that is the big problem because sometimes you need to, to finish something right away; you're waiting for confirmation on a sketch or specification, whatever, and you don't get it because it has to go through the system. And sometimes there are people that don't wait and they do it, whatever they think they could, and its wrong; sometimes it's right sometimes it's wrong. I think bureaucracy is our big enemy but unfortunately that's part of the system here. Its part of it, there's no way around it. ***Consultant Engineer-Project 1***

That afternoon as the concrete was being organized; a change from the lead architect came through, issued to us, which changed the beam on the slab that was ready to pour. It had been in (construction management team) for 3 or 4 days under review. They weren't as in touch with our concrete program as perhaps they should've been. So, it sat with somebody for 3 or 4 days before it came through to us. ***Contractor Coordinator-Project 1***

Another problem with the formal process of communication is the number of times that the document or information has to go through the same loop. This is exacerbated by the time it takes for a document to go through each loop. This causes the information to be delayed as at times approval is not granted, and thereby the necessity to repeat the loop. Following are statements to this effect from respondents in both case study projects:

Oh, damned it, to get the actual framework wall through (consultant), it must've been 8 or 9 rounds. The detailing and the fireproofing and what materials and submittals, you know; really that was the big thing. That was the big … it took a lot of my time, it took a considerable amount of WPM's time. ***Contractor Project Leader-Project 1***

There were attempts in both projects to reduce the time for documents to go through the formal process. This did alleviate some of the perceived impact of the slow formal communication process. However, it did not resolve the requirement for faster information flow as the following statement describes.

It doesn't take you usually more than …. we usually receive on the same day. In the beginning always until we make the procedure and everybody's on track and we have sufficient document controllers, it was taking some more time. But now I believe we have enough people, and they are already trained well with the procedures. We are trying from our sides to also shorten time. ***Senior Resident Engineer-Project 2***

An additional problem with the formal communication process is the requirement in both projects that the documents are to be handled by top management. This may be a necessity to maintain control over the information but at the same time it means that the documents have to pass vertically within each organization from bottom up and then top to bottom in the receiving organization. This means that the distance the documents travel is longer than going horizontally.

…. because communication procedure takes time, because you take it from lower level to the top management, to top management of Contractor, to top management of Client and down to my management, down to my engineer; it takes time. ***Contractor Project Leader-Project 1***

The official documents submitted are usually done with "all" information on them. If anyone is relying on a piece of information from all the information that is to be supplied on a document, it will be delayed on account of waiting for the full document to arrive via the formal process. The following statements describe this:

Or in certain instances if the drawing just doesn't stack up, something's wrong, ummm, been missed or … (consultant) will often update the drawing there and there so there aren't …. It should've read instead of ten of those it should've read a hundred, ummm, sign the drawing, give it back to that guy. He will give it straight to him, and he will go back through the system again as a recorded document, but at the same time they talk to the detailers and advise them, umm, of what changes whilst this formal process takes place. ***Work Package Manager-Project 1***

The above statement indicates a place for informal communication which is discussed in the following sub-section.

7.5.3 Informal communication

Informal communication included any “unofficial” transfer of information. This included verbal communication, “unofficial” meetings, emails, and phone communication. In the case of Project 1 even RFIs were considered informal. Informal communication and information transfer was unanimously perceived to be the best way to speed up the formal process. It even meant “bypassing” the formal communication process. It was therefore regarded as high in importance. Following are statements made by respondents from both case study projects:

In other projects he had asked the IT people to disable his email because he wanted people to speak to him directly……… He believes the information system doesn’t work. ***Contracts Manager-Project 1***

There’s formal and informal communication. One thing that pleases me a lot is the fact that we get very, very few letters in and out. I deal with all the principal – for the hotel we have about 30 contractors, and suppliers, what have you – all the correspondence that comes in and out through me and I’m probably not dealing with more than 10 to 20 letters per day, sometimes less, hardly ever more. Now to me that’s a very good reflection of communication. ***Project Leader-Project 1***

Types of informal communication

Informal communication was anything that was not considered as “official”. This included face-to-face communication, email, “unofficial” meetings, and the electronic system. In essence anything that was not in hard copy, signed and stamped as received. Their importance was clearly stated by the respondents in addition to the fact that informal modes of communication were more than the formal modes and was more “open”.

7.5.4 The importance of informal communication

The importance of informal communication was stated clearly by respondents. Why it was perceived as important needs to be investigated. This would shed light on its effect on the project. The essence is that a lot of time is saved and the iterative cycle of information is reduced to a minimum.

But there's communication through that whole process so … It looks like a pretty painful route but it actually hasn't been. Ummmm, because that guy can talk to that guy, … (pointing to lower level staff across organization charts sketched). ***Contractor Project Leader-Project 1***

The result of informal communication is that the iterative nature of information is reduced. A lot of the unnecessary iterations within the formal process are cut down considerably. The individuals communicated informally and directly with the person who would make a decision. That means that the preparatory work is completed unofficially and agreed upon. Therefore, instead of taking two or more iterations through the formal communication process, it was agreed unofficially and then sent for approval once through the formal communication process. This ultimately means less iteration of information and reduced time through the formal process.

very effective because you're talking to the person that is directly responsible for the completion of that building. Ummmm. My engineers and my site based senior staff talk directly to the individual inside the (construction management team) team who's also responsible for the delivery of that building. So you could talk real specifics and you won't send all the way through the consultant and all the way round and back round again. You can go directly to the person on the client's team who's responsible for the delivery of that building and my engineer could talk to his engineer and mine site based staff could talk to his site based staff; it's very effective, pretty good model. ***Contractor Project Coordinator-Project 1***

Additionally, it means that even those who are approving the documents would not require a long review time because it has previously been reviewed. This further cut the time of movement of information. Moreover, the document, despite being “unofficial” could be acted on prior to waiting for “official” approval. This ultimately reduces rework that would have been required otherwise.

If something’s coming on paper work they talk to me in advance. So, I guess, there’s something about not being blind sighted by the paper work, alright. Usually by the time the paper work comes to me, I know what the question is, I know what the issue is, and probably I have idea how it’s going to be solved. And I’ve done that with the package manager and with the contractor so when the paper comes maybe 8 times out of 10 that’s just a matter of me putting the answer down on the paper because I’ve done the hard work. … so what happens in the end is that the problem gets solved by voice, cell phone and sometimes by email or just being face-to-face. And then when the paper work comes, it’s just a matter of making sure its all on record. That to me is a good working relationship, and that’s the good part of the project. ***Consultant Engineer-Project 1***

We might have been advised verbally that the window schedules for a particular building was wrong and that the windows in that building needed to be a 100 mm wider, the windows we were forming. There was no drawing in place. There was no instruction in place but we had been advised verbally that it needs to be a 100 mm wider, and so we built it. Ummm, the drawing or the instruction or whatever carried the documentation for that change then comes through the system at a later date. Ummm, but then we’ve done the work and there is no unnecessary rework and no time for anyone. And in general that’s worked quite well. ***Contractor Project Leader-Project 1***

Some stated that the informal process adds some leniency to resolving issues. It gives an opportunity to convince the other person to take a decision that is “more reasonable” for those concerned. It is viewed that a decision made formally gets people entrenched in their positions and is more difficult to resolve.

what I find with a lot of this and obviously once a decision is made on something you need to, you need to record it and it’s usually recorded in a drawing or one of these instructions or something like that. In fact, if you sit down and talk and deal with them verbally, with small groups, I find that people don’t get so entrenched in a position *that it makes it difficult sometimes to come up with a best decision. People can get stubborn very easily, and once you have it in writing there's no more I told you that's the way it has to be. So I like to keep things fairly loose and fluid, I think you can reach a resolution quicker that way, instead of having people send letters, and ….* ***Construction Manager-Project 1***

He stated that he didn't have any problems when changes occurred because the communication was good. He added that any informal agreements were followed up by formal procedures and paperwork. ***Resident Engineer-Project 2***

Informal communication resulted in the ability to react faster to urgencies. It allowed any changes to be made in a short time. It was then followed up by official documentation. This was seen as the preferred route to take when an urgent situation arose. The ability to "use" the informal route actually stopped the project from being delayed as the example provided by one of the respondents shows.

The change ….. change needs to be managed in two ways. It needs to be managed operationally and it needs to be managed commercially, all rights. So change operationally, and depending on the timing of it, it's on one or the other end of a spectrum. It's either in good time and you've got time to stop the works out on site and you haven't progressed so far. So it means you've got time to put that on hold, put the drawings back into the machine, spits out a new drawing, give it then to the guys and they can go work on that and everything's fine. That's the one end of the spectrum. The other end of the spectrum is you're about to pour concrete and so Client comes along and says I don't like that slab there, take it out. We've had that here. We were about to pour concrete in one of the slabs in Tower one and he decided he wants some kind of dome that was gonna come up off one of the floors, and the dome would have poked its head through the slab. So the slab had to go, all right? So we're in a situation where we're about to pour concrete and we get told, no there is a change for it, stop, stop, stop, stop, and you just deal with it. You don't pour the concrete, you remove the rebar and the steel, you remove decking, you remove the false work, you remove all the equipment, you get back to ground zero, if you like, and then you put in the new piece. How that's recorded is down to the commercial department who sit next door. They go out. They record what we've got in place; they *photographic it. We write a letter to the client and say we were here, you said go there, this is the cost of removing this equipment, taking it out, clearing the decks, and putting up the new requirement. And we submit our application to be paid for, and most of the time they just pay it.* ***Contracor Project Leader-Project 1***

However, informal communication was stated as having its own problems which are discussed in the following sub-section.

7.5.5 Problems with informal communication

There are problems with informal communication that were stated by the respondents in both projects. These problems were in the fact that informal communication was not officially documented and could result in lost information or could easily spiral into an uncontrollable situation where information is lost. This was complemented by the formal process that was controlling the information. The following statements highlight this point:

the correspondence or the forms are, because you allocate number, you set the time for review, this is very, very effective in regards to controlling the flow of documents from Consultant to (project management firm) to the Contractor. It's very important to control. And this is the only way that you can do it. I mean it could be a disadvantage which takes time. Because from Contractor as I said to the Client, it takes time because procedure takes time. If every party they have their own log, they have their own secretarial work to control the documents entry and out. And this the disadvantage, it takes time. That's why we always encourage people to sit together informally to try to finalize what ever they can… ***Senior Resident Engineer-Project 2***

On a project this size, if you don't maintain some sort of recorded dialogue, then very quickly things can get lost or misinterpreted. I don't believe in meetings for the sake of meeting. It's very important to meet, discuss and then record what was discussed. Lots of people will sit down and not take notes, and not produce minutes. I don't believe it's worth sitting down if you don't write something down afterwards. And that's been going quite well. The minutes for meetings are issued as formal documents. ***Contractor Project Leader-Project 1***

Informal communication can sometimes be very chaotic and result in a problem. Following is a statement to that effect:

I think it's a danger these days, email. Email is an instant world wide communication and one of the dangers with email is that it can be done so thoughtlessly and so quickly and to the wrong people in the wrong places, if it's not handled properly,… So, e-mail's a huge advantage, but they're also a huge advantage if they're used wrongly. … So, that's very much a two edged sword. ***Project Leader-Project 1***

Informal communication is linked directly to human nature, and thereby, it is governed by individuals. Each individual has different perceptions and views and this is an added complexity.

Part of that, my personal perspective is part of that has to do with some of the personalities over there and the balance they've got between the site guys and the office guys.…… This is my own personal opinion, I get the impression a lot of their people are much happier to sit at a desk and fix a problem here when they can go to site and fix the problem in situ where it is and both of those have equal value in my mind. ….. I think the site guys don't want to get trapped in office work and I think the office guys perhaps don't want to go to site and get sweaty. ***Contractor Project Leader-Project 1***

… so I think we have got great professionals at all levels here and then it just becomes human social interaction of some people. We have certain ways of managing people and information, others have other ways and we're all … you learn how you fit it together and work as a team. ***Consultant Engineer-Project 1***

7.5.6 Summary of formal and informal communication

The advantages and disadvantages of the formal and informal communication routes and when each is used based on the data from the case study projects are summarized in the following Table 7-3. From the majority of responses it was stated that both formal and informal communication are important. Furthermore, it was found that both types of communication were complementary. The disadvantage of one was an advantage of the other as can be seen in Table 7-3.

Table 7-3 Advantages and disadvantages of formal and informal communication routes

Communication route	Advantages	Disadvantages	When used
Formal	o Provides a historical record of the project o Provides control for the project o Provides contractually obligatory process	o Slow movement of information o Many steps for transmission of documents o Gap between information required and available may cause errors and changes o Cannot react quickly to urgent situations o Is not able to handle iterations, particularly in approvals of submittals and changes o Information exchange is vertical and horizontal only at top between parties which makes distance documents travel long o Small pieces of information is not provided (i.e. only completed submittals go through official formal process	o When historical record is required o When contractual obligations are to be filled o When approvals are required o When there is no urgency for information o When there is no requirement for transfer of small pieces of information o When there is no interdependency with other tasks o When uncertainty is low
Informal	o Very fast process o Iterations of information reduced o Transfer of small pieces of information o Horizontal communication reduces time for information transfer o Communicate directly with those concerned and decision makers o Reduces review time because discussions result in understandings and decisions made o May allow action based on informal agreements o Reduces the preparation time for submittals o Provides leniency to resolution of problems before formalization and getting "entrenched" in position o Provides opportunity for negotiation and convincing of different viewpoint o React to urgencies quickly o No boundaries in place o Participants establish a system that works for their needs	o Usually not recorded o Not contractually recognized o Information may be lost o May cause misunderstandings o Is "chaotic" in nature o Governed by individuals and subject to various perspectives o Is not well established (i.e. it is based on how individuals find suitable) o Requires trustworthiness to be established	o When urgency is required to resolve a problem o When small pieces of information is required o When interdependency between tasks exists and requires communication between those concerned o When uncertainty of information is present and requires communication to reduce uncertainty o When reduction of iterations of information is required o When preparation time of works is required to be reduced (e.g. submittals)

7.6 Summary of communication methods

This section has provided the communication and information flow modes and processes in the case study projects. This analysis was guided by the questions stated in Section 6.1. The summary of findings is in Table 7-4 below.

Table 7-4 Summary of findings from Chapter 7

No.	Finding
1	Most communication modes are informal.
2	Various communication modes are effective in different situations.
3	The formal process is slow and cannot react quickly to the uncertainty and interdependence of tasks. Additionally, it leaves gaps because small pieces of information required cannot be supplied in time. However, it is good for historical record and control.
4	The informal process is fast and can handle uncertainty and interdependence of tasks. It also allows fro small pieces of information to be passed on quickly. It also allows for minimization of information iterations through the formal process. However, it has a bad memory and is “chaotic”.
5	There is a place for both processes and they are complementary to each other.
6	Formal process controlled by client. Informal process controlled by individuals.

It established that in the case study projects there are several modes of communication used, most of which were considered informal. The informal and formal methods of communication in the case studies have been recognized and the advantages and disadvantages of each analyzed. Additionally, it is found that the formal and informal processes are complementary and each has its place. The following chapter analyzes and discusses top management support, which is the second CSF that was a result of the analysis in Chapter Five. This chapter provides a basis for the following chapter, particularly as relates to the differentiation between the formal and informal modes of communication.

7.7 Summary

This chapter provided the analysis of the first most crucial CSFs from the exercise performed in Chapter Six to develop conclusions and findings towards achieving the research objectives. This analysis was guided by the questions stated in Section 6.1. The chapter provided a background of communication and information management in the case study projects.

The importance of communication and the modes of communication from analysis of the data were presented. A cross-case analysis of communication modes in the case study projects was presented showing that most channels of communication were informal. The effectiveness of each type of communication and the need for them are analyzed and discussed. It was established that the various communication methods were effective in certain situations and were complementary to each other.

Formal and informal communication in the case study projects were analyzed and presented showing the uses of the various communication modes as well as advantages and disadvantages of each. Furthermore, the definitions of formal and informal communication as perceived by the informants are presented. The importance and problems of formal and informal communication in the case study projects were analyzed and presented showing the advantages and disadvantages of each as well as when each was used. This showed both formal and informal processes to be complementary. The following chapter discusses top management support and the effect on communication and information management.

CHAPTER 8 TOP MANAGEMENT SUPPORT IN CASE STUDY PROJECTS

8.1 Introduction

Top management support was concluded to be one of the most critical CSFs in the case study projects from Chapter Five. This chapter shall analyze and discuss top management support guided by the following questions, which are restated from Section 5.1:

- What were the descriptions of top management for each of the main parties in the case study projects?
- How did each of the main parties contribute to the projects and who was crucial?
- Why was top management support perceived by respondents as important, particularly the client?

The chapter shall initially discuss the descriptions provided by respondents of each of the main parties to the case study projects. These descriptions shall be further discussed and analyzed to provide conclusions as to the most important party, the characteristics perceived by respondents as crucial and how they perceived it to be constructive to achievement of project objectives.

8.2 Characteristics of various parties in case projects

It may be worthwhile to get an overview of the descriptions of the main parties in the project organization. This may shed light on why the project was run in the manner it was and achieved the level of success achieved as perceived by informants. The client role in establishing the clear objectives of the project and his proactive role and quick decision making has been cited as one of the main reasons behind the successes in both case study projects.

8.2.1 Characteristics of the Client

The client was described by several of the respondents in both case study projects similarly, in the terms that follow with some respondent quotations for a few of the descriptions. Each description will be discussed briefly. This may provide the role of client and his effect in the project.

Client knows what he wants

The clients in both case study projects were characterized as knowing what they want. The representation of the client and their experience and knowledge seemed to play a major role in this characterization. The client representatives guided the implementation of the project strategy and had knowledge of construction to do that. The consultant staff stated that the client side was well represented during the design. Others stated that they enjoyed working with the client since he seemed interested in completing the project and knew what he wanted. It was added by a WPM in Project 1 that with a “weaker client you lose site of that”. The client was very visible in both case study projects and the staff perceived them to know what they are doing.

Has clear objectives and sends the message across

This was done by advising and maintaining the clear objectives of the project throughout the organization. The client had maintained a clear objective of completing the project on time, within budget and to an acceptable quality. This was clear to the entire project organization by the responses to the question as to what the project objectives are. The message had to be backed up by action on the part of the client. The responses in both case study projects indicated that in fact the client set clear objectives and acted to enforce them.

Collaborative attitude

The respondents were very positive when describing the client as being collaborative. In Project 1, this was particularly found critical by the large contractors. The client had decided to take the people from the contractors’ staff and placed them alongside others into a construction management team to achieve the objectives of the project and client in Project 1. In Project 2 the staff indicated that the client representative had a collaborative attitude and was willing to help and make decisions quickly. This attitude was consistently reinforced through actions by the client and top management in both case study projects. This was indicated as a relief by the staff, since in the U.A.E. in general, the culture was that of a confrontational nature.

Fair and reasonable

The respondents viewed the client and top management in both case projects to be a fair client. There were no instances stated where the contractor did not receive fair compensation for any work. This was due to several things as evidenced from the statements made. The first is the collaborative working relationship with the contractors and is an extension of the previous point. Additionally, the client and top management were reasonable in listening to and addressing concerns of contractors such as compensation or information requirements or problems they had. They were then provided “fair representation” in the word of one of the respondents working in a management capacity. The client’s own objective of not having any claims or outstanding issues with payments with anyone when the project is completed was reinforced through quick resolution of problems and swift attendance to them when any surfaced.

Encouraged informal rather than formal dealings

The client representatives in both case study projects encouraged informal communication and processes when and where required to maintain the project on track. This was acted upon and there were times when during the interviews some staff in Project 1 expressed frustration that contractors were not communicating between themselves to resolve issues and relied on management to do that for them. They also wanted all information formally. This was particularly an issue with the smaller contractors. The staff attributed that to the traditional main contractor culture in Dubai, where the main contractor was coordinating the activities of subcontractors and would rely on formalities rather than collaboration. The level of informal communication relied on the client attitude in this regard. A statement depicting the attitude of client in the level of informal communication as described in both case study projects states:

Yes, get things done and then follow with the paperwork. It depends on the attitude of the client. Some clients have the consultants out, because some consultants are good and some consultants are really strict. ………….. They’ve also got to know that *they're free to interface with whoever they like to get the job done. If they think I should know about it, then they'll let me know. They will be asked by anybody and they're at liberty to ask anybody what they need in order to make their job.* **WPM-Project 1**

Willing to take risks

The client was described by respondents as willing to take risks and described the culture in Dubai and how the case study projects were different. The culture in Dubai was that the client would be detached from the project and let the consultant and contractors "beat it out". This usually meant that the risk is borne by the main contractor. However, it seems that it was preferred by respondents that the risk is spread out between the parties and that the clients take some of the risk. By making decisions quickly the risk was ultimately reduced for all concerned.

And always the client sits on top of the tree and dictates down to two separate bodies and those two separate bodies fight it out and the clients sits aloof, away from all of that. But this has been much more inclusive and the client has been willing to be part of the problem as well as the solution, which is good. **Project Leader-Large Contractor-Project 1**

Proactive and involved

The client was described as being proactive in the project. This is stated in the above statement by the project leader of one of the major contractors in Project 1. The respondents all described the client as wanting to be involved. This was described as both an advantage and a disadvantage, but it was always stated that the advantages outweigh the disadvantages. But with this involvement came a sense that the client wanted to complete the job, where this was considered positive by the respondents.

Decision-maker and resolves problems quickly

The general statements made by the respondents in both case projects were that the client was a decision-maker and resolved problems quickly. The open door policy of the client and their attitude in resolving problems quickly and making decisions were felt by the respondents in the case studies. The presence of people making decisions on site was of value. The following statements reflective of the responses received in the case study projects.

Not only client representative, but the client themselves are on site. They have their own offices. The President of (Client) is on site. A couple of vice presidents are on site here. So whenever there is a need for a decision, decisions were made. And they're made very quickly, which helps the project. **Project Director-Consultant-Project 1**

….it is the first project for me where the Client representatives are all the time with us on the site, taking care of the problems, interested with the problems, trying to sort out whatever it is within their expertise and scope, to move forward the project. **Resident Engineer-Consultant-Project 2**

Accepts alternatives

The clients in both case study projects were described by respondents as one who accepts alternatives and is willing to consider suggestions. The suggestions would be provided from any source. This has helped in the client not being biased to any suggestion from a particular source. If a suggestion is found to be reasonable it was duly considered. However, at times this would create some friction between consultant and contractors since ideas to change challenged the consultant designs. However, the clients' persistence that he wanted the change would reduce this friction and focus people on getting it done.

Maintains open-door policy

The clients in both case study projects were described as maintaining an open door policy within the project. This was put in a positive light by some and by others in a negative light. The negative aspects were mentioned by the middle management in the projects as it was perceived to lead to loss of authority by the management staff. Despite that it was considered positively by the respondents in the case study projects.

Leadership

Respondents attributed the success of the project to leadership of the project. They pointed to the fact that top management was in control, knew what was happening and were involved. The following statement provides what respondents stated in the case study projects.

(construction management team) staff are technically and managerially qualified. More importantly, they are properly led. Effective leadership should be in management style and communication. That's why the project is running on time despite the problems created by the Architect. **Contract Manager- Project 1**

Controlling

The clients in the case study projects are described as controlling. This was stated in a positive light. Some respondents viewed this negatively in terms of the client giving orders and everyone else obeying. However, overall the respondents stated that there was leadership in the projects.

Chooses contractors and staff well

This was seen by respondents as one of the strengths of the clients in the case study projects. The clients were described as making a good choice of contractors and individuals in the projects. The respondents viewed the contractors as "good" contractors and thought the clients chose them well. In both cases the client was involved directly in accepting or rejecting any nominations of individuals joining the project from any party. This included the consultant and contractor staff. The individuals were hired following interviews with management in the projects. Additionally, hiring individuals were, where possible, based on personal knowledge by someone in the staff who knew a qualified individual to fill a certain requirement. If not available from within the network, other methods of hiring were used including ads and hiring agencies.

Makes changes constantly

There was an overwhelming agreement by respondents from all parties that the client changes his mind frequently. This was largely related to design issues. This was particularly in Project 1. This was not evident in the portions of the Project 2 the researcher was allowed access to. However, this may have been due to the developments being different in that Project 1 was targeted at users who seemingly changed their minds regarding what they wanted the tourist attraction to be.

Client attitude and effect on project

The respondents stated that the client attitude had a profound effect on the project. The effect was that the whole project organization was “infected” by it. The relationships were good on that account.

8.2.2 Characteristics of the Consultant

The consultant in Project 1 was not described well by the respondents. The reason may lie in the fact that the procurement routes reduced their “clout” versus the traditional procurement method. However, these descriptions, some negative, were found to be of relevance. The negative impression of the consultant was much more visible in Project 1, where it was perceived by respondents that the Architect was the cause of many problems in the project. Following are the descriptions by respondents of the consultant.

Helpful

In Project 2, the respondents stated that the consultant was helpful. In Project 1, it was slightly different in that the attitude towards the consultant was adversarial. Despite that there were many respondents from contractor staff that stated that the consultant did a “good” job despite being “understaffed”. This sentiment was also reiterated by the construction management team. It is noteworthy to state that some in the construction management team attributed problems with the consultant to the client who had “prematurely” ended the design phase.

Innovative and capable

Despite the animosity with the consultant apparent in Project 1, the respondents in both case study projects viewed the consultant as both capable and innovative. The capability stemmed from the consultant ability to put a design together. The innovativeness stemmed from the ability to provide solutions to problems when they occurred on site. An example was a solution to a problem in the slabs that the contractor could not resolve in Project 1. It is during these times that the engineering abilities of the consultant became evident.

Quick and efficient

Some respondents in Project 1 found that the consultant could be quick and efficient in processing submittals that were indicated as urgent. The reason was that the consultant would process based on first come first serve unless there is urgency, whereby the consultant would place that on top. In Project 2, the majority of respondents viewed that the consultant was quick and efficient in their response. This may be attributed to the fact that Project 1 was more complex and had many changes made to it throughout construction.

Strict and unreasonable

In Project 1, and probably due to its complexity, the consultant was perceived by some to be strict and unreasonable. Some respondents viewed that as perplexing given the “less than optimally coordinated” designs of the consultant. However, they also provided the justifications for the consultant including looking over his interests. They also pointed out that the consultant was “pushing to get the job done”. This was not the view of respondents in Project 2, where respondents perceived the consultant to be “good” and reasonable.

Adversarial

In Project 1 respondents suggested that the consultant should be working more on their side. Again, this may be an outcome of the complexity and constant changes that were happening in Project 1. Furthermore, this may also be due to the construction management team coming mainly from the contractors. Again, this adversary was not evident in Project 2.

Weak and slow to react

This perception that the consultant was weak and slow to react was particular to Project 1. The statements made by respondents there were that the consultant had one or two strong individuals whom were relied on. When they were on vacation, things simply were delayed until their arrival. The consultant was typified as a “typical” consultant who was never fast enough for the contractors. However, justification for the consultant as being understaffed was made by respondents. These sentiments again were not shared by respondents in Project 2.

Changes design

The consultant in Project 1 was perceived as changing his designs frequently. This was attributed to missing items in the designs. It was also attributed to lack of coordination in the design. Again this sentiment was not shared by respondents in Project 2.

8.2.3 Characteristics of the Contractor

The contractors were generally described positively in both case study projects. The exceptions were mainly the small contractors in Project 1. It seems that in both case study projects the contractors were chosen well and made a positive impact. Therefore, compiling how they were described and the role they played is important.

Collaborative

In both case study projects respondents viewed the contractors as ‘collaborative’. It was perceived that the contractor was doing his job diligently and well. In Project 1, the smaller contractors were perceived as “less collaborative” and caused problems in the project. They were perceived to be of “lesser quality” than their larger counterparts. However, this “slack” was taken up by the construction management team. Additionally, it was also mentioned by respondents that some teams were more collaborative than others, even in the large contractor organizations.

Self-reliant

Self-reliance was a term used to describe contractors relying on themselves to communicate with other parties interfacing with their work. This was particular to Project 1, since Project 2 had main contractors for each area. This informal communication was found to be invaluable to the construction management team as it would reduce the requirements of their direct intervention on smaller issues. As stated before, this was mainly attributed to the strong traditional procurement route culture prevalent in Dubai.

Capable

The respondents in both case study projects perceived the contractors as capable. The contractors’ contribution to the project was highlighted, including some of the changes proposed by the contractors and viewed positively by the respondents. The client was commended for their good choice of contractors in the case study projects.

Provide expertise

In Project 1, as stated previously, they perceived that there was a problem with the smaller contractors. They were viewed as unable to provide technical expertise. As such the WPMs had to focus on them and help them to complete the required works. The larger more capable contractors provided the expertise and WPMs did not have to focus on them. In Project 2, respondents viewed contractors positively and viewed that they are capable. However, since Project 2 had main contractors for each area, they did not have the same problems as in Project 1.

Stress quality standards

The contractors in both projects were perceived by respondents to provide quality standards. Even when there were problems, the contractors would correct them. The contractors were also viewed as stressing quality and delivering it. Respondents from contractors advised that they have quality standards and are stressed throughout their organizations. This was for the larger contractors, where smaller contractors in Project 1 were viewed negatively in terms of quality.

Safety conscious

The contractors seemed to stress the fact that there had been no safety incidents in their projects. They were safety conscious.

Motivating people

The contractors’ staff provided motivation to their staff for completion of the work. The terms ‘carrot’ and ‘stick’ to manage staff was used. Additionally, respondents in management capacities added that there were needs to maintain pressure in order not to have people accept lower output.

Continuous improvement and learning in the organization

Contractor management were seemingly interested to convey the fact that their companies always stressed the need to continuously enhance themselves. They were meeting to discuss the problems faced and how to resolve them. This was then documented for reference by anyone in the organization.

Provide for personnel development and formal career progression

The contractors in the case study projects conveyed that there was provision for personnel development within their organizations. This was done through performance evaluations or training. Staff viewed as "good performers" moved on to bigger roles. However, it is important to note that these were international contractors with a large number of staff working on several projects simultaneously.

Lack supervision and skills

The lack of supervision skills was stated by respondents in both case study projects. However, this was stated as an outcome of the lack of human resources due to the construction boom in Dubai. It was a problem for all concerned.

Incompetent

The description of incompetence was provided for the smaller contractors in Project 1. As stated before, the WPMs always had to "push" the smaller contractors to perform according to the requirements. There was no issue with the larger, more experienced contractors.

8.2.4 Most important characteristics

The following Tables 8-1 to 8-3 summarize the characteristics of each of the parties as described by respondents in the case study projects.

Table 8-1 Characteristics of the client

Knowledgeable of the construction process
Knows what he wants
Has clear objectives & sends consistent message across
Has a collaborative attitude
Fair & reasonable
Encouraged informal communication & processes
Willing to take risks
Proactive & involved
Makes decisions & resolves problems quickly
Accepts alternatives
Maintains open-door policy
Provides leadership
Controlling
Chooses contractors and staff well

Table 8-2 Characteristics of the consultant

Lenient & reasonable
Helpful
Innovative & capable
Strong & fast to react
Quick & efficient
Collaborative

Table 8-3 Characteristics of the contractor

Collaborative
Self-reliant
Capable
Provide expertise
Coordinates with everyone
Works well
Provides good supervision and skills
Competent
Provides staff with formal progression
Instils learning in organization
Stresses quality standards
Continuously enhance themselves
Continuous improvement in organization
Safety conscious
Motivates personnel

As can be seen from the above characteristics, most are attributable to individuals. The organization does not have most of these attributes (e.g. collaborative); hence, the importance of viewing the individuals within the case studies. The following statement reinforces this conclusion:

So, there's lots of different aspects to look at in order to conclude a decision. I think one of the biggest, biggest things here which we have with a developer who what they want, who knows how to get it and is able to make the decisions that make the difference. If you make decisions, you're gonna make some wrong decisions, and okay, as soon as you identify wrong, then it needs to be changed, we've changed it, but that doesn't happen very often. You'd have to have a machine that has good decision making process, and I think we have that, and it relies a lot on individuals, and it relies a little bit on systems. **Project Leader-Project 1**

Additionally, the client and top management were the most cited by respondents and who they thought were the most important. This was followed by descriptions of the contractors, whom again were perceived to be of importance. The consultant was considered the least important in terms of achieving project objectives and it may be due to the non-traditional procurement routes in the case study projects. The following statement provides a summary of why the contractors are important:

The contractors are a thinking contributing part of this whole deal. And I think if you look around Dubai at the successful projects, they've got better contractors. They may not have the best consultants, but if they've got the better contractors, then those contractors have made better use of the consultants. ……. The projects that are not going too well, they will have incompetent contractors. **Project Leader-Project 1**

8.3 Characteristics of individuals in the case study projects

The characteristics of individuals in the projects were perceived by respondents as being a critical component to the success of the projects. These characteristics were obtained from the interviews of both projects. As it shall be seen there were no "emotional" characteristics mentioned indicating that the staff were "above personal issues". Additionally, the people factor was stressed throughout the interviews, and therefore, the individual characteristics warranted exploration. Many respondents tied between systems and people and stressed the people component. What was interesting is that the respondents acknowledged that systems don't work without people. The results from the interviews of both projects were similar despite the various backgrounds of the respondents.

Following this is a list of individual characteristics that was compiled from the interviews. This list is to provide a basis of what characteristics to search for in individuals that would join mega construction projects to provide a collection of individuals that would be willing and able to work together cooperatively. This, in turn, would mean that informal systems would most probably work.

Committed to solving problems

It was stated by several respondents within the interviews that one of the characteristics of the staff is that they were willing to take an extra load of work that they were not responsible for, for the sake of the project. They were also described as committed to the project. Both case study projects, but Project 1 in particular, had several key people leave the project during the construction of the project. Some left willingly. Others were asked to leave. Despite the vacuum left by the staff that left, they were covered well by others in the project. An important point to mention is that respondents felt a lot of this was due to top management.

Qualified, experienced and capable

One question in the interview asked the point of view of the respondent regarding the technical and managerial qualifications and abilities of the staff throughout the project organization. The responses were overwhelming that the majority of the staff was technically and managerial qualified and capable of performing their job.

The staff in both case study projects viewed their colleagues positively. They viewed each other as qualified and capable. This view was not made by coincidence. It has to do with the choice of individuals to come into the project. The choices made by all parties, which had to be accepted by the client for the key staff of all parties, established “trustworthiness” between staff. It has been stated that since trust takes time to be established, which is not available in the case study projects, then it would be “trustworthiness” that established this view between staff of all parties.

Professional and focused on objective of the project

The vast majority of the respondents described the individuals in the project as “professional”. This may be a natural result of how the staff viewed each other. They also described the staff as trying to get the job built. That is, they were focused on the objective of the project. The “trustworthiness” established by choice of individuals seems to have been further established and a natural consequence is “trust”.

Pushing to establish trust

Individuals seemed to sense the importance of trust and therefore endeavoured to establish that with others. At least, they strived to achieve “trustworthiness”, which seemed to become “trust” with interaction between the staff of the various parties. This is believed to come from the view that the client chose well the individuals and from experience in working in the construction industry.

Proactive and responsive

The trust to be built between individuals had a basis of initially establishing "trustworthiness" through choice of individuals. This alone was not all that was required. The other is establishing it through action. The respondents described their counterparts throughout the project organization as being proactive and responsive. This was also clear in Project 1 despite there being some animosity between the consultant and the construction management team. However, this was not allowed to be reflected in the progress of the project and remained in the background.

It is again important to note that in both case study projects the same description was used to characterize the client and top management. This attitude by the staff may be a result of the clients' attitudes in both case study projects.

Cooperative working relations

This cooperative attitude established in both case study projects may be reflected by the description of working relations between the staff. The working relationships between individuals were described as "casual". It is a reflection of the attitude of the individuals and the general environment created in both projects. It also was a reflection of the amount of informal interaction taking place within both projects.

The general atmosphere was friendly and casual despite the diverse cultural background of the staff. It seems that all the above characteristics overcame these barriers. Again, it is important to stress that it seems that the client and top management played a major role in achieving this.

Under pressure

The individuals were kept under pressure continuously. This was partly due to the urgency imposed by the client time objectives. Some respondents found the pressure overwhelming. However, it was viewed by others as a "motivating" factor to maintain a high level of performance as any decrease in performance would be difficult to regain.

This pressure is typical of the construction industry. However, it seems to have been reduced considerably solely by establishing good working relationships in the project. The "cooperative environment established in the case study projects seemed to reduce the pressure. It is logical, since the added pressure caused by excessive animosity between staff of the various parties has been kept to a minimum.

Versatile and adaptable

Individuals in the projects were described to be versatile and adaptable. This is particularly true for Project 1, where the contractor's staff were on loan to the construction management team. The organization required that the project staff be versatile and adaptable to changes. This was reflected in the fact that the members in the construction management team had to be versatile enough to adapt to a new position in which they could be in conflict with their colleagues from the same company.

Know what they are doing

Several respondents had mentioned that they did not know what was going on. However, that was the exception rather than the rule. And even those who responded in that manner actually thought the organization was very effective. But the majority perceived that "everyone" knew what they were doing. This is despite Project 1 not having an officially posted organization chart. It seems that the attitude in the project and the "cooperative" atmosphere has made the staff know what they are doing simply by the informal dealings and the vast amount of information being transferred between the staff.

Follow up

The characteristics of the staff as described by respondents included follow up of the work. This included running after approvals, placing reminders, etc. In one response it was stated that if there was no follow up, some information would be lost. This is logical as it may be a result of procrastination. Therefore, this may legitimize the claim that keeping the pressure on is healthy for the project.

8.4 Trust in the projects

There was no definition of trust that could be provided either from the literature or from the responses during interviews. However, it was found that certain words were related to the definition of trust. Amongst these words are collaboration, reliability, cooperation, as well as trustworthiness. Additionally, the "intrinsic" meaning of trust was found to be one of the influencing factors in establishing an effective communication system. In the research the word “trust” will be used in its “intrinsic” meaning.

… that level of trust is important and you must have that, and I can’t think of one instance where either (construction management team) or the employer has not backed up what he said, and vice versa hopefully. **Project Leader-Main contractor-Project 1**

8.4.1 Individuals and interpersonal trust between the parties

From the responses of the interviews it was found that the individuals in top management of the parties played a major role in instilling a cooperative attitude throughout the project organization. Interpersonal “trust” was based on the perceptions individuals had of each other. This was particularly true for the top levels. Their perceptions of each other included qualifications, reliability, reputation and ability of the individuals. Since they perceived each other as qualified, reliable and able and their reputations were good, the cornerstone of “trust” between them was established.

It is stated that “trust” between individuals takes time to develop. In these cases, there was already a reputation of both the individuals and the organizations that had been present to establish “trustworthiness” of the organizations and individuals. This was already half the battle to establish “trust” and therefore not much time would be required to develop it between individuals.

Interpersonal trust within the whole project organization was established in a similar manner. In both projects, the client had a right to interview anyone within all organizations prior to working in the project. The client in Project 1 and client representative in Project 2 seemed to choose individuals based on their abilities, technical skills and their people management skills. It seems that in both projects there was an awareness of the importance of choosing the individuals working on the projects. This provided a basis for everyone that the qualifications, abilities, reliability and “trustworthiness” was established.

In both projects the client would not maintain any person viewed as "non-collaborative". In Project 1 there were instances where the Works Package Manager would "disappear" and not be replaced. It was stated that the WPMs in some instances were giving "excessive" non-conformance reports, which ultimately stopped the work of the contractor instead of helping him to achieve the project objectives. It was stated that the purpose is not to issue paperwork, but to assist the contractor to perform the work required of him according to project objectives.

In Project 2 there were some instances where there were some people relieved and replaced from within the whole project organization. It was found that it was the attitude of the individual in "slowing" down the work that was the cause for replacement. Again, this was due to the "non-collaborative" attitude of the individuals. In both projects this extreme measure was taken after all attempts to correct their attitudes were exhausted. As it has been established previously this was done even with the knowledge that the market was not full of qualified staff. In the case of Project 1 the individuals were not all replaced and in those cases the Package Quantity Surveyor were given that responsibility as they had the knowledge of the package.

From all of the above it was found that interpersonal trust was a key factor in establishing inter-and intra-organizational trust. The relationships of individuals in the top management of all organizations had provided the basis for an environment of "trust" in both projects. Therefore, interpersonal trust is found to be a key factor in the establishment of "trust" and a collaborative attitude within the whole project organization in lieu of the adversarial attitude present in construction projects. The client and top management of teh various parties played a major role.

8.4.2 Client related factors that enhanced trust

Many of the respondents perceived that the cooperative attitude in the project started from the top. This was the case in both case study projects. The client characteristics described that were conducive to achievement of this environment included hiring the right people, being pro-active, solving problems, experienced and knowledgeable, interested in getting the project built and being fair and reasonable.

The client and his management were instrumental in achieving “trust” and a collaborative attitude within the whole project organization. There were several main factors in particular that affected this attitude. The first is the client objectives. This was done by advising and maintaining the clear objectives of the project throughout the organization. The clients in both projects had maintained a clear objective of completing the project on time, within budget and to an acceptable quality. This is clear from the description of the client or client representative in Subsection 9.2. The perception by respondents was “the client knows what he wants”. Therefore, the entire project organization, whether intra- or inter-organizational, were focused on that single objective that “never changed”.

Another important factor for all parties was that the client was fair and reasonable. This was clearly indicated by respondents in both projects. This was based on actions rather than the words of the client. It was stated by respondents that there was no instance that they recalled where the client did not back up what he said he would do. The individuals in top management positions in each organization had clearly received the message and this was filtered across the whole project organization. Additionally, the middle management, such as the QSs, who were at the nitty gritty of things, perceived the same attitude.

The clients in both projects were described as proactive and involved. This was unlike the culture and Dubai and it was described as “unusual” and “refreshing”. This was also stated as a disadvantage because the client would be on their backs, but it was also stated that it was far more an advantage. The client was involved in the daily work of the project. This was perceived as an advantage in that when problems were raised, such as variations or claims, the client was already knowledgeable of the issue and was thereby more “understanding” towards finding a solution. This involvement was described by a respondent as such:

you have a client who is willing o be part of the problem as well as the solution. **Project Leader-Project 1**

From the above it is evident that the clients in both projects were willing to take a risk. In a traditional main contractor set up the contractor bears all the risk. In these cases the clients were willing to spread the risk by dividing the packages in a manner that increased their own risk. This seemed to be comforting to the other parties involved.

From the statements made by respondents it was viewed that hiring the right people was viewed as one of the positive characteristics of the clients. Therefore it is important to discuss the individual characteristics of the staff in the project.

8.4.3 Individual characteristics that enhanced trust in the projects

Human interaction was clearly perceived as the most critical component for project success by the vast majority of respondents. This fits well with the fact that the effectiveness of communication was as effective as the people involved. In the end it was the individuals who “made the success”. Additionally, trust was based on individuals. One respondent stated that

you can bring a bad individual to run a good company or a good individual to run a bad company, the latter works, but the former doesn’t. **Project leader-Project 1**

The characteristics of individuals in the project organizations were found to be critical to establishing trust and achieving team “chemistry” and effective communication and information transfer. The main characteristics of the individuals that were conducive to achieving a “trust” environment were mainly described in the Characteristics of Individuals in Subsection 9.3. The individuals in the project played a major role in establishing an environment of trust. This trust is crucial to the informal process to work to achieve project objectives.

8.5 Client, individuals, trust and the informal process

The above discussions provide a basis for why the informal process worked well in the case study projects. The clients in the case study projects were intent to get the project built, knew what they wanted, were clear in their objectives, facilitated resolution of problems quickly, and chose individuals well. Additionally, their knowledge of the construction process was found to be one of the main reasons for the characteristics described by the respondents. This knowledge of the construction process made the clients encourage informal processes amongst individuals.

Yes, get things done and then follow with the paperwork. It depends on the attitude of the client. **WPM-Project 1**

Since the informal process is actually created by individuals, the informal process may have a positive or negative impact on the project and the client has little direct control over it. Figure 8-1 describes the information management systems including both formal and informal processes as seen from the case study projects data. The informal processes in both case study projects had a positive impact because the clients and their top management were knowledgeable of the construction process, and thereby, utilized the informal process positively. Additionally, the characteristics of individuals chosen by the client to work in the project added to the control and positive utilization of the informal processes.

The individuals were quite focused on the task at hand. Informal processes were used in the case study projects to facilitate achievement of project objectives by individuals in the project. However, the positive utilization of the informal processes seemed to be based on an environment conducive of “trust”. This environment seemed to be the cornerstone for the informal process working to achieve project objectives. The characteristics of the individuals were conducive to establishment of the required “trust”.

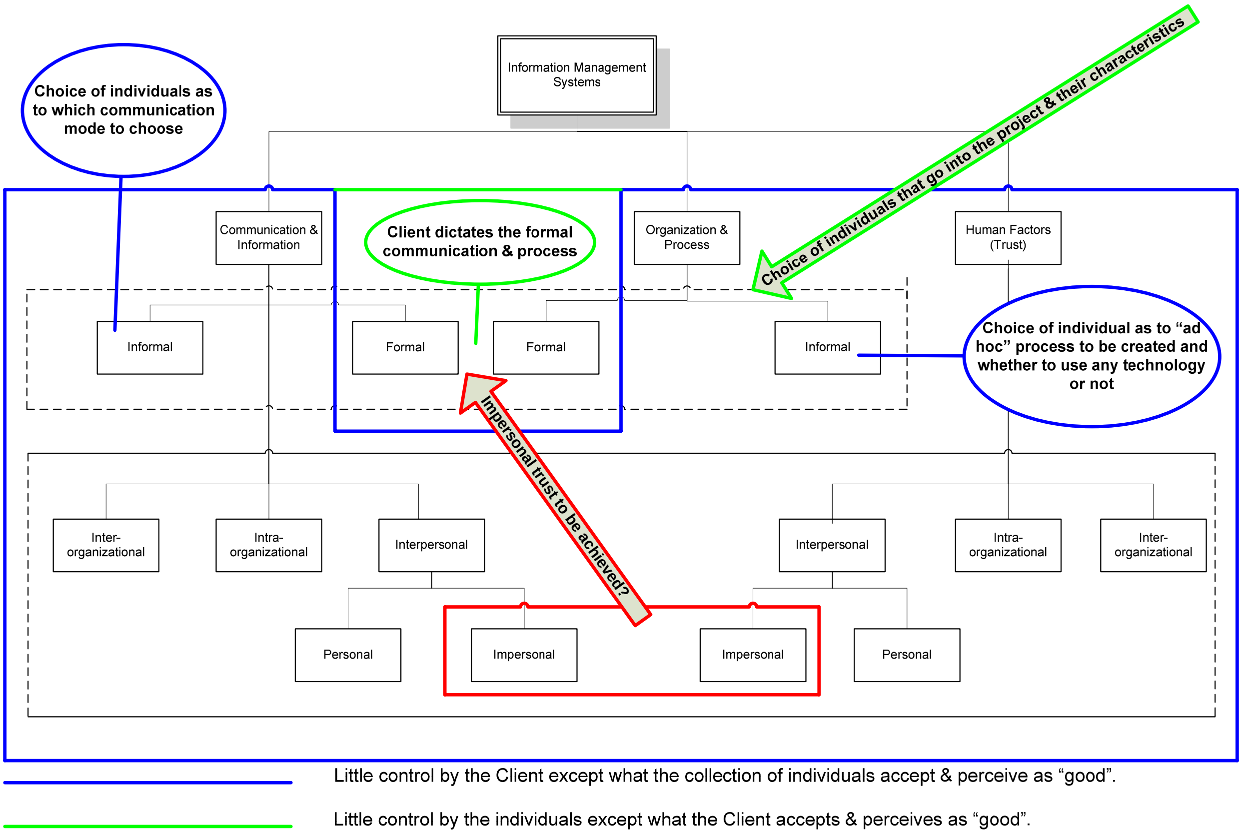


Figure 8-1 Description of formal and informal processes in information systems

The informal system seemed to provide the individuals more leniency. The formal process was only one method with one communication mode, which was the signed and stamped document. However, with the informal process individuals could use several modes of communication. This in itself provided better communication and information transfer. Since individuals have different preferences as to mode of communication, individuals with different preferences could be "accommodated" in the informal process. From the above and the research data Table 8-4 presents the framework required for the hybrid model for communication and information management.

Table 8-4 Framework for hybrid model for communication and information management

Characteristics of	Characteristics positively affecting hybrid model
Client	Knowledge of construction process
	Acknowledgement and encouragement of informal process
	Insistence of use of formal process to follow any informal agreements
	Knows what he wants
	Has clear objectives & sends consistent message across
	Has a collaborative attitude
	Fair and reasonable
	Encouraged informal communication & processes
	Willing to take risks
	Proactive and involved
	Makes decisions & resolves problems quickly
	Accepts alternatives
	Maintains open-door policy
	Provides leadership
	Controlling
	Good choice of individuals in project
	Good choice of parties to the project
Individuals	Qualifications commensurate with task
	Committed to solving problems
	Qualified, experienced and capable
	Professional
	Push to establish trust (i.e. trustworthy)
	Proactive and responsive
	Maintain cooperative working relations
	Work under pressure
	Versatile and adaptable
	Know what they are doing
	Have good follow-up instincts
	Good communicator
	Reliable
	Good problem-solver

8.6 Summary

This chapter has provided the framework for the hybrid model for communication and information management. The framework includes the characteristics of the client and the individuals in the project. The concept of trust is reviewed and it is concluded that interpersonal trust was the most crucial even in intra- and inter-organizational trust. The informal process is then discussed in light of the characteristics and it is concluded that trust formed the basis for positive utilization of the informal process. Table 8-4 provided a summary for the framework for the hybrid model for communication and information management. The research performed would not be complete without validating it. The following chapter discusses the validity of the research performed.

CHAPTER 9 EFFECTIVE CHANGE MANAGEMENT IN CASE STUDY PROJECTS

9.1 Introduction

This chapter builds upon the results of Chapter Six, particularly as relates to formal and informal communication. Initially, this chapter presents the background of processes in each of the case study projects providing an overview of how work was performed, including an outline of formal and informal processes. The chapter then presents the cross-case comparison of the processes of the case study projects from the data where single case analyses are provided in Appendix 3. The chapter presents the capabilities of the formal and informal processes in handling complexity, uncertainty and ambiguity in the construction processes. A question is presented to further guide the research relating to the implementation of the framework. Seven main processes for the case study projects are compared and discussed, including both the formal and informal processes.

The analysis and discussion of effective change management in the case study projects is guided by the following questions developed from Chapter Three:

- How was change managed in the case study projects?
- What work methods were used in the case study projects?
- Why was the informal process perceived by respondents as important and how did it contribute to the perceived success of the case study projects?

Chapter Six has concentrated on statements made by the interviewees in both case study projects regarding communication in general and method of communication. Further, informal and formal communications were discussed as well as the importance of both and advantages and disadvantages of each as provided by the respondents. This chapter will further this discussion to the processes and information transfer, particularly during change. The formal and informal communication processes and information transfer as provided by the respondents shall be presented. The main uses of formal and informal processes are presented from the data. Furthermore, the capabilities of formal and informal processes in regards to complexity, uncertainty and records are presented from the data highlighting how both processes are complementary.

9.2 Background of processes in case study projects

The process of work was important to map in order to show how communication occurred in the case study projects. The processes were mapped during interviews and shown to the respondents who either agreed to the sketch or made corrections. The process was then further divided into the formal and informal processes as it was clear that communication was used both formally and informally. However, the processes were different although they were a means to achieving the same end.

9.2.1 Description of processes in Project 1

The process of work in Project 1 was divided into three main parts. These were:

- Those of interest to top management which included things of a nature that was contractual, affected costs or affected planning.
- Those of a technical nature, which were of main interest to technical staff such as shop drawings, method statements, etc.
- Those of a quality control nature such as inspections.

Top management in mega projects has a big task in the project to manage and control it. Top management would not be able to handle the technical aspects on a daily basis and manage the project at the same time. Therefore, aspects that were technically oriented were not of interest to them. What was of interest was that the technical productions did not affect the progress or cost of the project. The details were left to the technical staff.

Top management of the project was interested in managing and controlling. The managing and controlling parts involved ensuring that the project was delivered on time, within budget and at an acceptable quality. Therefore, of interest were all contractual aspects of the project. There was an importance given by top management to the contracts between the client and all parties. This is evident in the contracts manager reviewing all contracts and ensuring the contracts were complete prior to signature. This was then placed in a large fireproof safe in his office. Reference is always made to the contract for any disputes.

Part of the contractual issues is the correspondences (letters). This was of extreme importance to top management. No official correspondence would go out except with the Project Leader's signature. No other signature was accepted on outgoing letters. All incoming letters were sent first to the Project Leader who would then forward it to all those who should either read the letter, act on the letter or respond to the letter. This is sent to document control for distribution. Those who should read it do so on Expedition and are sent emails advising them or from the hard copy file available that is read by all. (When the file was moved, each had to sign that they read the hard copy). Those to whom it was sent for action, took the action required based on the circumstances and events. Sometimes this was simply responding to the letter. Those asked to respond to the letter sent a draft of the response to the Project Leader. The Project Leader would read it and if he agreed with it, the secretary would put it in an official letterhead, the Project Leader would sign it and send it to document control for distribution as per the checks on the distribution stamp. If the Project Leader did not agree or did not understand the draft, the person initiating the draft would meet with the Project Leader and would finalize the draft, which goes through the same process again for outgoing letters.

An important issue for top management was control of costs. This was evident during the tender process where following the tender, there were negotiations with the contractor. The client was directly involved in the negotiations of the larger contracts. Smaller contracts were left for the WPM to negotiate. In all cases, the client was to approve the contract and had the final say. The client always wanted to maintain control over the contracts as well as the budget.

Part of cost control is control over changes after contracts are awarded. The change process was very lengthy on account of the number of people involved in the process. The people involved started from the WPM to the Package QSs to top management to four people from the client organization, in addition to the contractor. This was evidence of the importance of cost to top management and the client. Again, the client had the final say on whether a change with a cost impact would be made or not.

Besides the contracts and cost control, time control was important. As stated previously no time extensions were made. The project was to be delivered on time. Planning was close to the Project Leader s and supplied them with time control charts. These time control charts were not bar charts but were showing actual against planned. These charts were hanging on each Project Leader’s wall for various packages. He did not like using the Primavera Planner software and stated that he hated it. Therefore, the planners provided a simple form for him to follow the progress of packages. Time control was also evident from weekly progress meetings attended by the Planning Engineer with all contractors. If any delay or problems are seen in any packages the planning engineer along with the contractor try to find ways to absorb the delay and finish on time. Any problems in this regard were followed closely by top management and they pushed to make up the delay. This push included placing urgent documents on top of the list of submittals and letting everyone involved know the urgency.

Another top management issue of importance was to ensure the smooth flow of information and progress of the work. This was evidenced by their close eye on the process of work and where exchange of paperwork was excessive between parties, or when complaints were made over any slow down of progress of work. This was encouraged by the open door policy made where any contractor could complain to top management. There were several instances when the contractor would complain that the WPM or consultant would give too many Non-Conformance Reports (NCRs). The Project Leaders and client meet with all those involved and if there were too many rejections they would come down on the person issuing the NCRs or making the rejections. At times the client would fire the WMP or person responsible if he continues giving NCRs and rejections excessively. The client and top management were not interested in getting paperwork showing there was a problem. The client and top management were more interested in establishing team work with minimal paperwork on site. They were not interested in who was responsible for the NCR or rejection but were more interested in getting the problem fixed. They encouraged team work amongst the parties for achieving the project objectives and discouraged any “finger pointing”. The client and top management wanted the WPM and consultant to assist the contractor to perform his work.

There were instances where the contractors would try to bypass the WPM to achieve some benefit, be it approval or a claim. This was discouraged by both the client and top management. The contractor doing this type of activity got a slap and a warning. Playing “politics” was completely discouraged in the project. This is not to say that there was no politics in the project, but it was discouraged and had little effect on the project negatively, if at all.

Top management was not very interested in the day to day technical issues. These were left entirely to the technical staff, who constituted the “middle managers”. Top management were interested that the technical issues did not affect cost and time, and to a certain extent, quality. If they did look at any technical issues, it was for several reasons including:

- To ensure that technical information was proceeding smoothly.
- When a modification affected cost or time.
- When a problem occurred requiring their interference.

Other than that, all technical issues were entrusted to the Work Package Managers (WPMs). They were given ownership of their respective packages. The WPMs were responsible to ensure the smooth flow of technical information between the respective contractors and the consultant and the coordination of their respective packages with all other parties as required. This started from preparation of the package scope of work and tender documents to recommending the contractor to timely completion of preparatory works, such as shop drawings, method statements, etc. until actual physical completion of package works at site.

The WPMs were the focal point between the contractors and consultant and all other parties regarding the packages. All technical information for the package was facilitated by the WPMs. These were considered top management concern. These may be distributed for or for information to the various WPMs as directed by the Project Executives. The technical process was left entirely to the WPMs. This included the change orders, variations and claims, which top management, had final approval for.

There were other processes that did not fit with either top management concerns or with technical issues. These processes were on the periphery of the main process described above. These included logistics, contracts, QA and Environment and consultant inspections of the works of contractors. These processes seemed to work on the periphery of the main process. Other than those concerned, very few talked about their processes or advised that there is an interface with them. This does not mean that these processes are not important. They were, in particular logistics, which was crucial. However, they had their own processes with little overlap with the main process.

9.2.2 Description of processes in Project 2

The process of work on Project 2 was slightly different than Project 1. The main difference is an outcome of the organization in the project. The organization in Project 2 was a project management firm representative of the client and main contractors for various areas in the project. The consultant and QS firms were similarly divided along the same areas in the project.

The Project Director of the project management firm was interested in ensuring that the entire project was managed correctly. He was interested in the follow up of activities of his Senior Project Mangers (SPMs) who were responsible for their respective areas in its entirety. The Project Director would follow up the logs of activities for each of the areas. He would become involved directly in the following circumstances:

- Weekly progress meetings
- SPM asks for his interference in a certain issue.
- A problem arises that requires his presence and/or decision.
- Any of the parties (i.e. consultant, contractor, etc.) ask for his involvement.

The Project Director was not interested in any day-to-day technical issues except where it affects cost, time, and sometimes, quality.

Contractual issues were of high interest to the Project Director of the project management firm. Therefore, he would receive all incoming correspondence and distribute them for information or action to the required people. Anything involving a certain package went to the respective SPM. Anything involving cost and time in particular he followed up. Otherwise, each SPM was given ownership of the area he was looking after. That included responding to correspondence from various parties concerning his area, including contractors and consultant.

The SPMs were completely in charge of their areas, including managerial and technical aspects. They constituted the focal point between the QS firm, consultant and contractor. All information flow went through the SPMs, with the exception of inspections and NCRs, which were left directly between the consultant and contractor, where copies only were sent to the SPMs. The SPMs reviewed, responded to, and forwarded all documents as required. However, the technical aspects were overwhelming. The review of this technical information in detail was not possible by the SPMs. The technical aspects of the project were left to the consultant. The SPM would just quickly check the technical documents to ensure that the consultant did not respond or comment anything that would affect the cost of the project. Coordination and a more detailed review were performed by the MEP coordinator and project manager under the SPM. Any problems were brought to the attention of the SPM.

The SPMs were responsible to complete the project on time, within budget and to an acceptable quality. Time was of extreme importance to the client. They had to deliver their projects quickly to start receiving revenues and to deliver the properties to the buyers. The SPMs worked closely with all parties to recover any delays. The Projector Director would be heavily involved in such situations.

Cost control was another main part of the work of the SPMs. There was a fixed budget which was not to be exceeded. There were extensive “value engineering” exercises performed to reduce costs. This was encouraged by the client and their representative. There were major changes made in the original designs by all the contractors. These design changes affected both time and cost, supposedly in a positive way in most instances. There was close collaboration between Contractor, QS firm and Consultant with the SPMs to realize the time and cost benefits. The SPMs were at times faced with a situation where there would be an additional cost. In these instances the SPMs would make a “value engineering” exercise to make up the added cost by reducing costs elsewhere. The SPM that managed that effectively was considered successful by the Project Director.

Quality was another important issue for the SPMs. But it was not as important as time and cost factors. As stated previously, it seems that quality always had the “short end of the stick”. However, the quality to be delivered still had to be acceptable to the client. It ultimately had to be acceptable to the buyers of the properties. This was a subjective area, which became a judgment call for the SPM and the client.

As stated previously inspections and Non-Conformance Reports (NCRs) were left entirely between the Consultant and Contractor. They corresponded directly between them in this regard and provided a copy to the respective SPMs. The Consultant did not have a QA/QC, but relied on their site inspectors to maintain quality. The site inspectors also performed some preemptive inspections and would write a site instruction where quality or safety may be compromised.

QA/QC and safety were largely left to the Contractors. They had small teams for the direction and follow up of these issues. But even here the QA/QC and safety were peripheral processes that really did not “fit” in the main Contractor process. It also did not “fit” in the main project process. As in Project 1, other than those concerned, very few talked about these processes or advised that there is an interface with them. Again, this does not mean that these processes were not important, but they had little overlap with the main process.

9.3 Cross-Case comparison Processes in case study projects

The processes in both case study projects have been described from the perspective of the formal process and formal organization. However, the reality included two main processes and organizations. In this research the organization and process will be considered the same based on Balle’s (1996) description. There are two main processes in the case study projects, namely the formal and informal. The cross-case analysis of the processes shall be presented for the case study projects. The differences and similarities in each of the processes between the case study projects shall be highlighted.

The submittal process and the Request for Information (RFI) process are interdependent as shall be seen from the processes. The RFI process is the Request for

Information (RFI) process. The RFI process shall be described in the following Section 9.3.2.

9.3.1 Submittals process

Introduction

The initial work to be performed following start of the project is the submittal process. The submittal process includes the preparation of the shop drawings, material submittals etc., which is prepared by the contractors and their subcontractors. This process is shown for Project 1 and Project 2 in Appendix 4 in Figure 0-1 and Figure 0-2, respectively. The submittals process involves the preparatory work for the purpose of translating the construction documents received from the client into working documents. This includes preparation of the shop drawings, material submittals, method statements, quality control documents, etc. These generally followed the same process.

Cross-comparison of project processes

It is seen from the processes in Figure 0-1 and Figure 0-2 that the submittals processes in both case study projects are quite similar. Both projects had an established method for control of document flow through a preconceived system. Despite the use of an electronic management system in Project 1, it was found that the similarities still existed. The purpose of the formal submittals process was to receive all working documents and place them for safekeeping and use by others requiring that information.

In Project 1 the electronic system assisted considerably the retrieval of documents, and thereby, could be used by anyone. In Project 2, there was no electronic system and retrieval was simply by getting papers out. In terms of record keeping and retrieval, the electronic system in Project 1 had a value.

The formal submittals process varied between case study projects. The variation was largely how each case study project was organized and the level of control required. Project 2 had a required level of control higher than that in Project 1. The reason is that all document movements within the project management team were controlled. So the PMT document control would transfer documents to the SPM officially. This was slightly different in Project 1 where the transfer of documents within the construction management team was controlled by CMT document control.

In both case study projects, it is evident that the submittals process alone had several iterations within it. The first is within the preparation of working documents by the contractors, where input may be required from several disciplines. This includes information required from subcontractors where their input may be required and which provide for added iterations. Thereby, the length of the iteration is increased due to subcontractors being an external entity. These iterations are largely caused by the interdependence between disciplines.

Further interdependence lies in the documents themselves. The most important to note is that each type of submittal relies on information from another submittal. For example, the shop drawings may rely on the material submittal. However, the material to be used may be delayed on account of negotiations with suppliers or subcontractors. This in turn causes uncertainty and delays the shop drawing submittals. This interdependence may cause several iterations to complete a submittal as required.

Another source of interdependence and uncertainty arises from any questions that need to be answered through the RFI process. Again, a submittal may rely on the response of an RFI. The interdependency between the RFI and submittals process, and the uncertainty that is caused delays the preparation and forwarding of submittals.

The uncertainty and interdependence between tasks was a concern for the case study projects. The formal submittals process in both case study projects was incapable of handling these issues due to the length of the process itself, and thereby, any iteration would simply increase the uncertainty and not decrease it. Another inability of the formal process is to provide small pieces of information. A submittal from another source may require a small piece of information in the submittal document to be completed. If the formal process is used that small piece of information will not be forthcoming. As such, the dependent submittal will be delayed.

The other processes that are shown in the diagram in dashed lines are the informal processes. The informal process was allowed to bypass the formal process many times in the case study projects where there would be agreement on actions to be taken, which are performed and then the documentation follows through the formal process. The informal process was used in the submittals process to reduce the number of iterations in the preparation of the submittals. For example, the subcontractor could simply go directly to the contractor staff and coordinate their submittals instead of going through the formal process several times. This reduced the time required for the submittals to be prepared. The informal processes are in every process and are shown in the detailed process descriptions in the figures.

The informal process in the case projects was rather loose and fluid. Anyone from any party could contact anyone else from any party to check on their work or request clarifications. This informal process was clearly approved by management of all parties. In fact, the researcher observed this whether it was a contractor with the client or the contractor with the construction or project management team or with management at any level. This was reinforced through the open door policy in both case study projects. Additionally, through this process agreements are reached on submittals such that once the official submittal goes through the formal process it is just a matter of “formality”. This process assisted in avoiding the long iterations in the formal process.

The informal process is very much able to handle uncertainty, reducing iterations of information and passing small pieces of information. The informal process is based on people and as Balle (2003) states, people are smart and will find the best way to work. By using the informal process the number of iterations can be reduced substantially. For example, if a dependent submittal is awaiting completion of another, the people involved may meet and discuss the issues to reach a resolution for the stagnation and dependencies. Once a resolution is arrived at, the submittal goes through the formal process as a matter of formality. Additionally, any uncertainty that is present would be dissipated by resolution of the problem and the dependency. Furthermore, small pieces of information required by a downstream submittal may be received informally to allow completion of the subsequent submittal. This would reduce the uncertainty and the time until resolution of a simple issue, thereby achieving concurrency.

9.3.2 RFI process

Introduction

During the submittals process, there may be queries or clarifications required by those preparing the working documents. This is called the RFI process. The RFI process is depicted for Project 1 and Project 2 in Appendix 4 in Figure 0-3 and Figure 0-4, respectively. The submittal and RFI processes are interdependent as the clarifications may be required for the submittals. These two processes overlap and precede the approval process, which involve mainly the construction or project management teams and the relevant consultants and sub-consultants. These processes constitute the initial preparation to start of the task required to be performed. The rate at which the preparation is performed affects the progress of the task as well as other tasks relying on the progress of it.

Cross-comparison

The RFI processes in both case study projects were quite similar with two main differences between them. The first is that the organizations were different in the case study projects and as such the number of stops and review of RFIs were different. In Project 2 it was a longer path with a greater number of stops throughout. The second main difference between the two case study projects is that the RFIs were considered non-contractual in Project 1. Despite the “non-contractuality” of RFIs in Project 1, and the understanding of that by contractors, it was still used extensively. This may be because of the written nature of the process and the psychological effect of “formality” in the process. Due to the non contractual nature of the RFI process in Project 1 there were several problems that were created, where the contractor would act upon the RFI response and the client would reject the change. However, these problems were minimal as most contractors would check beforehand with the client regarding the response on the RFI.

As stated previously, the submittals process relied on the RFI process be it contractual or not. There was a clear interdependence between these two processes. The formal process again was not able to handle such a situation. The path the RFI took was long. By the time the RFI is answered and goes back through the formal system, a lot of time passes. Any interdependencies between the two processes or between two submittals would increase uncertainty since RFIs are inherently created to reduce uncertainty.

The informal RFI process was better able to reduce the uncertainty and interdependencies by getting informal responses on RFIs faster and by moving information along faster than the formal process. The formal process would then be used as a matter of record keeping only. All the people involved would have known the response before it went through the formal process. If the informal process can reduce the uncertainty and interdependence, then it logically reduces the number of iterations of information, especially along the long path of the formal process. Hence, the informal RFI process is able to achieve concurrency.

9.3.3 Approvals process

Introduction

Once the submittal and RFI processes are completed and submittals have been prepared they are sent through the approvals process. The approvals process is to check that all the submittals are according to original design intent or the change made. This is largely to maintain control over what is actually being constructed. The approvals process for the case study projects, Project 1 and Project 2 are shown in Appendix 4 in Figure 0-5 and Figure 0-6, respectively.

Cross-comparison

The approvals processes in the case study projects were quite similar. The submittals would be provided to the consultant through the management teams of the projects. This provided the opportunity for the case study projects’ management to review the submittals in order to stop any subtle changes from taking place whether from the contractor submittals themselves or from the response of the consultant on the submittals. The respective WPMs and SPMs in case study Projects 1 and 2 were supposed to review all submittals. In reality at times the WPMs and SPMs would be overwhelmed by the number of submittals received, and at times may review quickly or simply pass it on to the consultant for his review.

The informal process through approvals relied on whether or not there was previous agreement through the informal submittals and RFI processes before the submittal or

RFI was sent for approval through the formal process. Within the approval process there are quite a few paths of action that may be taken. The course of action to be taken depended on the situation at hand. It also depended on how urgent the situation is. If there was previous agreement in previous processes, the submittal would usually go through the formal approvals process smoothly.

The paths of action to be taken in the approvals are both formal and informal. This would rely on the individuals and their preference as well as the level of urgency. If the submittal is required urgently, the informal paths of action are used. Usually, the contractor would be advised informally of approval until the formal procedures are completed. If there is no urgency the course of action and level of formality will rely on the individuals. The most important note in the approvals process is the length of the process and the effect of informal agreements reached in the previous processes, which are the preparatory work. Additionally, it is of importance to note that if the informal processes did not reach agreements before the approvals process then there may be further iterations through the long formal approvals process. Once there is approval on the submittal it is sent for distribution according to the distribution requirements that the SPM and WPM provide prior to sending the submittal to, respectively, the PMT and CMT document controls for distribution.

There was little evidence of a high impact through the approval process as can be seen in Figure 0-5 and Figure 0-6. The approvals process relied heavily on informal agreements reached at the RFI and submittals processes. Whatever was agreed between individuals involved would result in a smooth flow of the documents through the formal processes. Overall it really did not matter that the document took some time through the formal process, since the answers were available and any uncertainty settled. If no informal agreements were reached prior to submitting formally, the uncertainty remained and the submittal could be rejected. In this case another iteration through the long process is required and any interdependencies with that submittal will simply be prolonged. The uncertainty would surely be higher and concurrency would not be achieved.

9.3.4 Distribution process

Introduction

Once there is approval on the submittal it is sent for distribution. The distribution may be made from a preset guide or according to a distribution list provided from the person responsible. It can also be both. The distribution process for case study Project 1 and Project 2 are shown in Appendix 4 in Figure 0-7 and Figure 0-8, respectively.

Cross-comparison

The distribution process in the case study projects seemed rather simple, but in reality the formal distribution system was long. The main issue was that at times documents were required urgently but were not forthcoming through the formal systems due to the large number of stops. The informal processes helped in this regard by giving advance copies to those requiring it in order to progress the works. The formal process would not achieve this.

The informal process of distribution is slightly entangled with the previous processes. Additionally, the needs at site may pull the information before completing the formal process in order not to delay progress on site. It was normal to receive “advance copies” from the consultant or WPM or SPM where urgency was required. This again depended on the situation and the individuals involved. Once formal distribution is completed “formal” execution starts. However, ‘informal’ execution may start before ‘formal’ execution based on ‘informal’ distribution. This process is outside the realm of the research due to site being off limits.

9.3.5 Inspection process

Introduction

Once the work is executed through the execution process, it is to be inspected. The inspection process results in rejection, modifications or acceptance. This process is shown in Appendix 4 Figure 0-9 and Figure 0-10 for the case study Projects 1 and 2, respectively. Once the task is approved it is considered completed. The rate of inspection process affects the task completion and the tasks that follow it that are reliant on its progress.

Cross-comparison

Despite the seemingly simple inspection process, it was long and time consuming. Sometimes, the inspectors would be extremely busy and as such scheduling inspections cause a delay. This was particularly true of the Authority inspectors who, during the construction boom, were very busy. The consultant and contractor relationships with the Authorities would be crucial in getting the inspections performed earlier. However, Authorities were not required to be present in all inspections, and was largely for structural integrity and safety issues.

In other inspections, the process relied heavily on how relations were between the contractor, consultant and construction or project management team staff. If relations were good and there was trust between the staff, the inspections were largely performed on the go and the inspectors would advise the contractor what was required. The contractor staff in turn would perform what was stated verbally to them and the inspector would simply check on the go. Once the work is completed, the inspection sheets would be a matter of formality. If there was no trust between the staff, the formal process would be adhered to strictly and the contractor would be delayed, which in turn delayed subsequent works.

The informal inspection process was initially performed as quality control before the works were completed. It also allowed subsequent works to proceed informally if there was a good relationship and trust between the contractor staff performing the following works and the consultant and construction or project management team staff. Additionally, through the informal process, site inspectors would advise the construction managers and WPMs or SPMs of situations where any possible changes would be initiated earlier through the prechange process, which shall be described in the following section.

The inspection processes in the case study projects were very similar. Both case study projects left the inspection process between the contractor and consultant. This was due to the fact that the number of inspections was large and it would overwhelm the management staff if they were involved. This again was not interesting for management as stated previously in Section 9.2. The management in each case study project were content to receive the inspection sheet after completion of the inspection process.

The formal inspection process was long and tedious. Additionally, it would come after the work has been completed, and thereby, any rework would be costly. Furthermore, if an inspection has any comments, rework has to be performed and the inspection process started again adding iterations through the long formal inspection process. It is important to note that parts of these formal inspections were unavoidable where Authorities were concerned.

The informal processes would counter these shortfalls. First, the informal processes would allow continuous inspections during the progress of the works where the inspectors would be on site advising the contractors what is required and any changes. This would be done largely informally. It is noted that there is an official inspection during progress of the works but, again it was long with Non Conformance Reports (NCRs) issued and it largely follows the same inspection process and withholds the receiving works to be initiated delaying its start. This process was not presented in the research due to inability to be on site.

Another way the informal process assisted completion of inspections quickly were by informal agreements what should be done to accept the works if the comments are rather simple. The informal process in both cases would lead to quicker acceptance of the work in order to start subsequent works faster, thereby reducing the time between interdependent task executions. It would also reduce the uncertainty of the following task as to when the task would start and allows the contractor to plan better his resources. Additionally, the informal process would reduce the number of iterations through the formal process, which in turn assists in achieving concurrency.

9.3.6 Prechange process

Introduction

The prechange process is largely informal, except once a decision is made to pursue any change further by the client. This process is provided in Appendix 4 in Figure 0-11 and Figure 0-12 for Project 1 and Project 2, respectively. This is actually not in any of the formal processes devised by the clients of the case projects but it was the only way that the ideas could be forthcoming from any source. The idea of a change would gather “steam” as staff discussed the possibilities and potential of the idea.

Cross-comparison

The prechange processes in both case studies were very similar. They were also largely informal until client approves the change to be formally placed. This was accepted formally by all members of the case study projects despite it being informal. Additionally, it was not written anywhere in the documents of formal processes in either case study projects. However, the high level of informal processes in prechange is evidence that the informal processes reduce uncertainty and interdependence as well as the number of iterations of information flow. At any change there is an iteration of information and the information is still “up in the air”. This informal process allowed quick transfer of information between staff in the projects and discussions as to viability of a change was done informally before anyone got entrenched in a position.

9.3.7 Change process

Introduction

The actual “formal” change process would start once a “formal” proposal is submitted. The change process is shown in Appendix 4 Figure 0-13 and Figure 0-14 for Project 1 and Project 2, respectively. This process includes for urgencies, but even that is slow through formal channels. The cross-case analysis of the change process shall be described in the following subsection.

Cross-comparison

There are two main differences between the change processes in the case study projects. The first is in the naming of the change instructions. The second is in the path that the documents flow through where the organization of the project played a difference. Other than this the change processes in both case study projects were similar.

The change process was the most crucial of all processes. It was also the longest of all processes as it involved all other processes. Any change would send a chain reaction throughout both the formal and informal systems. Any change would involve RFIs and the submittals. Furthermore, the approvals processes would be started again for the change. After completion of the execution of the work, the inspection process is started again. In essence, this causes uncertainty, which would be higher than without a change. The formal process again is unable to handle this type of uncertainty and the iterations that are performed as an aftermath of any change. It is through the informal process that changes can be managed. The uncertainty and interdependence should be handled properly if changes are to be absorbed into the process quickly.

9.4 Use of informal processes in case study projects

The informal process was used considerably by the participants in both case study projects. This was found to be very effective by the participants in the project. It was stated that without the informal process, the projects would not be where they are now.

The informal process in the case study projects was used particularly in five cases. The five cases are:

- Where urgency is required
- In order not to delay any works
- To reduce the preparation time through official channels
- To close the gap between information available officially and actual site conditions
- To avoid rework on changes that will be forthcoming when completed officially

The following statement shows where the informal process is used where urgency may be required:

again in certain instances where we require the information very urgently that we've got a wall that's about to fall or something like that we still would find that this lack of information on certain things, then we'd get an advance copy of the drawing. We'll get, you know, that gets issued to the contractor and then the normal process through for, we'll get through the normal way, but by then when he gets the actual drawing, by then normally the work is done already. **Work Package Manager-Project 1**

The following statement shows where the informal process is used in order not to delay any works:

The other end of the spectrum is you're about to pour concrete and so(Client) comes along and says I don't like that slab there, take it out. We've had that here. We were about to pour concrete in one of the slabs in Tower one and he decided he wants some kind of dome that was gonna come up off one of the floors, and the dome would have poked its head through the slab. So the slab had to go, all right? So we're in a situation where we're about to pour concrete and we get told, no there is a change for it, stop, stop, stop, stop, and you just deal with it. You don't pour the concrete, you remove the rebar and the steel, you remove decking, you remove the false work, you remove all the equipment, you get back to ground zero, if you like, and then you put in the new piece. ***Contractor Team Leader-Project 1***

The following statement shows where the informal process is used in order to reduce the preparation time through official channels:

Yes, then I go into that process, and then that's where, umm, usually on those paper work things, they talk to me before the paper work comes, right. The package manager and the contractor, I have open channels of communication by phone or by face-to-face, cell phone or face to face. If something's coming on paper work they talk to me in advance. So, I guess, there's something about not being blind sighted by the paper work, alright. Usually by the time the paper work comes to me, I know what the question is, I know what the issue is, and probably I have idea how it's going to be solved. And I've done that with the package manager and with the contractor so when the paper comes maybe 8 times out of 10 that's just a matter of me putting the answer down on the paper because I've done the hard work. ***Consultant-Project 1***

The following statement shows where the informal process is used to close the gap between information available officially and site conditions:

All so many subtle changes are made in the field because of field conditions and they aren't available to every consultant. They aren't. There is a gap there and that gap of *information needs to be filled somehow, but it has to be filled easily. I mean ten years ago people were talking about PDAs in the field, you know, what's a good hand held computer then allows you to confirm. You know, first of all, you've got to have the GPS stuff in there because you need X, Y and Z on everything that's out there so that what you look at on the screen is actually X, Y and Z for that. That's not been done here and you know I was kind of hoping to see something like that here. Well since it isn't being done, then it really is about people. Who's the guy that's been managing the infrastructure? Who's the guy that's been managing structural? He knows where all that stuff is. It's not on the network. .... I'm looking for smart drawings, object oriented stuff and not just lying there and they help understand what the impacts like you said of a change showing the different disciplines. You think it's small but it isn't, you know, we sit there in progress meetings for construction and say, well let the landscaper get in there and plant trees next week while he can't plant the trees because there's still scaffolding up there while they're doing the theming, and while no, they couldn't get that up because they have to get the windows in first. Now all of this information is only available in meetings. It's not available …. you can't pick it up on the network.* ***Consultant-Project 1***

The following statement shows where the informal process is used to avoid rework:

We might have been advised verbally that the window schedules for a particular building was wrong and that the windows in that building needed to be a 100 mm wider, the windows we were forming. There was no drawing in place. There was no instruction in place but we had been advised verbally that it needs to be a 100 mm wider, and so we built it. Ummm, the drawing or the instruction or whatever carried the documentation for that change then comes through the system at a later date. Ummm, but then we've done the work and there is no unnecessary rework and no time for anyone. And in general that's worked quite well. ***Contractor Team Leader-Project 1***

Although the official process is necessary to maintain a historical record for the project, it cannot work without the informal process. The informal process is a much shorter route than the formal official one. The informal process is also necessary. It is necessary to complement the official process. There are several situations where the informal process is required to complement the official process as stated above. It is in these situations where the informal process should be encouraged. It should be encouraged more strongly in complex projects since these situations are more common.

Additionally, when informal processes were used in the case study projects are provided in Chapter Seven. The following Table 9-1 summarizes the results.

Table 9-1 When informal process was particularly used

Where urgency is required
In order not to delay any works
To reduce the preparation time through official channels
To close the gap between information available officially and actual site conditions
To avoid rework on changes that will be forthcoming when completed officially

9.5 Capabilities of formal and informal processes

This section is a discussion of the formal and informal processes in relation to certain variables. The variables are records, uncertainty, and task interdependence, small pieces of information, information iterations, concurrency and control. Each of these shall be analyzed separately for each of the formal and informal processes. This discussion shall be based on the data from the conduct of the research as well as the cross-case comparison of the processes in the case study projects.

9.5.1 Capabilities of Formal Process

The formal process as stated earlier is the “contractually” recognized process. This process is largely made to control documents and have them on record available for use. In this regard the formal process performed its functions well. It was particularly useful with an electronic system, where retrieval was easier than documents. The records kept were of value. Additionally, in Project 2, the contractors did maintain electronic systems and they did view them of value. However, it was the project management team on the project as well as the consultant who did not maintain electronic databases for the project. Despite that it was of value since the main contractors were performing the work and retrieval was critical for them.

The formal system as seen from the process diagrams presented in rich picture format were long and had many stops to reach between the parties involved. This was not the only problem. Other problems include the time required for preparation of submittals and time to review and approve them, or in the case of RFIs, to answer them. Thereby, it took some time before any information required could be provided through formal processes.

Once a submittal goes through the formal process there are no guarantees that the submittal would be approved or would have comments that require iteration through the same process. The same is for RFIs, where the response may not be what was required and it has to go through the formal process again. This would be an even longer process if approvals on submittals are required by Authorities.

If another submittal is dependent on completion of a previous submittal, the problem is exacerbated. The time it takes for each submittal, one waiting for the other, and the interdependency delays the whole cycle. Additionally, awaiting RFIs through the formal process significantly increase the uncertainty since decisions have to be made and progress of the work relies on the submittals. In starting a certain task, the submittals and RFIs have to be complete. Thereby, small pieces of information required by another submittal from another source would not be available early. The formal process, thereby, cannot handle information iterations, uncertainty or interdependence, and with that cannot achieve concurrency.

This is particularly relevant at the start of construction activity where uncertainty is highest (Mahmoud-Jouini et al., 2004). At the beginning of preparation there is no system freeze and as such change is applicable. Once the uncertainty is decreased and parts of the design are frozen, then the formal processes may be sufficient.

9.5.2 Capabilities of informal processes

The informal processes were incapable of maintaining any records. These processes were largely ad hoc and used on an as need basis. Even where records were available, they were non contractual. However, the informal processes did have value.

There were more channels of communication through the informal processes than formal ones as seen from Chapter Six. The informal processes were also versatile and flexible in allowing anyone to discuss anything with anyone. There were no boundaries. The only boundary set is by the individuals themselves who may have a preference of using a communication method over another, which also depended on the situation itself. These were used extensively by staff in the case study project due to these particular reasons.

In the informal processes, staff communicated. Discussions were ongoing for any issue between relevant staff from any party they originated from, be that client, consultant, contractor or anyone else concerned with an issue. From this communication and discussions, decisions are made. Once decisions were made the uncertainty is reduced.

From Chapter Six, it was seen that the informal processes were fast and efficient in transfer of information. Additionally, the uses of informal processes were largely to settle urgent issues, to get advance information for preparation of submittals, and to fill gaps between information required and information available. This ultimately leads to reduction of uncertainty and interdependence, since any information required by interdependent tasks may be supplied earlier than through the formal processes.

By receiving early information and through discussions and agreements “pre-approvals” may be received that would result in preparation of submittals earlier and putting through the long formal process only once. This in itself reduces both the distance the information must travel and the number of iterations. In essence, all the iterations that may have been performed through the formal processes are done in the discussions between relevant staff. With the reduction of iterations, concurrency is ultimately achieved.

Additionally, small fractions of information are readily passed through the informal processes in lieu of waiting for complete submittals. This reduces both uncertainties where questions are answered as well as reduce the effects of interdependence. A submittal requiring a piece of information from a different source would be able to receive the information required from the source informally. They can then prepare their submittal on that basis instead of waiting for the completed submittal to go through the formal process and receive approval.

The informal processes are rather “chaotic” and at first glance may seem “uncontrolled”. However, there is a degree of control through peers. In many of the responses it was found that staff was concerned of how others viewed them, particularly their capabilities and trustworthiness. Additionally, informal processes are based on “trust”. It is based on trust since each one needs to trust the fact that the information supplied is correct and that what each states he/she can do or is capable of doing will be done. Therefore, with a “trustworthy” client, management and individuals in the project, that level of control required is achieved by peers.

However, it is stressed that the formal and informal processes are complementary to each other. The strengths of one cover the weaknesses of the other. It may also be viewed that the formal processes are static and bureaucratic while the informal processes are dynamic and “chaotic”. Ironically, it is the “chaotic” nature of informal communication which may be the same reason for its strength.

9.5.3 Summary of characteristics of formal and informal processes

The cross case analysis has been presented in this section showing how the formal systems related to the informal processes. Additionally, during the discussions, the abilities of the formal and informal processes are analyzed. Table 9-2 summarizes the results.

Table 9-2 Characteristics formal and informal processes are equipped to handle

Characteristics	Process	
	Formal	Informal
Records	Can handle well	Cannot handle well
Control	By documents	By peers
Uncertainty	Cannot handle well	Can handle well
Task interdependence	Cannot handle well	Can handle well
Small pieces of information	Cannot handle well	Can handle well
Information iterations	Cannot handle well	Can handle well
Concurrency	Cannot handle well	Can handle well

9.6 Summary

This chapter provided the background of processes in the case study projects to enlighten the reader of how work was performed within them. Having provided the background, the cross-case analysis of the seven main processes are described in more details. The cross-case analysis of processes highlights how formal and informal processes worked in the case study projects as well as how each contributed to the work. The comparison further details the relationship between formal and informal processes to seven characteristics, namely: records, control, uncertainty, interdependence, small pieces of information, informations iterations and concurrency. The uses of informal processes are then highlighted from the data. Furthermore, the characteristics that formal and informal processes are able to handle are discussed and summarized. The following Chapter Ten is based on this section and develops this discussion into the hybrid model for communication and information management.

CHAPTER 10 THE HYBRID MODEL FOR COMMUNICATION AND INFORMATION MANAGEMENT

10.1 Introduction

This chapter builds upon Chapters Seven, Eight and Nine. The purpose of this chapter is to develop a model of construction processes in the case study projects and the guidelines for it to work. It attempts to answer the following question developed previously:

Can a hybrid model for communication and information management be developed?

This chapter shows formal and informal processes and their interaction in the case study projects as provided from the data collected and the sketches made during the interviews.

The chapter initiates by using the Ford (2003) and Park and Pena-Mora (2003) models and describing the models in phases similar to those used in practice in construction projects. The models are critiqued in regards to the terminology used and the description presented of construction processes. The formal phases and processes in the case study projects are described building on the Ford (2003) and Park and Pena–Mora (2003) models by using the outcomes from the research data.

The processes and information circulation in the case study projects are presented. From the principles of the Ford (2002) and Park and Pena-Mora (2002) models of information iteration, a hybrid model for communication and information management shall be developed. The processes shall be discussed and also provide how each of the processes relate to issues of complexity including uncertainty, interdependence of tasks, movement of small pieces of information, information iterations, concurrency and records.

The formal model of the construction process is to be developed using the rich picture diagrams for the case study projects as a basis. The processes are then simplified in order to use in the development of the hybrid model for communication and information management. A synthesis is made from the cross-case analysis, the simplification of processes and the dynamic planning models presented in the literature review in Chapter Three. The informal processes are then added to the formal process model using the research data and simplification of the processes. The Hybrid Model for Communication and Information Management is then presented and the guidelines for this process to work are outlined to provide a framework for the model.

10.2 The Ford (2002) and Park and Pena-Mora (2002) models

10.2.1 Brief of the model

The hybrid model for communication and information management is developed from the basics of the Ford (2002) and Park and Pena-Mora (2002) models. Each model is shown depicting what components of the models relate to which processes as provided in the section above. The Ford (2002) model shows information processes for a task as shown in Figure 10-1 with the comparable processes from the research. However, change and rework are not distinguished in the model and the processes are not evident as performed in practice (e.g. RFIs).

The Park and Pena-Mora (2002) model with processes from this research highlighted is shown in Figure 10-2. The differentiation between rework and change is evident in the model even though there is overlap between the two as seen in the figure. Again, the processes in order as performed in practice are not evident in the model. From the basics of both models the research processes are applied to reflect what was described by respondents during the interviews. The main components of the models are then used to develop the hybrid model for communication and information management, which shall be described in the following subsection.

Figure 10-1 Ford (2002) model compared to research processes

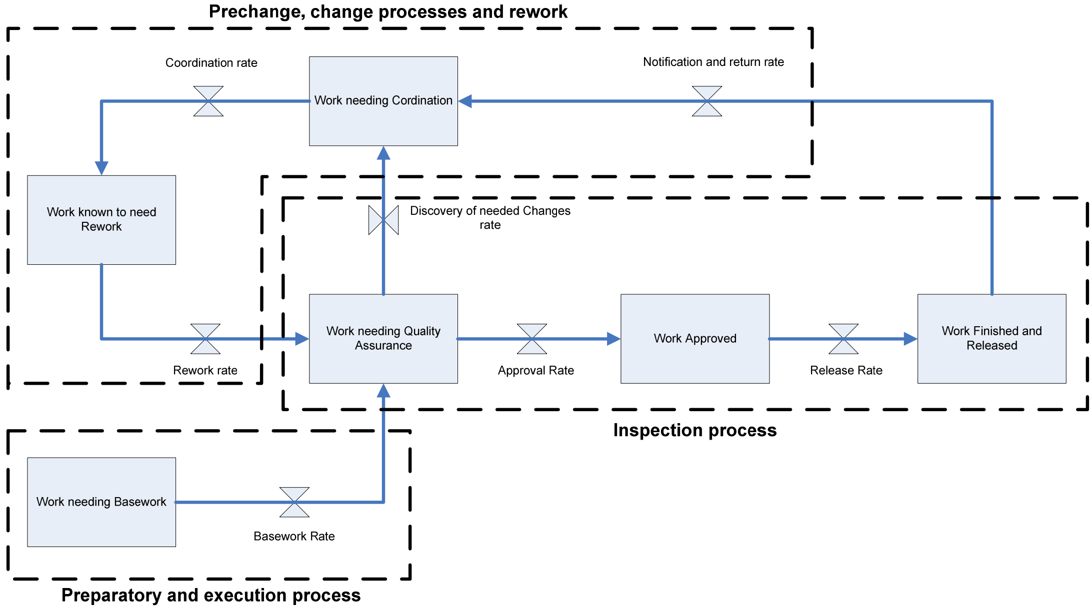
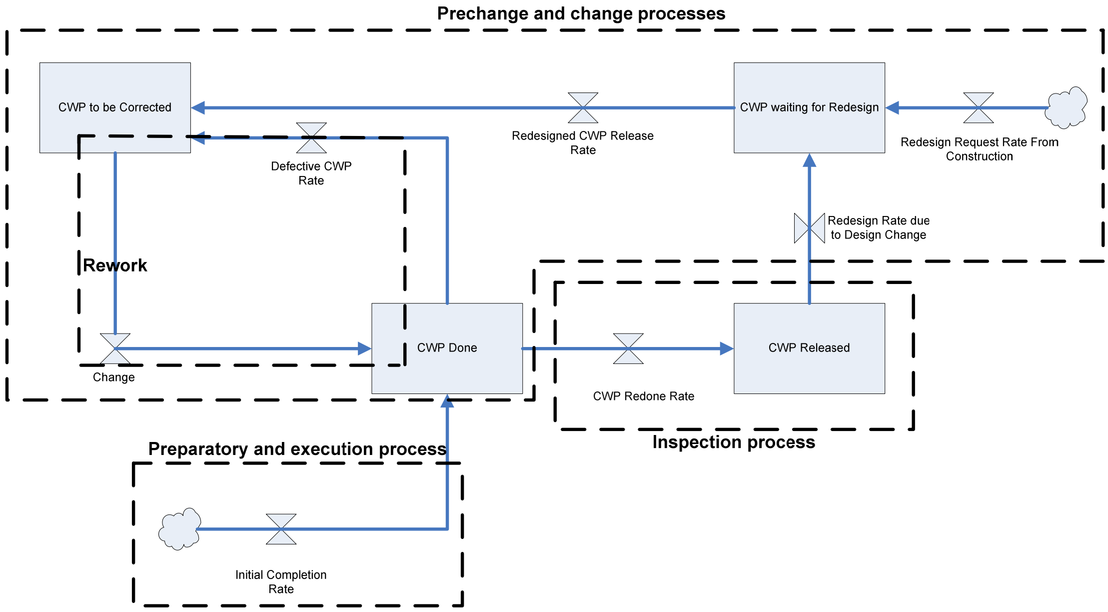


Figure 10-2 Park and Pena-Mora (2002) model compared to research processes



10.2.2 *Problems with the existing models*

The Ford (2002) and Pena-Mora (2002) models have been critiqued in Chapter Seven. In this subsection, the problems in the models are illustrated in terms of its applicability to construction practice and its ease of use by practitioners. The three main issues that were found are the terms used by the models, the processes depicted in the models and the absence of informal processes.

Terms used are not in industry

The terms used in the Ford (2002) and Pena-Mora and Park (2002) are not similar to those used in the construction industry. Examples of terms used are:

- Work needing basework, Work needing coordination, Work Approved
- Initial Completion Rate, CWP waiting for Redesign, CWP Done

These are not the terms used in the construction industry in practice. Therefore, it is difficult to understand how to relate the model to industry practice.

Processes are not same as industry:

It is also not a reflection of how the process are performed as evidenced form the rich picture diagrams of the case study projects” method of work. The terms used to describe the process in both case study projects include:

- Submittals process
- RFI process
- Inspection process

There is a difficulty to relate the processes in the case studies to use in the Ford (2003) and Pena-Mora (2003) models. For example, where would the submittals and RFI processes be indicated in these models? Furthermore, how are they interrelated is not easily visible in the models. The main phases can be viewed from the models as shown in Figure 10-1 and Figure 10-2 highlighted in the models. However, the processes within each of the main phases remains unclear relative to those used in practice as shown from the case study projects.

Informal processes not shown

The informal processes in the Ford (2002) and Park and Pena-Mora (2002) models do not differentiate between formal and informal processes even though the Authors do indicate the importance of informal processes. Furthermore, the models do not show how formal and informal processes interact. It has been recognized from the case study projects that informal processes are crucial in achieving project objectives. It is, therefore, an important part of communication and information management systems in construction projects. Hence, it is necessary to be visible in any model and to show how both formal and informal processes interact.

Each of these processes is complex and all are intercalated. In order to reflect industry practice standards the models will be modified to:

- o reflect terms used in construction industry practice
- o reflect actual process in construction process
- o reflect the informal processes in construction projects

The process shown in dynamic models should reflect what is actually done in practice. In developing a dynamic model reflecting construction processes, it can be easily read by practitioners and may be further developed for use by both practitioners and researchers.

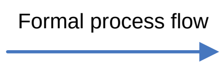
10.3 Annotation for Hybrid Model

As can be seen from Appendix 4 the processes in the case study projects are complex. A model must be developed to simplify these processes yet be reflective of how work is performed in practice. The model will use the following annotations to reduce this complexity. Each process described has a formal and an informal process. The formal processes shall be simplified and shown as follows:

Construction Phase

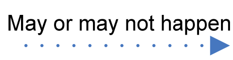
The formal process flow of informationa and work is simplified to a solid arrow indicating the direction of flow.

Process Flow

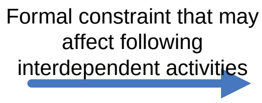


The flow of information and work that may or may not occur are presented as a dotted arrow in the direction of flow.

Process flow that may or may not occur

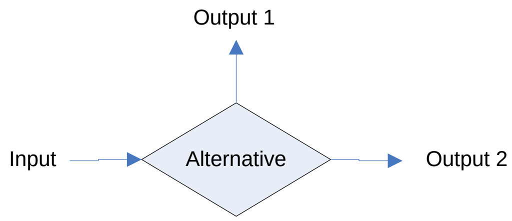


The constraints that are imposed in the process are shown as a thick solid line in the model.



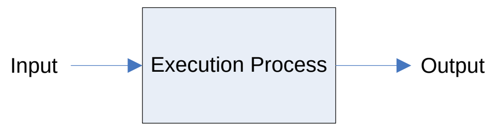
In the model decision nodes or alternative routes are presented as a diamond shape showing the information and work flow as well as the alternatives.

Decision or alternative routes node



Each process shall be depicted as a solid box frame with inputs and outputs. The inputs and outputs as stated previously are the information and work flows.

Construction Process

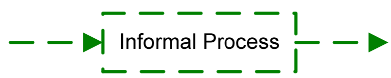


These annotations shall be used in simplifying the complex processes into a simplified model reflecting the formal processes. This is performed in the following subsection following a detailed description of the formal phases and processes.

The informal processes are ‘ad hoc’ and largely develop based on indivduals in the project. Thereby, these processes are difficult to capture. However, these processes will be shown in the Hybrid model as well as how it interplays with the formal processes, which are simpler to capture.

The informal processes and information and work flows shall be simplified and used in developing the Hybrid Model. The informal processes shall be indicated by a dashed box and the information and work flows by dashed arrows in the following way:

Informal processes and flows



10.4 The Formal Process

The main formal processes can be divided into four main phases. These phases are shown in the Ford (2002) and Park and Pena-Mora (2002) models in Figure 10-1 and Figure 10-2, respectively. The phases are listed below:

- Preparatory phase
- Execution phase
- Inspection phase
- Change phase

The three phases captured in the research are the preparatory, inspection and change phases. The execution phase was not captured as it was off limits to the research. The three main phases are divided into seven main processes, which are described in this research. The phases and processes in each are shown in Figure 10-3.

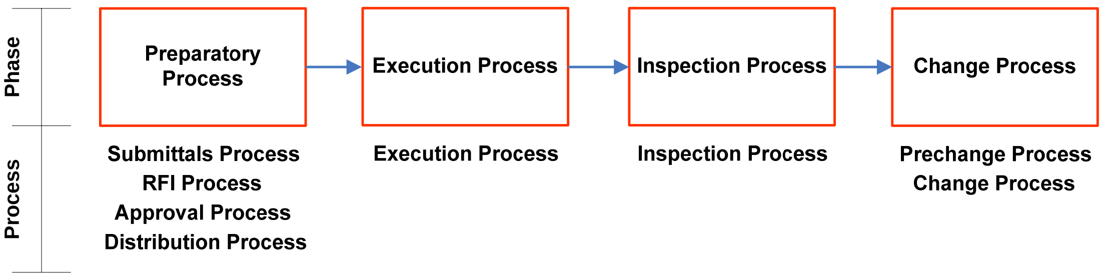


Figure 10-3 The main phases and processes in case study projects

Although the phases are all very interrelated and interdependent it is necessary to divide them for simplification to develop into a model. Furthermore, it is important to note that the change phase involves all other phases and affects them. Additionally, although the phases may seem linear in nature, they are not. Changes may disrupt at any phase and each phase may affect the transformation process of the product. For example, a change order would ultimalily affect the preparatory phase, execution and inspection phases. However, the inspection phase may find work not performed according to original designs but due to time constraints a decision may be made to change designs. This would be a managerial change according to Park & Pena Mora's (2003) definition.

10.4.1 Basics for the development of the hybrid model

The model is developed by grouping processes that are closely interrelated in an attempt to reduce the complexity of the rich picture diagrams. The first group shall be referred to as the “preparatory work”, which includes the submittals, RFI, approvals and distribution processes. These shall be assumed as one unit since a submittal would have to be performed throughout this group before reaching the execution stage that follows it. The execution stage follows and is considered separate. It is not mentioned except as a single stage as it is not within the scope of the research.

The inspection process results in various outcomes. The result of the inspection can be rework or can be managerial change if rework is considered to have a negative impact on the project as defined by Park and Pena-Mora (2003). Additionally, there may be continuous inspection during execution and may be formal (QA/QC Department) or informal where inspectors are on site providing comments.

The prechange process is largely an informal process without which changes would not be forthcoming from any source. The prechange process may be a result of a managerial decision to change design in lieu of rework. It may also occur at any point in the overall project process. The prechange process provides preliminary approval for a change proposed from any source. The end result of the prechange process is the Change Proposal, which initiates the change process.

The change process is a natural outcome of the prechange process. It can also occur at any point throughout the overall project process. The change process simply formalizes the process of documenting the preliminary approval. It provides a documented form of the change and the consequences of it, including agreements on cost of the change between client and contractor. The change process is indicated as a single process. However, its effects are far reaching and intervene in every single process, since any change would affect submittals, RFIs and would then be required to be executed and inspected. The grouping of processes shall be used with consideration of components of the Ford (2002) and Park and Pena-Mora (2002) models as shown in the following section.

10.4.2 Preparatory phase

The preparatory phase involves all activities that are required to be performed before the start of the execution phase. The submittals and RFI processes are within the preparatory phase. These processes prepare all works required for the execution phase to be performed. It is, therefore, inclusive of the shop drawings, method statements; material submittals, QA/QC manuals, etc. As indicated previously in chapter Nine these submittals follow a similar process as shown in Appendix 4 in Figure 0-1 and Figure 0-2. As seen in these figures the submittals process is complex and needs to be simplified to develop a model depicting construction process in the case study projects.

The RFI process is used in practice to ask questions and receive clarifications on the designs, specifications and other project documents. This process is shown in Appendix 4 Figure 0-3 and Figure 0-4. The response will usually be incorporated into the construction documents to be developed for execution. These documents include the drawing submittals where the designs may be modified if there is a conflict as an example. The materials submittals may be affected by a response to an RFI, and may affect the drawing submittals. For example, an RFI on an FCU may modify the dimensions of the FCU affecting the false ceiling levels. Furthermore, this may affect the procurement of the material for execution on site as ordering and shipping of the material may be affected by the response to the RFI.

The submittals and RFI processes are tightly linked and interdependent. Therefore, the completion of both is necessary to complete working documents for execution. However, when these processes are completed there are other processes to follow prior to the delivery of working documents for execution. These are the approval and distribution processes.

The approval process is in place to ensure that the documents submitted by the contractors are reflecting the original project documents. The approval process is depicted in Appendix 4 in Figure 0-5 and Figure 0-6. The process is also to ensure that there is no unacceptable deviation from documents, including quantities and costs. This process is performed by the client or client representative at site and consultants in the project. The process is long and may involve several parties. The result of the long formal approval process may be rejection or modification of the submittals, where another iteration of the previous processes is to be performed and the documents are distributed back to the originator. If the reviewing parties approve the documents they still have to be distributed to those concerned.

The disturbution process is used to ensure that documents are received and distributed in a timely manner between those concerned. The distribution process is provided in Appendix 4 in Figure 0-7 and Figure 0-8. The process is long and has many stops. It involves almost all parties that are involved in the project. The receipt and distribution of the documents are the main concern to all the relevant parties to the project, and thereby, each has a document control unit. This ensures that each party has a trackable record of documents and is contractually important to all parties.

10.4.3 Execution phase

Once documents are distributed to those concerned with the execution of the project, the execution phase may ‘formally’ start. The execution phase is mainly concerned with the physical transformation of the project. The execution phase is not included in the research as the sites in both case study projects were off limits. However, it is incorporated into the model as it is an important phase in any construction project. It falls between the preparatory phase and the inspection phase. Those mostly concerned with the execution and inspection phases are contractors and site personnel.

10.4.4 Inspection phase

The insepction phase is mainly concerned to ensure that what has been built is what was intended. The inspection process is shown in Appendix 4 in Figure 0-9 and Figure 0-10. The main problem with the ‘formal’ inspection process is that it comes largely after completion of the work. For example, a reinforced concrete slab will be inspected after all the formwork, steel, electrical conduits, etc. are in place just before casting of concrete. Any rework is difficult to perform. At times there would be a change due to time or cost implications of performing the rework. In this regard, a change can be made as a result of an inspection. The inspection may result in corrections to be made where the contractor performs the rework and starts the inspection process again.

The inspection process may result mainly in rework, a change or approval. If the result is rework then another iteration of the process is required. If a change is the result, then the change phase is started. It is noted that the change phase may be initiated at any phase.

10.4.5 Change phase

The change phase is mainly concerned with the management and control of changes during the execution of the project. Change involves mainly two processes, the prechange process and the change process. These processes are shown in Appendix 4 where the prechange process is provided in Figure 0-11 and Figure 0-12 and the change process in Figure 0-13 and Figure 0-14. Although, change was viewed unfavourably by respondents it was seen as ‘a fact if life’ in construction projects. This confirms three main points. The first is that change is difficult as it involves all phases in the constrction process. It involves changes in the preparatory phase such as submittals, RFIs, etc. It also involves changes in the execution phase as well as the inspection phase. The second point confirmed is that change involves effective communication and management to control the negative effects of change. The third point is that change may have a positive effect on the project. An example from the case study projects is when the cast-in–situ concrete was changed to precast concrete. The change assisted in achieving the schedule, made logistics more manageable and reduced the risk resulting from scarce manpower resource requirements, unavailable at the time.

The prechange process is largely an ‘informal’ one by what was perceived by respondents in the case study projects. Despite this process not being in the ‘Procedures Manuals’ of both case study projects, it was perceived as an integral part of the change phase. The main purpose of the prechange process is to discuss possible changes and the effects as well as to develop ideas that would produce beneficial changes to the project. The changes to precast concrete came through this process and brought ideas from the contractors to the attention of decision–makers concerned. The end result of the prechange process is a change proposal which initiates the ‘formal’ change process.

The ‘formal’ change process is concerned with the control and management of changes. As stated previously, changes may be initiated from any phase or process. For example, an RFI can lead to a change and so can an inspection result. The ‘formal’ change process involves almost all parties in the project. However, it is long and complex.

The formal process in the case study projects is developed from the previous description and the rich picture diagrams in Appendix 4. The formal model uses the annotations developed for simplification for the model as previously described. The formal part of the Hybrid Model is shown in Figure 10-4.

10.5 The Informal Process

The ‘formal’ model of the construction process developed is not depicting the actual processes as it neglects the ‘informal’ processes, which were perceived by respondents in both case study projects as crucial. The formal model will be developed further to reflect the ‘informal’ processes in construction projects.

Each of the processes in the case studies had a ‘formal ‘and an ‘informal’ component, which were named formal and informal processes, respectively. The informal processes were found more effective in achieving project objectives than the formal processes. Therefore, informal processes should be reflected in any dynamic model of construction for communication and information management in construction projects.

Having described the formal phases and processes as well as the informal processes, a model combining both formal and informal processes may be developed. The annotations used provide the simplification necessary to depict the complex processes and develop the model. The model to be developed is the Hybrid Model for Communication and Information Management, which is described in the following section.

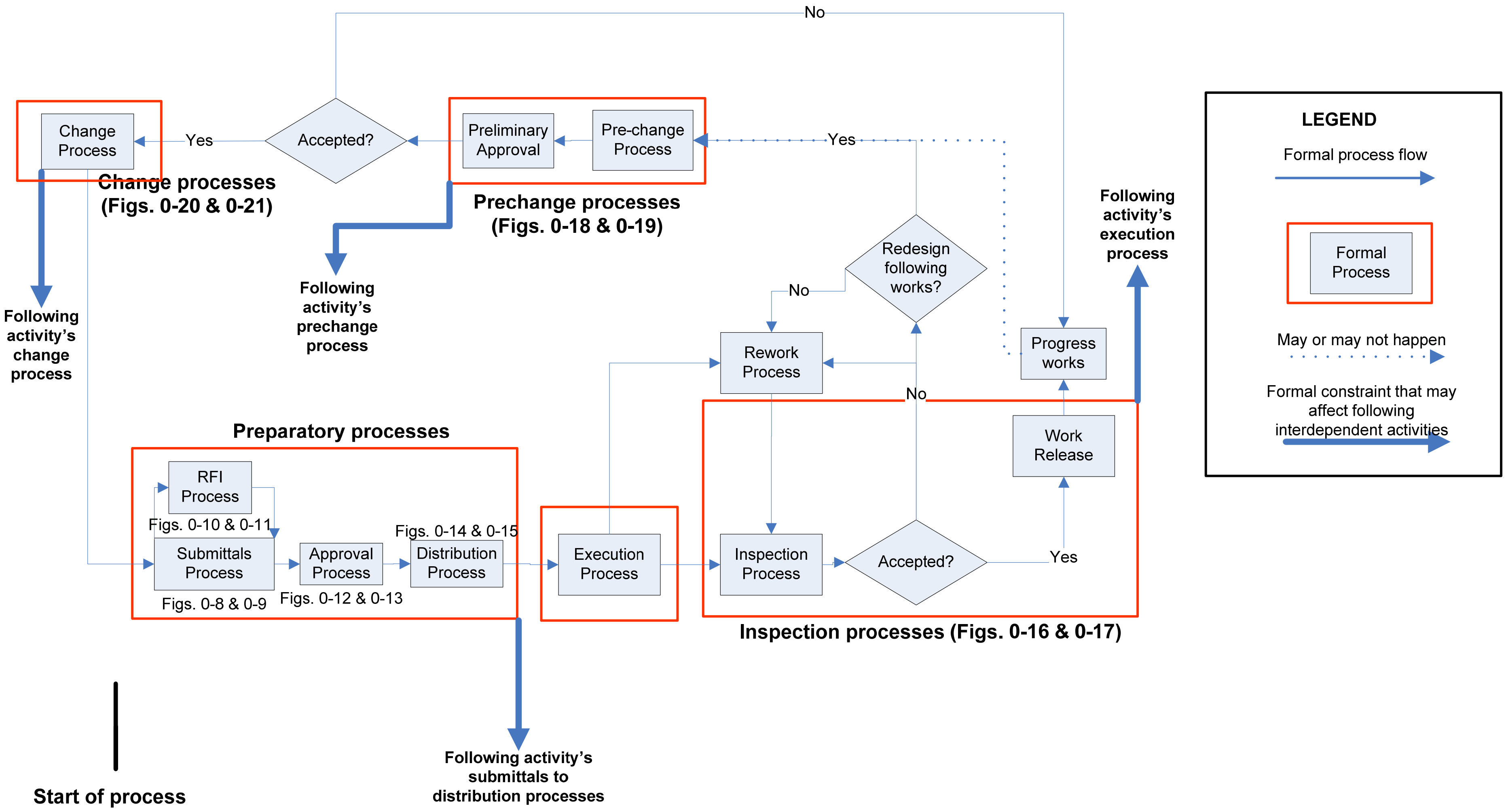


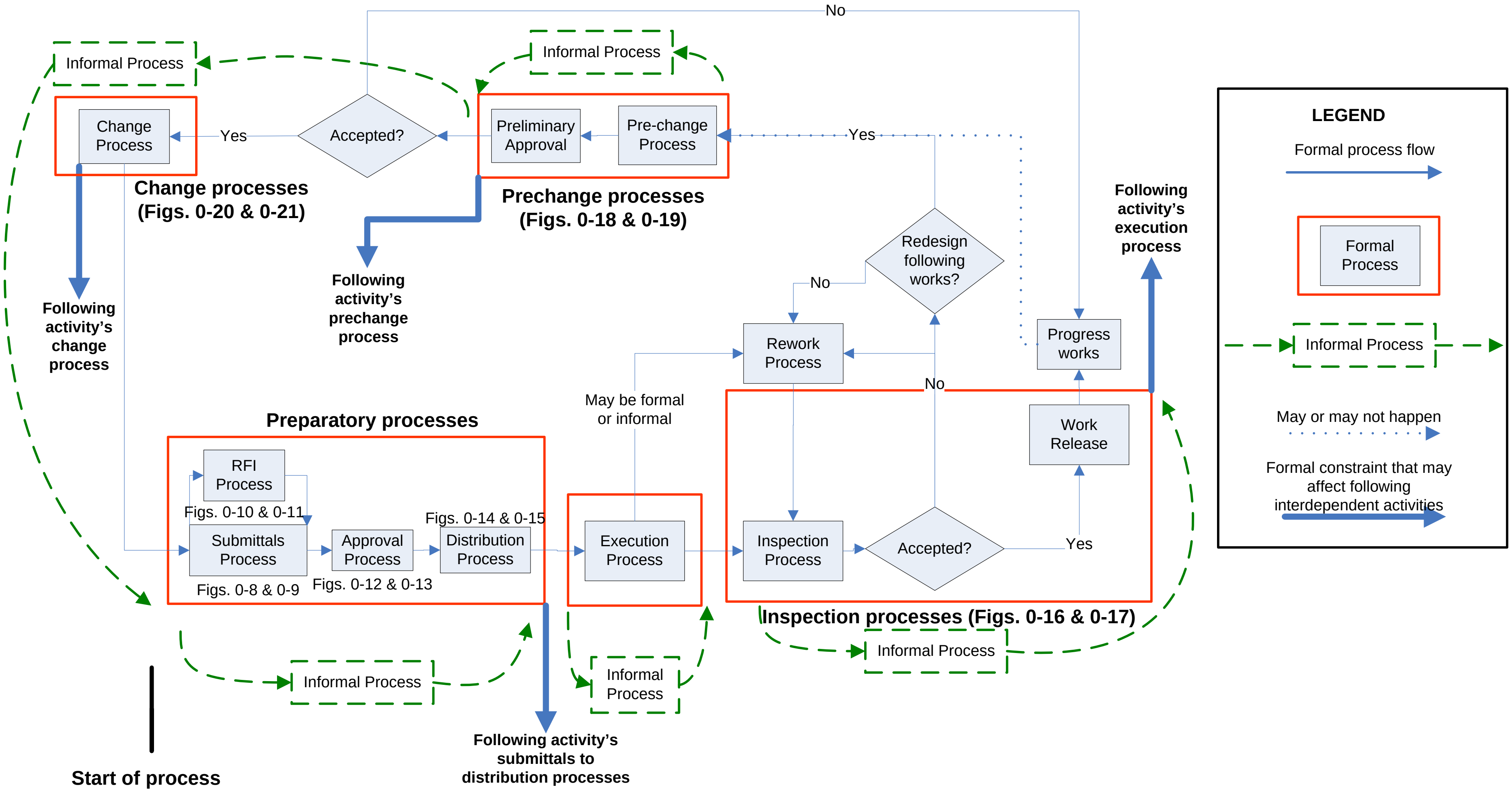
Figure 10-4 Model of formal construction processes in case study projects

10.6 New hybrid model for communication and information management

The hybrid model for communication and information management is depicted in Figure 10-5. The formal processes grouped in phases as stated in the previous section are shown boxed by a solid line. Each of the formal processes is shown in order and highlights the relationships and constraints within the model for the formal and informal processes. Each of the group of formal processes had “synonymous” informal processes in the case study projects. These are depicted in dashed boxes and by dashed arrows, which highlight the fact that the informal processes may bypass the formal processes. The informal processes are shown in detail in Appendix 4.

The model development shall consider a single task, and by simplification of the process, show how an iteration of a process is completed in the case study projects. The single iteration of the model is shown in Figure 10-5. The site construction process starts once the construction documents are provided to the contractor. The contractor reviews the construction documents and prepares the submittals required, such as shop drawings and materials submittals. Once completed the submittals are sent to the consultant for review and approval. Within the submittals process, there may be questions by the contractor where there is interdependence between the RFI process and the submittals process. Submittals rely on RFIs and vice versa. This interdependency itself causes an iterative process as can be seen in the process diagrams in the submittals and RFI processes. Once this interactive cycle is completed and there is sufficient information to provide the completed submittal it is sent to consultant for approval. The approvals process itself is quite lengthy, particularly in mega projects where there are several contractors and subcontractors, as well as consultants and subconsultants with various specialties, each independent from the other (i.e. different organizations). If the submittal is not approved then it is returned to the contractor for resubmittal, where the process described above is repeated. If the submittals are approved, it is sent through the distribution process, which is a lengthy process as shown in Appendix 4 in Figure 0-7 and Figure 0-8. This description is for the preparatory group of formal processes.

Figure 10-5 Hybrid Model for Communication and Information Management



The informal preparatory process is much shorter as shown in figures in the rich picture diagrams of the processes in Appendix 4. The reason is that there are more communication channels and open to anyone concerned and are decision-makers. Contactors' staff may simply go to the consultant staff, client staff, as well as other contractor staff and discuss what is of concern, get a preliminary agreement and act upon decisions made informally. At the same time, all agreements can be documented and sent through the formal process once. This helps in several ways:

- Small pieces of advance information required may be provided to complete submittals relying on it. Hence, cutting the time required considerably settling concerns of interdependence
- Agreements are reached quickly
- Action based on informal communication may be acted upon if required (i.e. if there is urgency)
- The iterations through the formal processes are minimized. In essence, the informal processes bypass the formal processes to get work done and follow it with documents through the formal processes.

If there is urgency, execution may start based on informal decisions until formal processes take their course. The execution process is the actual implementation of the documents approved and distributed through the formal channels, or agreed informally awaiting approved document distribution. The execution phase is considered as one phase simply because the research scope could not cover it. However, the informal process can help in that a subcontractor may not have received a formal instruction but can work based on informal agreements with supervisors until formalities are completed.

Once execution of the task is completed, the inspection process is initiated by the contractor. This process is shown in Figure 0-9 and Figure 0-10 in Appendix 4 for the case study projects. The inspection request is provided by the contractor directly to the consultant in both case study projects, and a copy is sent to the client or management team. The consultant provides a time to inspect and goes to inspect at the scheduled time. The result of the formal inspection is either to accept the work, to provide comments, or reject the work. In all cases the consultant responds on the inspection sheet and it is documented and sent through the formal process with a copy to the client or management team. If there are comments or a complete rejection, there is rework. In some cases the non-conforming work changes the design based on client or management team approval. Rework as defined by Park and Pena-Mora (2003) is correction of work to be as what was originally intended. In the case of rework, the comments are corrected by the contractor. Once rework is completed the inspection process is restarted.

As can be seen from the processes, the formal inspection process is rather long and several iterations may delay the following task. The informal process reduces the iteration by contractor, consultant and client staff by meeting up on site, agreeing informally on any comments; perform required rework and following this by formal procedures. If informally the work is accepted, the following tasks may start whilst formal procedures are completed. Unless there are changes, the inspection process stops here.

Changes may be initiated from any source as shown in the prechange process. In this particular process, there is a mixture evident between the formal and informal processes. This may start simply from someone's idea which is spread to various people of concern and which may find preliminary approval by staff and "resonate" to reach the client, which may lead to a change. Change may also come from completed work on site which is not according to intentions, whereby the following task may change their work to accommodate if rework is viewed by decision-makers as prohibitive.

Once a change goes through the prechange process and is approved, the change process starts. Change in this research takes Park and Pena-Mora's (2003) definition of management change. Change involves redesign, sketches, costs and whatever is necessary for the contractor to modify and complete the task. In both case study projects, change instructions were of two main types. The first is for urgently required changes to be implemented. In this case the contractor is instructed to perform the change and submit costs to the client. The second is a change instruction which is not urgent where the contractor is to provide the cost of the change, and only if approved by the client should he proceed. Both of these changes have iterations within them. In the first case, the iterations come after work is started and is largely to achieve an agreed cost. In the second case, the iterations come before the change is started, which is largely to achieve an agreed cost.

The change process is long as can be seen in the figures for processes shown in Appendix 3 for the case study projects. The informal process may reduce the time and iterations in the change process by the concerned project participants agreeing informally on the change, starting implementation and following up with the formal process. This is seen in the examples provided by project participants in Project 1 where a slab ready to be cast was at last minute stopped by the consultant. The consultant, client and contractor staff met and agreed on changes, which were implemented quickly and followed by formal procedures.

In this model it is to be noted that change can occur at any stage within performance of the task. Change does not necessarily occur after work release following the inspection process. Change can occur during the submittals process, execution, or even inspection process. Additionally, where extremely urgent situations occur, the informal process for change may even “skip” the submittals, approval and distribution processes and directly to execution of the change, following through with formal systems. The informal process can bypass many of the formal processes depending on urgency, preferences of individuals and needs.

The formal process as described previously is necessary. However, if the formal process is followed strictly it is a long and tedious process that is followed. During change, the process is even longer and even more tedious as it involves all the processes. The length of the process creates a further issue if there are any iterations of the information. One can just imagine if a drawing has to go through the long official process several times, in addition to several times if there is a change.

Figure 0-1 to Figure 0-14 in Appendix 4 present the processes for information flow in the case study Projects 1 and 2, respectively. The processes are shown in rich picture format. The complexity of the processes is evident in the diagrams. Additionally, if the formal processes were followed strictly by the staff in the projects, it is evident that there would be serious delays. The length the information must travel is very long and the path has many stops to ensure that the documents are controlled. This situation is even worse when there is a change as it adds to the length the information must travel as well as an increase in the number of stops.

When a change occurs, it causes information iterations. This naturally has a time impact and may cause repercussions to other information that are interdependent with it. The ideal situation is to reduce the iterations of information during change in order to reduce the time impact of information exchange. However, it is not practical to assume that the formal process would do that as it adds processes to the already long formal process as can be seen above. The path of the information is increased. If there is any iteration it becomes even longer. The length and complexity of the formal process is evident when seen in conjunction with the rich picture process diagrams presented in Appendix 4.

As stated previously, both case study projects had time and cost as critical and would not be changed. Therefore, the activities became more and more concurrent as time went by, particularly when changes were introduced. A statement by a contractor staff in Project 1 was:

It's very difficult to get something finalized in terms of a design or concept. Until that's done, we at the hard end of the concrete delivery, we can't move forward comfortably until all the boxes are ticked. Invariably, the end date of the project never shifts. What happens is, the point at which all the information is available, becomes later and later and later. So the project duration squeezes from the start back up towards the end and you're forced to work in an environment where you are hand to mouth, where you have to respond very, very quickly to information. ***Coordinator-Contractor-Project 1***

By the logic of the vicious circles of parallelism described by Williams et al. (1995) and reinforced by Ford (2002) and Park and Pena-Mora (2002), the project would spin into a vicious cycle of iterations whereby delay and cost overruns would be results. However, despite the above logical explanations, neither project seemed to be in delay nor over budget and both had changes during project execution.

It is the intent of this section to explain why the projects, despite having many changes and interdependent tasks, did not go through this vicious cycle of parallelism. The formal process would have ended both projects into the vicious circle of parallelism as information required by one task would have to wait for information from another task to complete its process. This interdependence would mean several iterations through the long and complex formal process. The formal change process was suggested to be modified by some respondents in Project 1.

Three of the main items that we will change, if we were to do a similar thing again, wouldn't be the idea of an integrated team or the way this has been managed. Its certainly the processes we have in place for the number of major issues, which is change management, variations, alterations and add-ons that we would give to various contractors. ***Project Leader-Project 1***

It's absolutely typical of our business the things that cause problems, delays in responding, delays in resubmitting, and inconsistencies in resubmitting and inconsistencies in responding. This whole business is drawings in and out, for review, submittals in and out too, submittals in and out for review. ***Project Leader-Project 1***

This was not very much appreciated by the vast majority (approximately 85 %) of respondents in both projects. However, due to the higher complexities in Project 1, the deficiency of the formal process was very evident. This was particularly true of changes and the formal process of issuing a change order. One of the contractor's staff stated:

Potentially, you have to respond to advance information that isn't issued formally that might change, and there is no adequate time for review, and that leads to mistakes. ***Coordinator-Contractor-Project 1***

The staff actually bypassed the formal process and agreed informally on solutions and then followed it through by the formal process for documentation purposes. The informal process is highlighted by dashed lines in the figures of processes in Appendix 4. It shows how the project staff bypassed the formal system, which took too long. In one statement one of the project staff stated regarding change instructions:

What really could happen is the package QS could go to the Client QS and discuss it directly and that would circumnavigate four or five signatures. ***WPM-Project 1***

In reality, that is exactly what would happen, particularly in an urgent situation. Agreement would be made between the staff informally and the change would be initiated without any formal procedures, which would follow thereafter.

The informal process devised by the staff was actually what allowed the project to be on time. The informal process allowed the information to be flowing quickly and work to progress by not delaying an issue. The information would be agreed and any interdependent tasks requiring this information would flow to it simultaneously. This was done by circumventing the formal process. This was especially true of urgent situations where very fast decisions had to be made on the spot. In cases like this, waiting for the formal process would have caused a delay, particularly for critical activities where a delay would occur in subsequent activities. A case in point is the example stated by one of the contractor’s staff of the slab that was modified to accommodate the dome where the concrete was being prepared for casting of the slab.

The informal process worked well in both case study projects. It also worked well with the formal process. This is particularly true of Project 1 since it was more complex and had more changes throughout the project execution. There was a general agreement from the respondents in both case study projects that the informal process was successful in large part due to human factors. This is clear from the interviewees who responded that the construction industry is a people based industry and from their descriptions that people “glued” it together. Following are statements from respondents:

I think this is once again there is a lot of greyness in here and what keeps it all working is the commitment by good professionals in all four of these right here. I don’t think that the systems or processes are what, set up in the management system, and what keeps us glued together it’s the people to people who glue it together. And I *don't know if that is calling as systems or just the nature of the people who are on this job.* ***Consultant-Project 1***

But overall it works quite well. I think the idea of everybody working as a team is the idea that's gonna flourish in Dubai. You have people who are a team. You are schedule driven very often. Projects must be completed on time, because time means money for the client, especially in this case. You need to start getting paying customers to this project. So, in a time driven project, schedule driven project, teamwork is very important. You need to talk to people. You need to understand each other. ***Consultant Project Manager-Project 1***

Is there anything that's done well? (Laughs). Yeah, I think … I think there's a, ummm, there's … there's a commitment to getting problems solved, nobody just … nobody throws their hands up and say, "I quit". ***Consultant-Project 1***

As is indicated by the above responses, it is found that the human dimension plays a major role for the success of a construction project. Since the informal process has been established as key to enhance communications and reduce time impacts of change, then the human factor is critical in any construction project, particularly mega construction projects. The following section provides guidelines for the Hybrid Model for Communication and Information Management to work.

10.7 Guidelines for use of the Hybrid Model

10.7.1 Introduction

The importance of the client or client representative as well as the characteristics of individuals in construction projects has been established in Chapter Seven. It has been identified that informal processes are "chaotic' and are 'ad hoc'. Individuals in the projects are the 'controllers' of informal processes as they are established by them. Managers are able to control formal process but have no control over informal processes. Therefore, managers can only establish a culture conducive to effective communication and information management in construction projects.

It has been mentioned that informal processes may lead to disasters by informants in the case study projects. They can be a source of problems. The disadvantages of informal processes have been provided in Chapter Seven. Alongside the disadvantages of informal processes there are many advantages which have been presented in Chapter Seven. It was seen that informal processes are capable of reducing the effects of complexity, interdependence, concurrency and information transfer is fast. However, the main disadvantages are that informal processes can become counterproductive when “bad” politics and rumours are in play and informal systems leave no records.

The formal processes have many disadvantages, including being slow and unable to reduce the effects of complexity and interdependence or achieve concurrency. However, the advantages of formal processes are that of maintaining records and ease of finding them. There is a need for maintaining a trackable record of project information in construction projects.

It is evident that the advantages of formal process are the disadvantages of informal processes and the disadvantages of formal process are the advantages of informal processes. They are, thereby, complementary and should work together to achieve project objectives. However, it is necessary to find what makes informal systems work in tandem with formal ones to achieve project objectives, which is developed in the following subsection.

10.7.2 Client characteristics

In Chapter Eight, the chracteristics of the main parties to the case study projects were compiled from the data. It was found that the characteristics of the client or client representative were crucial in establishing a culture for effective communication and information management. Furthermore, it was concluded that the characteristics of individuals in construction projects was crucial in achieving project objectives. These characteristics were conducive to effective communication and information management.

The characteristics of the client that were conducive to effective communication and information management were compiled from the data as shown in Table 10-1. It is clearly mentioned by respondents that the client played the most important role in creating a culture that fosters effective communication and cooperation amongst the project team. The client should be knowledgeable of construction processes as this would assist in understanding of how effective communication is performed, and thereby, encourage informal communication to complement the formal system. It will be known to them the pragmatism required and not to be rigid with formal systems. However, they would also know that the formal systems must follow any informal agreements.

Table 10-1 Characteristics of client or client representative conducive to effective communication

Description of characteristics
Knowledgeable of the construction process
Knows what he wants
Has clear objectives and sends consistent message across
Has a collaborative attitude
Fair and reasonable
Encouraged informal communication and processes
Willing to take risks
Proactive and involved
Makes decisions and resolves problems quickly
Accepts alternatives
Maintains open-door policy
Provides leadership
Controlling
Chooses contractors and staff well

The client's knowledge of construction processes would make him understand that construction requires collaboration amongst the team. It would, thereby, make the client encourage collaboration and discourage anything that will affect that. In this regard, the client would be more proactive and involved in the project for achieving project objectives. That would include taking risks alongside the contractors and consultants to make them feel more 'secure'. Furthermore, the client would be proactive by making decisions and resolving problems quickly and not allowing

With knowledge of construction processes, the client must know what he wants and convey that to the project team. Even if there are changes made by the client, the project team would 'feel' whether the client knows what he wants or not. In Project 1, the client made many changes, but the project team was convinced that the client knew what he wants. This was relayed by having clear objectives that were sent consistently across to the project team. In the case of Project 1, the development was to attract tourists from the Gulf region by providing a theme park that was not in the area. The changes assisted in making this realization more practical, and as such the team understood that and were convinced that the developers knew what they were doing.

The client must be present and proactive and as such should maintain an open door policy to settle any problems swiftly and to know what is happening on site. Furthermore, maintaining an open door policy may allow ideas to be provided to enhance the project or at least achieve project objectives. In both case study projects complaints voiced by contractors against individuals in the consultant teams led to the client removing them from the project as they were not collaborative. This further reinforced the culture as it was clear that the clients were not interested in ‘blaming’ and throwing responsibility at any individual or party. They were more interested in having a collaborative environment which would deliver the project on time, within budget and in an acceptable quality.

The clients in both case study projects were characterized as being fair and just. The above example reinforces that where the contractors were found to be ‘unduly’ delayed by the consultant staff. At other times, the client’s management team members were reprimanded if found ‘uncooperative’. Furthermore, the clients of both projects were keen on resolving any outstanding variations quickly and fairly in order not to have any claims from any party when the project is completed. Furthermore, in both case study projects, respondents from the contractors’ staff viewed that the client staff always ‘backed up’ what they said. This led to the contractors trusting what the client staff said they would do. In fact, several changes were made based on that trust informally, which was followed by formal documentations.

The clients in the case study projects were visible and present and seemed to be anxious to achieve project objectives. This was not common in Dubai and was viewed as an advantage in the case study projects. The clients provided the leadership that was required to achieve project objectives as seen from the examples stated above. Furthermore, the clients were controlling the site well as respondents indicated. This control was necessary in order to allow work to move forward ‘smoothly’. For example, at times the contractors would provide ideas and alternatives to the designs, which the consultants would not be happy with. Through the open door policy, the client would listen to both sides and choose the course of action that seemed most reasonable. Once that decision is made the clients saw to it that it was done.

The alternatives and ideas came many times from the contractors in both case study projects. It was viewed that both clients chose the contractors well. The contractors were not chosen based on costs but rather on their capabilities and abilities to perform the case study projects. The awards of contracts came mainly through negotiations in Project 2. In Project 1, the contractors were prequalified based on each work package, and the tenders were awarded to the contractors that were most qualified to complete that particular work package.

It has previously been indicated that in both case study projects the clients were involved in the choice of key staff of contractors, QCs and consultants. It was viewed by most respondents (about 80 %) that the client chose staff well. It seemed that they accepted staff not only on the basis of technical know-how, but even on ‘attitude’. Therefore, any staffs entering the projects were viewed as ‘trustworthy’, which was another reason for achieving the collaborative attitude seen in the case study projects.

10.7.3 Individual characteristics

In Chapter Eight, the charcteristics of individuals in the case study projects was viewed as a requirement for effective communication and information management. These characteristics themselves were not the ‘direct’ reason for achieving that but were conducive to achieving it. This was in order for both formal and informal systems to work in tandem to achieve project objectives. These characteristics are provided in Table 10-2.

Table 10-2 Characteristics of individuals in construction projects conducive to effective communication

Description of characteristics
Committed to solving problems
Qualified, experienced and capable
Professional and focused on objectives of the project
Pushing to establish trust
Proactive and responsive
Maintained cooperative working relations
Were kept under pressure and able to work
Versatile and adaptable
Know what they were doing
Maintained good follow-up

The perceptions in both case study projects were that the project team was qualified, experienced and capable. This was a positive view as it provided an element of 'trustworthiness' amongst the team. Several respondents even stated that establishing their trustworthiness was very important in construction projects. This would be a starting point for the ability to cooperate. Furthermore, it was perceived that the project team was professional and focused on achieving the objectives of the project. There were rarely any cases where there was any 'political' element that would distract the staff from achieving project objectives in the case study projects. It was, therefore, no surprise that the staff perceived others to know what they are doing.

To enhance the positive view of the staff was the proactive and responsive attitude that the majority of respondents (approximately 75 %) perceived to be present in the case study projects. This proactive and responsive attitude was an element that the staff viewed necessary for 'trust' to develop amongst the project team. Respondents viewed that anything required from anyone on the project teams were always responded to in a proactive manner. If problems arose, the staff would try to resolve them, mainly through the network. This allowed for versatility and the ability to adapt to situations before anybody took a 'staunch' position on a certain issue. Once decisions were made the staff followed it up to its implementation.

With all the above descriptions of staff by the team members in both case study projects, it is not difficult to see that there was a collaborative culture in the case study projects. The project team members seemed to maintain good cooperative relationships in the cvase study projects. This is despite the pressures that the project team was under to perform, each by their respective management.

10.7.4 Guidelines for the Hybrid Model

From the research analysis it was found that the characteristics of the client staff and the individuals in the project team were crucial in achieving effective communication and information management in the case study projects. These characteristics were found to be conducive to a culture that would establish effective communication. The main reason for this was found to be that these characteristics affected the positive use of informal processes. As stated previously, it was found that informal processes were established and maintained by the individuals in the projects. It is, therefore, logical that the charcteristics of the individuals in the projects would have either a positive or negative effect on informal processes. Since informal processes are found to be an important part of the communication and information systems in construction projects, anything that impacts it will impact the effectiveness of these systems. Therefore, the characteristics summarized in Table 10-1 for the client and Table 10-2 for individuals in the project were found to be crucial for establishing effective communication and information management systems in the case study projects. Through these characteristics the informal processes would work with formal processes effectively for the achievement of project objectives, and thereby, are guidelines to be used as a framework for the Hybrid Model developed..

10.8 Summary

The chapter has presented the Ford (2003) and Park and Pena-Mora (2003) models highlighting the main construction phases in them. The models were then critiqued regarding the terms used in the models highlighting that they are not used in practice and that the construction processes are not presented as used in practice. Using the Ford (2003) and Park and Pena-Mora (2003) models as a basis, the terminologies and construction processes were changed to that used in the case study projects.

The formal construction process was developed using the research data and rich picture diagrams and simplified to develop the formal part of the Hybrid Model. The importance of the informal processes are described and added into the formal part of the Hybrid Model to present the Hybrid Model for Communication and Information Management. The Hybrid Model and how it works is described highlighting how the formal and informal processes work together and their interplay.

The guidelines for the Hybrid Model to work are presented and its importance is highlighted to act as a framework for it. The charcteristics of the client staff is described and how they impacted overall communication and information management in the case study projects. The characteristics of individuals in the project teams are summarized and described as well as how they impacted the overall performance of the cases study projects. These charcteristics were then justified as guidelines to act as a framework for the Hybrid Model to work effectively. The following chapter provides the validation process for the formal and informal process as well as the Hybrid model and the framework developed.

CHAPTER 11 VALIDATION OF THE RESEARCH

11.1 Introduction

Borret et al. (2007) state that ‘models are critical tools for determining how elements combine to generate the complex system dynamics that we observe in nature’. It is thereby imperative to check that the model of what was observed is ‘actual’ depicting the reality of the system. In an attempt to confirm ‘observed’ with ‘actual’, the hybrid model for communication and information management and the framework were sent to practitioners for evaluation and feedback on ‘practicality’ and ‘need’ of the system in practice.

This chapter presents the results of the evaluation process. This is performed using the validity measurements used in the literature. This chapter initiates by providing the objectives of the validation of the research. The measures of validity followed by the objectives of the evaluation process. The responses to the evaluation exercise are provided and discussed.

11.2 Validation objectives

The validation of the model and framework focuses on evaluation of the conclusions and findings of the research. It is also important to acknowledge the significance of the research findings to the construction industry. Furthermore, it is important to evaluate how the research findings have met the goals and objectives of the research (Bryman and Bell, 2003 and Yin, 2003b). In order to achieve this, the objectives of the validation process are set forth:

1. To verify and validate the existence of both formal and informal communication channels in mega construction projects as well as when each is used.
2. To verify and validate the advantages and disadvantages of formal and informal communication as well as the need for both in mega construction projects.

3. To verify and validate the interaction between formal and informal communication as presented in the hybrid model of communication and information management developed for mega construction projects.
4. To verify, validate and evaluate how and under what circumstances informal communication is able to reduce complexity factors, thereby reducing information iterations, reducing the negative effects of change and achieving concurrency.
5. To verify and validate the importance of top management, particularly of the client, in establishing effective communication and information transfer in mega construction projects.
6. To verify and validate the importance of individuals in mega construction projects and their characteristics as a group which are conducive to implementation of an effective communication system.
7. To obtain feedback for improvement of the findings and to highlight any disagreements with the findings.
8. To obtain suggestions that would provide future directions of research.

11.3 Participants in the evaluation

11.3.1 Importance of validation

Yin (2003) states that the third tactic to be used for construct validity is having the case study report reviewed by key informants. He advocates that the participants and informants review the draft case report and comment on it, which may be published as part of the case study if helpful. Bryman and Bell (2003) add that respondent (or member) validation is the process by which the researcher provides the participants in the research conducted an account of the findings. The aim of this process is to check agreement or disagreement of the account the researcher has arrived at (Bryman and Bell, 2003) and should be refined in light of the subjects' reactions (Reason and Rowan, 1981 c.f. Silverman, 2005).

This has been popular in qualitative research as a check of fitness between the research findings and perspectives and experiences of the participants. The form of respondent validation varies. The researcher may provide each participant with the account arrived at or feed back to a group from the participants (Bryman and Bell, 2003).

11.3.2 Respondent validation difficulties

Bryman and Bell (2003) state that respondent validation has practical difficulties. First, it may meet with defensive reactions from the participants and even censorship. More importantly, respondent validity is highly questionable as it means that inferences are being made for a business and management academic audience. Even though respondent validation provides a positive response, the researcher still needs to provide a framework for publication through the development of concepts and theories. Silverman (2005) states that problems arise when giving privileged status to accounts of informants and cites a statement by Fielding and Fielding (1986: 43):

there is no reason to assume that members have privileged status as commentators on their actions … such feedback cannot be taken as direct validation or refutation of the observer's inferences. Rather such processes of so-called 'validation' should be treated as yet another source of data and insight.

If participants in a study may not really 'validate' the findings, then should other 'non-participants' be provided the opportunity to 'refute' the findings? After all they would not take a defensive stance, and thereby, would probably be more objective in their assessment of the findings. In this research the refutability principle has been applied to validate the findings. The refutability principle provides that the evidence leading in an interesting direction must be subjected to every test (Silverman, 2005).

An added impetus to use non-participants outside those participating in the research is to attempt to reduce the criticism of generalizability in qualitative research. The intent of qualitative research is to generalize to theory and not to populations (Yin, 2003b and Bryman and Bell, 2003). It is the inferences made from qualitative data that is critical in assessment of generalization (Bryman and Bell, 2003). Gillham (2000b) states that in human behaviour, generalization from one group to another is suspect due to the fact that many elements are specific to that group. Gillham (2000b) adds that theories cannot be proven; only disproven. In case study research everything is weighed and sifted and checked and corroborated (Gillham, 2000b).

The research findings are "possibly generalizable", which is the nature of grounded theories. In essence, they are starting point of research rather than definite proof. In this regard, the purpose of the research was to propose a new grounded theory. The generalizability would rest with future researchers applying the theory in a different context than which it was studied (Marshall and Rossman, 2006).

Although, generalizability to other populations, settings and contexts may be problematic, this weakness, as viewed by positivists, may be counter challenged. This may be done by establishing solid theoretical parameters for the research where policy makers may determine its generalizability. Additionally, readers and users may see how the research ties into a body of theory (Marshall and Rossman, 2006).

However, a theory developed in one context with one group may be generalizable to another group in a different context. To test this means that a broader group of respondents in different contexts should be used to evaluate the theory and its generalizability. Despite this attempt to generalize out of the context in which the research was conducted, no conclusions are declared regarding generalizability to the population. The extent of "generalizability" of the findings of the research is mainly left to future research. The attempt is to test the theory developed and possibility of generalizability to other contexts.

11.3.3 Choice of participants for evaluation

From the previous section it was decided to use 'non-participants' in the research study to evaluate the findings. 'Participants' in the research were also used to evaluate the model and framework. The participants in the evaluation included key informants and others who were provided through acquaintances. The 'external participants' were of similar experience to respondents from the case study projects. They were to have similar experience in mega construction projects. Further details on the respondents are provided in Table 11-1.

Table 11-1 Respondent data

No	Participated in research	Construction experience	Value of largest project (USD)	Description of work	Years worked in Gulf states	Countries worked in
1	Yes	20+	Billion +	Project Manager	--	UAE
2	Yes	30+	Billion +	Sen. MEP Manager	--	UAE
3	No	10+	Billion +	Design Coordinator	4	UAE, Qatar, Yemen
4	No	30+	Half Billion +	Design Manager for PM/CM	10	KSA, UAE, Qatar
5	No	15+	Billion +	Sen. MEP Manager	11	--

11.4 Feedback required for validation

Due to resource constraints it was found that open discussions via telephone conversation following an email of summary of findings and the main questions was the most appropriate for use in evaluating the research findings. A total of 5 evaluators with experience in mega construction projects participated in the evaluation process. Feedback was gathered on the following findings:

- Formal and informal communication channels, formality of each and how and when each is used as well as advantages and disadvantages of each.
- The importance of formal and informal communication, when each is used and advantages and disadvantages of each.
- Times when informal communication is particularly used and the relationships of complexity factors and the abilities of formal and informal processes to handle each.
- Verification and validation of the hybrid model developed and the interaction between formal and informal communication and how the main parties may use the model.
- The importance of top management characteristics for effective communication, particularly the client.
- The importance of individuals and their characteristics in fostering effective communication.
- Establishment of the importance of researching formal and informal management systems for the construction industry and future directions in the research.

11.5 Confirmability

The concern of the confirmability construct has to do with the researcher’s bias. In this regard, the thought process during the analysis of the research is made clear. Furthermore, the credibility construct concerned with the believability of the findings would also be made clearer through the thought process and the steps taken during the execution and analysis of the research. Additionally, a part of credibility has been settled from the previous sections through the responses to the questionnaire.

11.5.1 Execution process

The test of reliability aims to demonstrate that the procedures of the research may be repeated and should arrive at the same findings and conclusions (Yin, 2003; Bryman and Bell, 2003). Yin (2003) stresses that emphasis is on performance of the "same" case over again and not on "replication" of the same results from one case to other. The goal of reliability is minimization of errors and biases in a study (Yin, 2003). To avoid poorly documented procedures, Yin (2003) recommends the use of two tactics, namely: (1) use of a case study protocol and (2) development of a case study database.

11.5.2 Research activities prior to conduct of interviews

To achieve the aims and objectives of the research meant to provide questions that were rather "generic" and probed various aspects with an open mind. In essence a largely inductive approach was used initially from establishing the questions for the semi-structured interviews and probing into interesting tangents that became evident during the interviews. The semi-structured interview was chosen as the most appropriate method.

11.5.3 Pilot study of interviews

Two pilot interviews were performed on several people who were similar to those that will respond to the interviews that would be conducted in the case study projects from different projects. They were from different nationalities and varying experience. The purpose of the research study was explained to them. The interviews were conducted as actual cases and included probing the tangents that were found to be interesting.

Following the pilot interviews the respondents were asked to comment on the questions and to provide input. They were satisfied that the questions were relevant and found that the questions were sufficient to achieve the aims and objectives of the research. However, the pilot interviews resulted in a slight modification to the method of conducting the interview. The modifications were:

- The communication table was dropped from the interview cases completely. This was done because the information provided was found not to be useful. The information was better shown on the organization charts described by the respondents. That is what finally had been done in the case study interviews.

- o Additionally, the time required for filling the communication tables was excessive. It took over 20 minutes to fill out. The interviews ended being over one hour and 40 minutes, which was too long for respondents who were very busy. Removing the communication table allowed the interviews to remain within one hour and a half.
- o The procedure of applying the interview was toned and the questions were slightly modified for clarity.

The data was found to be of the quality required to achieve the aims and objectives of the research. The following step was to find two case study projects that were willing to participate in the research.

11.5.4 Search for project case studies

The search for prospective case study projects had been ongoing even prior to my arrival in the U.A.E. through a network of friends. Prospective projects had to be within the population as described previously. Letters were sent to several prospective projects (shown in Appendix 6) and meetings were held with others. The letters were provided with a letter supplied from the university and a brief summary of the research. However, the majority of projects approached either did not respond or declined to participate in the research on account of time constraints. Sometimes one party to prospective projects would refuse to participate and this was considered to be a shortfall by the author and was rejected on that account. However, management in Project 1 had shown interest in the research and the author met with management to further clarify the research and schedule interview times.

During our initial meeting management refused one of the questions, which was:

"Could you provide a brief history regarding change orders, variations, claims, and time extensions in the project?"

The author was advised to change the question due to sensitivity regarding financial issues. The author obliged and changed the question to

"If any changes occur, what happens?"

The position of the question was changed in order to flow better with the overall interview questions. The question still achieved the main purpose, which was to establish how change was managed in the project. However, it meant that there would be no explicit examples of such changes, which was still acceptable by the author.

The search for the second project was still in progress while Project 1 interviews were being conducted. There were many approaches to several projects, most of whom refused to participate in the research. Finally, a breakthrough came when one of the respondents referred the researcher to the management of another mega construction project whom he had worked with previously. Several meetings were convened to describe the purpose of the research to Project 2 management and to respond to their concerns. To the content of the researcher, the management of Project 2 agreed to participate in the research.

11.5.4 Conduct of the interviews

The author had been working in the U.A.E. for several years in a project management capacity. This time had yielded friends and acquaintances in the same field. Many were contacted to assist in having projects participate in the research study. Despite the number of friends, this was a difficult task for several reasons.

- Several projects did not fit the description of the population, in particular as relates to the cost.
- Several projects refused completely the idea.
- In several projects one or more of the parties refused to participate. These again were abandoned.

A letter had been sent to several prospective projects that fit the samples of the population. (Copies of the letter with the attachments are shown in Appendix 6). A breakthrough was made when one project contacted the author. This was made with the assistance of one of my previous colleagues working in the same project.

Prior to performing the interview process several steps were taken to ensure this process achieved its objectives. The first step was to ensure that for each case study projects that all points of view were considered. This meant that the respondents were to come from various parties and from various levels from the staff in the project. At the outset of each project staff was chosen representing the main parties to the projects and the various levels within each ranging from top management to supervision level. In the case study projects, the number of interviews conducted was

83 interviews in total. 47 of those interviews were conducted in Project 1 and 36 were conducted in Project 2.

The next step was to establish a schedule of staff to interview from the project. The staff considerations were again to interview from all parties and levels. A preliminary schedule was developed and provided to management who sent the schedule with a letter explaining the research and advising that it is not compulsory but participation was encouraged (Copy of letter provided in Appendix 7). Prior to each scheduled interview, the researcher would call the person to be interviewed and confirm the interview time. There were many who rescheduled their interview times and the final schedule was quite different than the initial one. (The original and final schedules for interviews are shown in Appendix 8 for Project 1 and Appendix 9 for Project 2). This was to be expected since some people were either on vacation or had prior commitments. Overall, the schedule, with all the changes, went quite well. Some of the interviews were not conducted and upon request of the author alternative interviews were scheduled and accepted by management of Project 1. In fact, they even gave the author authorization to interview anyone who accepted to participate.

During the time interviews were being conducted the search for another case study project was taking place. Letters were being sent and meetings were made. However, the second case study came by recommendation of one of the staff in Project 1 who took an interest in the research and was one of those interviewed. Upon the recommendation a meeting was arranged with Project 2 management and the same exact process for getting management approval and establishing the schedule of interviews was performed. It is noted here that the same modified questions were used during the interviews for Project 2. During the conduct of interviews best practice guidelines were followed (e.g. Fink, 2003).

The interviews were recorded on a Sony digital recorder (ICD-P520). Following each day’s completion of interviews the data was downloaded to the researcher’s computer. Each interview was filed by name, date and project. However, in three cases the respondents refused to be recorded and the interviews were conducted and recorded on paper. This was noted and these interviews were typed and filed with the transcripts. The unavailability of sound was recorded for these interviews.

During the interviews both the organization chart and processes of work were drawn as described by the respondent. A sketch book accompanied the researcher for this purpose. While drawing the organization chart and processes the respondents were given the opportunity to look at the diagrams and correct any errors they saw or any modifications they wished to make. This ensured that the drawn up sketches were "correct" as they stated. On each sketch for each respondent the name, date and project were written in order not to cause any confusion after the interviews. These drawings were redrawn on the same day of the interviews and each, including original sketches, was filed by the project and respondent name.

During the interviews notes were made on each respondent and these were typed and incorporated into each respondent's folder. This was done the same day of the interview in order not to lose any data. These notes helped in reminding the researcher of any distinct occurrences during the interview such as any language barrier, problems faced during the interview or reluctance by the respondent to answer questions, etc.

Field notes were maintained throughout the time the interviews were conducted. These included observations made by the researcher such as incidents happening during the time on site and comments made casually by staff. However, observations were for periods that were in between interviews. Since the interview schedules were very tight the observations were less than desired.

The last source of information was documents from the projects. Any financial information was off limits in both projects. In addition to that, other documented information was reluctantly provided. However, the documents that were made available were portions of the document control of Project 1, the document control manual of Project 2, the organization chart of Project 2 (Project 1 did not have an organization chart), photographs of progress in both case study projects and contractors' quality control manual from both projects.

These documents were filed by project. The source of the documents was added and the date received was attached. These were used to check issues such as the formal processes described by the respondents.

The researcher maintained a log of all items including interviews, documents, field notes, sketches, and transcripts. This log was maintained throughout the research. The log filled in was an excel sheet as shown in Appendix 10 for Project 1 and Appendix 11 for Project 2. The database was always and still is maintained. A back up of all the data was maintained continuously during the conduct of the research every day. The back up was maintained in a different place in the case any accidents happen to the originals.

11.6 Credibility

Construct validity concerns the establishment of correct operational measures for the study (Yin, 2003). Yin (2003) provides three tactics for increasing construct validity. The first is use of multiple sources of evidence where data from the various sources are convergent (i.e. data triangulation). The second is establishing a chain of evidence. The third is to have informants review the draft case study report.

11.6.1 Multiple sources of evidence

The various sources of evidence used on this research are interviews, documents, field notes and observations. During the interviews two sketches were drawn and described by respondents, which were viewed by respondents while sketching. The sketches were for the project organization and processes. Although the formal and informal processes and organization developed from the interviews, the formal organizations and processes sketched were cross-checked with the documents provided from the case study projects. The informal processes and organizations were cross-checked with the field notes and observations made by the researcher where there was a lot observed and noted which confirmed the statements made by respondents regarding informal processes and organizations.

Each respondent may be considered a source of evidence (Yin, 2003). Then by cross-comparing the interview transcripts and sketches of organizations and processes construct validity may be tested. In the research the statements and sketches made during the interviews converged very well to enable development of the hybrid model and reach the findings.

Respondents from each case study project may also be considered different sources of evidence. Although this is stated as increasing reliability, the convergence of evidence from respondents from each project may be considered as increasing construct validity (Yin, 2003b). In the research the statements and sketches during the interviews made by the respondents in each case study project were similar and converged to reaffirm the hybrid model and the findings of the research.

11.6.2 Establishing chain of evidence

Yin (2003) compares the establishment of a chain of evidence to that of forensic investigators. Therefore, the thought process and how the evidence is put together to reach certain conclusions and findings is of concern. In this research the thought process is of crucial importance and is presented.

Creating a Case Study Database

Developing a database is concerned with organizing and documenting data collected for the research, which is generally documented in two ways:

- *the data is evidentiary base*
- *the report of the investigation, whether in article, report, or book form*

This distinction, however, has yet be institutionalized practice as case study data are often synonymous with the narration presented in the research report (Yin, 2003). In this research, the database has been created with due consideration to maintaining the confidentiality of both the case study projects and respondents.

Maintenance of Chain of Evidence

Yin (2003) states that maintaining a chain of evidence increases reliability. The aim is for the reader to follow how the researcher arrived from the initial research questions to the conclusions including the ability to trace the steps taken. Therefore, proving that the process is tight enough to ensure that the conclusions and findings are based on data collected is important. Thereby, no data should have been lost through carelessness or bias. If these objectives are achieved the problem of determination of construct validity would also have been addressed, increasing the quality of the case study (Yin, 2003). Several guidelines are provided by Yin (2003) to achieve increased reliability and address construct validity. These are summarized as follows:

- The case study report should make sufficient citation to relevant portions of the case study database such as documents, interviews or observations.
- The database should reflect evidence and circumstances under which the evidence is collected, such as time and place of an interview.
- The circumstances of data collection should be consistent with procedures and questions of the case study protocol.

Overall, maintaining a chain of evidence should follow Figure 11-1 as developed form Yin (2003).

Case Study Report

↕

Case Study Database

↕

Citation to Specific Evidentiary in the Case Study Database

↕

Case Study Protocol
(Linking questions to protocol topics)

↕

Case Study Questions

Figure 11-1 Maintain a Chain of Evidence

11.6.3 Thought process

From Chapter one, it has been indicated that the initial research approach would be an “exploratory” investigation with an “open mind”. The analysis of the data was largely performed in three phases. Figure 11-2 will assist in understanding the thought process and the actual work performed.

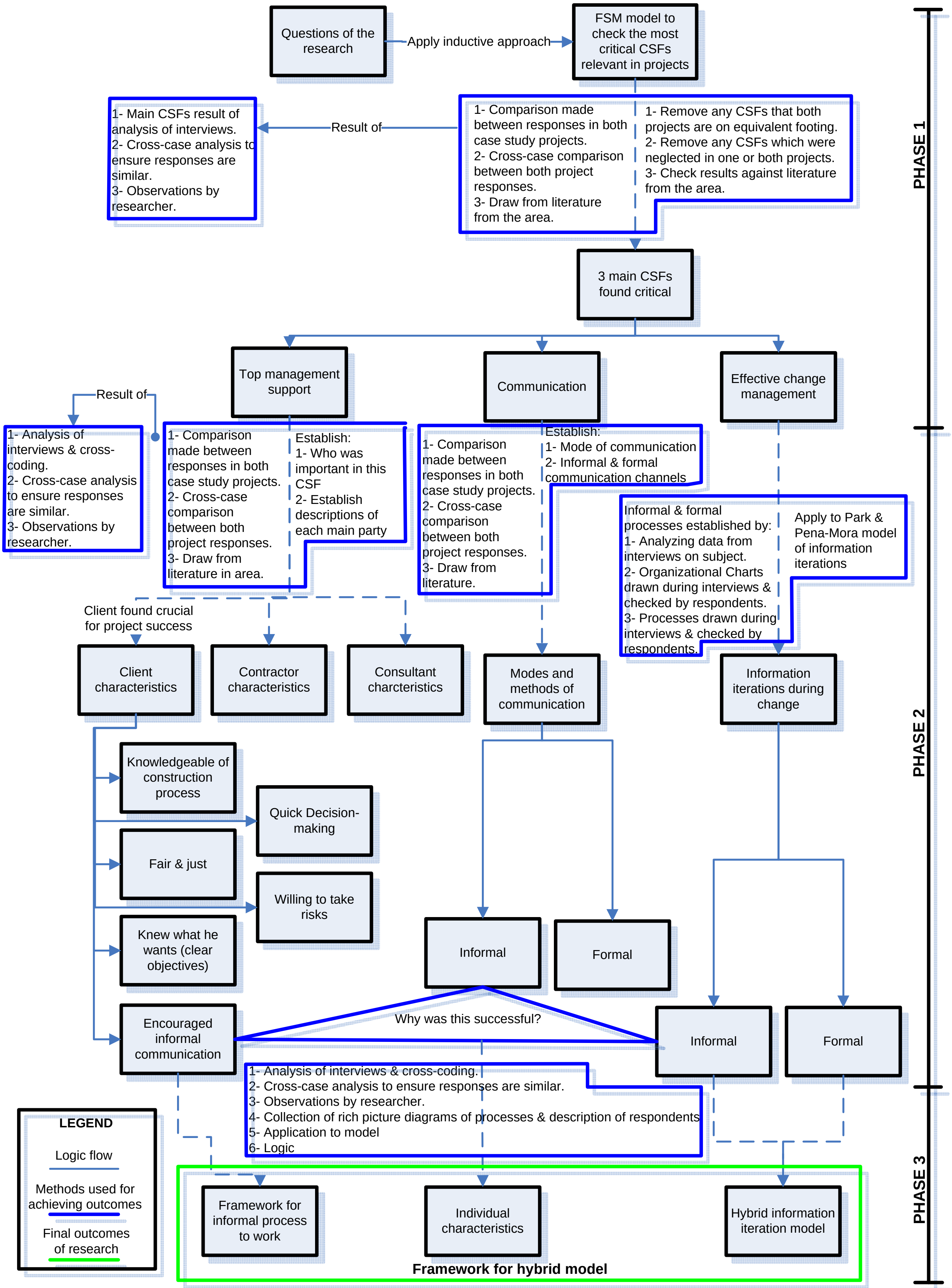


Figure 11-2 The three phases of research analysis

Phase 1

Due to the large volume of data and the large number of themes that were developing, the author decided to narrow down the focus by finding the major CSFs affecting mega construction projects in Dubai. The logic is that since CSFs are interrelated then the result would provide a good direction as to what to focus on. This constituted the first phase of the analysis and was to find the most crucial CSFs in the case study projects. In this regard, the CSF literature was reviewed. Most of the CSF literature provided lists and applications to particular situations or procurement routes, among others. A framework around CSFs was required to “make sense” of the lists of CSFs as well as the interrelationships between them. As provided in Chapter Two, the FSM model was applied to the case study projects.

The result of the first phase of the analysis was arrived at by comparisons of analysis and cross-coding of responses from each case and then comparing results across cases. Additionally, the CSF literature emanating from the region provided another verification of the results. The final result of this exercise provided three most critical CSFs, namely:

- Top management support
- Communication
- Effective change management

This result was the input to the second phase of the analysis.

Phase 2

There were further questions raised from the results arrived at in the first phase to be answered in the second phase of the analysis. The responses in each case study were compared for each of the three CSFs aforementioned. They were again compared across the cases. The results were similar in both cases. Additionally, cross coding was used to compare responses in different codes through QSR NVivo software. The answers to the questions for the second phase were similar within and across the cases.

Next to consider was what elements made a difference in each CSF. Each CSF was analyzed critically and examined. From all the CSFs the formal/informal divide was found to be crucial in them. From the outcomes of phase two of the analysis it was found that the informal process, informal communication and the client characteristics, particularly encouraging informal communication, and the informal processes provide a thread between them that should be followed. The results from the second phase provided the basis for the third phase of analysis.

Phase 3

In order to further understand why the informal process was used heavily in both case study projects the description of iterations of information by Williams et al. (1999) was drawn upon. The case study projects were then applied into the principles of two construction process models investigated (i.e. Ford, 2002; Park and Pena-Mora, 2002).

From the literature and comments made by participants in the research, it was found that the informal process relied on individuals. One of the questions asked involved how the respondent viewed staff in the project organization from all parties. The descriptions provided by respondents in each case study was collected and a cross case analysis was performed thereafter. The descriptions and discussions have been previously presented in Chapter Nine. Several characteristics were provided for the "collection" of individuals, which was similar in both case study projects.

11.7 Transferability and dependability

As stated from Subsection 5.10 the transferability and dependability construct requirement have to do with the applicability to other contexts and applicability of the findings at other times. In this regard, the respondents to the evaluation of research findings were chosen from participants and non-participants in the research. Furthermore, the responses would indicate the applicability at other times. The following sections describe the responses to the questionnaire.

11.7.1 Evaluation of research and model by informants

One of the requisites in achieving construct validity is to have key informants review the draft report. Several of the informants were contacted. Unfortunately, Project 1 was already completed and Project 2 was closing down and many of those interviewed left the projects and their contacts were lost. However, some were contacted and requested to respond to some simple questions to a very brief summary of the model and findings of the research.

The respondents were in a management capacity with over 20 years experience. The responses to the questionnaires are provided in the following Table 11-2. The responses led to a modification of the hybrid model. Additionally, some of the comments were considered within the analysis of a framework for the hybrid model such as the chaotic nature of the informal process and the rework or change resulting from lack of formalities.

From the responses to the hybrid model for communication and information management, there were several issues raised. These are listed below:

- Addition of other processes, such as QA /QC.
- It is a starting point only.
- RFI process may generate changes that should pass the “change route”. This modification is shown in the revised Figure 11-3 of the hybrid model.
- The informal process “bypassing” formal processes may spell “disaster”.
- Informal processes can work provided the formal processes are completed.
- Construction success needs to find a balance between formal and informal processes.

The research study, as any other, is limited by time, costs and other factors. Due to these factors, the research was limited to studying the main processes in the development of the hybrid model. Thereby, the hybrid model developed is not an end but is “only a start” as one of the informants correctly stated. Future research should develop the model further to incorporate additional processes.

The RFI process and the relation to the change process were reviewed as per the comment made by one of the informants. The researcher reviewed the sketches made of the processes as well as the narrative descriptions made by the respondents. The comment was found to be correct and supported by both the sketches and narratives. The model was therefore modified to reflect the relationship between the RFI and change processes.

Table 11-2 Summary of responses to model and summary of findings

Respondent Position	Senior MEP Manager	Project Manager
Respondent Experience	+ 30 years	+ 20 years
Responses to questions		
Does the model reflect construction processes?	The model reflects the basic processes that identify the fundamental sequence of works necessary to control site activities and operations. You can add other procedures such as QA/QC and RFI systems as required.	Not completely – e.g. RFI process can generate many changes that should pass the ‘change route’. The informal process bypassing ‘Acceptance’ can cause many problems with non-conformance work. Redesign after inspection is too late and must be captured at RFI/Submission stages.
How may each of the following parties use the model?, and what for?		
Client	Give confidence to the Client that the construction is being managed properly and allows the Client to interact where he feels it is necessary.	The informal process can work provided the formal process is completed. Bypassing areas can cause problems with audits and hidden time/cost issues for Client.
Management team	Allows the management to control the construction process and implement any additional procedures that may be necessary.	A model is essential for formal management. Collaboration tools help enforce accurate business. Formal lines can work if people assigned are experienced and proactive and stay within agreed response times.
Consultant	Allows the consultant to interact and maintain quality control.	Same as above.
Contractor	The contractor will know what to do when a process has passed or failed. He can maintain his contractual obligations by following the execution process (model).	Contractors may think they benefit via the informal process in the short term but successful contractors are the ones that have a strict formal process. Records are essential to assess historical work.
Other	Informal process leads to unapproved works and mistakes which are costly and timely to rectify.	
Any comments regarding the hybrid model?	It is a starting point only.	There is no short change to success. A formal process needs quality people. An informal process with inexperience can spell disaster. Construction success needs to find balance between the two areas of informal and formal.

Statements made by the informants indicate that bypassing the formal processes with informal processes may cause problems. The chaotic nature of informal processes has been highlighted by respondents and stated clearly in the research. Interestingly, as indicated by the informants, in order for the informal systems to work properly ‘experienced’ and ‘quality’ people are required and that the informal processes may work if formal processes are completed. Reinforcing this is a statement by one of the informants adding that “construction success needs to find a balance between the two areas of informal and formal”. This statement confirms one of the findings of the research that the formal and informal processes complement each other.

As stated above, the indication of one the informants to “people” reinforces the importance of individuals in construction. The description stated of ‘experienced’ and ‘quality’ people, and neglecting which party they came from, reinforces the findings of the research that the characteristics of the individuals in the project are an important consideration for the construction process to work. An additional statement is that “a informal process with inexperience can spell disaster”, which indicates that ‘poor quality’ people would cause the informal systems to fail.

An additional interesting statement is the balance required between informal and formal processes for construction success. When considered with the above logic indicates the need by practitioners for researching the formal and informal processes and providing tools and guidance to be used practically in mega construction projects. Furthermore, the statements made by the informants do not “neglect” the informal process, but it seems that the “balance” between them and achieving that is not clear. This research may provide a starting point towards reaching that clarity.

11.7.2 Evaluation of research and model by non-informants

Communication modes

According to the questionnaire responses several amendments were made to the communication modes, uses of communication as well as advantages and disadvantages of each. It is important to note that the modifications required were made by the ‘external’ respondents. This confirms the uniqueness of each project and the differentiation as to the organization thereof. The modifications requested are shown in Table 11-3. All comments and modifications made by respondents are shown in bold font in the same table.

Formal and informal communication

All the respondents agreed with the view that both formal and informal communication is important. This is summarized in Table 11-4. Furthermore, they are all in agreement that both processes compliment each other and neither can be accepted separately as the whole information system. A statement from one of the respondents summarizes this:

Construction success needs to find balance between the two areas of formal and informal

Another respondent added that:

This informal mode must always be followed by a formal communication to record the events.

The use of informal communication was stated by the respondents largely ‘to advance a forthcoming instruction’. An example was provided where there may be an abortion of work or forthcoming changes in design or work method as well as other things arising in an ongoing instruction. In these cases informal communication is made but should be followed by formal communication to record the changes.

One respondent adds that generally informal communication is based on ‘trust’ between the parties involved and that this is the norm in the construction industry. He further adds that this is ‘why nobody in the construction industry will breach that trust’. An example provided is when PM/CM or consultant fails to issue a formal instruction following an informal one, and then chances are that the contractor will not adhere to further informal instructions. The respondent further adds that ‘trust’ is one factor in delivering a project.

Another respondent stated that the importance of formal communication is in order to control the project and fulfil contractual obligations. The importance of informal communication is to fill the gaps in the formal communication and to improve the flow of information. A third respondent stated that the importance of formal communication is that it is contractual, and as such, will be taken seriously by others and helps in solving issues while informal communication helps in reducing documents in the project. All comments and modifications made by respondents are shown in bold font in Table 11-4.

Hybrid model

There was general agreement that the hybrid model for communication and information model reflects construction processes in practice. However, one respondent added that the formal process is an essential part of the work and that any informal agreements should be followed via a formal document reflecting that. A note has been added to the hybrid model to reflect this concern as the respondent viewed that it should be provided in the model. Furthermore, another respondent stated that due to the enormous amount of information flow the formal process should be used heavily. There is no disagreement with this point of view as the model provides that both processes are complimentary. However, there has been a modification made to the hybrid model based on a comment made by one of the informants. It is shown in Figure 11-3.

Table 11-3 Summary of communication modes, formality, uses, and advantages and disadvantages

Communication mode	Formality		Use of communication mode	Advantages	Disadvantages	Remarks
	Project 1	Project 2				
Correspondence **Letters** **Memorandum** **Other**	Formal	Formal	o To establish historical records and fulfil contractual obligations o To maintain control o **To issue/acknowledge an instruction or ask for information**	o Documents establish rights and obligations o Historical records of project established o **To facilitate proper work procedure** o **Helps in getting people's attention and clear commitments**	o Slow **(particularly when one person authorized to sign)** o Always a gap between information required and provided o Does not allow small pieces of information to be passed on o Inability to handle task interdependency o **May start a 'letter war' with correspondence going back and forth**	**Disadvantage of informal: People may not stick to their commitments**
Telephone **Land Based** Cell phone	Informal	Informal	Provides mobile communication	o Ability to resolve ongoing problems immediately o May initiate resolution to problems on site	Limited to verbal understandings	
Meetings	Formal/Informal Formal for minuted meetings	Formal/Informal Formal for minuted meetings	o Coordination o Follow-up o Formal coordination and planning o **In order to gain common understanding among the participants**	o May resolve issues o May maintain coordination efforts o May provide a good control medium as participants provide their points of views o May highlight problems to come	o Larger meetings may not result in resolutions o Easy for participants to "stick" to their positions o Participants may become defensive if "criticized" o Takes valuable time from staff o No records for informal meetings and misunderstandings may develop	

Face-to-face **Person to Person**	Informal	Informal	o To resolve problems o To reflect on ideas o To transfer information o To negotiate	o Ability to use all of the senses o Resolve problems before it is contractual o May convince others of different point of view before getting engrained in a position	o May stop ideas from developing prematurely o Misunderstandings are possible if each understands statements differently	
Email	Informal **Sometimes considered formal**	Informal	o Explore options o Reporting on issues o Passing information	o Provides a traceable “feel” o Is instant o Can attach documents for clarifications	o Is instant and may cause misunderstandings o May become “stuck” in response and counter response without resolution o Keeps people “glued” to their seats and not use other communication modes	
Electronic IMS	Formal	Not used	Same as correspondence	o Same as correspondence o Ability for anyone to view records o **Immediate access to all types of information related to the projects** o **Client/Consultants/Contractors access to all correspondence between parties involved in the project**	Same as correspondence	

Added communication modes:
Presentations
Sign-boards
Workshop
Awareness Programs (Safety and Health)
Non-verbal (Body language and voice inflection)

Table 11-4 Summary of respondents' views of formal and informal communication and when it is used

Communication route	Advantages	Disadvantages	When used	Remarks
Formal	o Provides a historical record of the project o Provides control for the project o Provides contractually obligatory process	o Slow movement of information o Many steps for transmission of documents o Gap between information required and available may cause errors and changes o Cannot react quickly to urgent situations o Is not able to handle iterations, particularly in approvals of submittals and changes o Information exchange is vertical and horizontal only at top between parties which makes distance documents travel long o Small pieces of information is not provided (i.e. only completed submittals go through official formal process)	o When historical record is required o When contractual obligations are to be filled o When approvals are required o When there is no urgency for information o When there is no requirement for transfer of small pieces of information o When there is no interdependency with other tasks o When uncertainty is low	
Informal	o Very fast process o Iterations of information reduced o Transfer of small pieces of information o Horizontal communication reduces time for information transfer o Communicate directly with those concerned & decision makers o Reduces review time because discussions result in understandings & decisions made o May allow action based on informal agreements o Reduces the preparation time for submittals o Provides leniency to resolution of problems before formalization & getting "entrenched" in position o Provides opportunity for negotiation & convincing of different viewpoint o React to urgencies quickly o No boundaries in place o Participants establish a system that works for their needs	o Usually not recorded o Not contractually recognized o Information may be lost o May cause misunderstandings o Is "chaotic" in nature o Governed by individuals & subject to various perspectives o Is not well established (i.e. it is based on how individuals find suitable) o Requires trustworthiness to be established	o When urgency is required to resolve a problem o When small pieces of information is required o When interdependency between tasks exists & requires communication between those concerned o When uncertainty of information is present & requires communication to reduce uncertainty o When reduction of iterations of information is required o When preparation time of works is required to be reduced (e.g. submittals)	**Disadvantages of informal:** **It results in a lot of wasted time (i.e. time you spend reading emails that many of them are not related to you).** **Some cases it will affect negatively on the team spirit and will result to taking it personal.**

Formal and informal processes and complexity

The respondents generally agreed to the uses of informal processes. This is shown in Table 11-5. However, most added that the importance of formal communication is in order to control the project and fulfil contractual obligations. Informal communication is to fill the gaps in the formal communication and to improve the flow of information. However, one respondent stated that informal processes may sometimes have a role in delaying the work. This is accepted as the participants in the research had indicated that if informal processes are mismanaged (mostly by inexperience) the communication process is quickly faltered. All comments and modifications made by respondents are shown in bold font in Table 11-5.

All of the respondents agreed that formal and informal processes were complimentary, each having its own strengths and weakness as well as abilities to handle complexity and other issues. This is shown in Table 11-6. The only comment received for modification was in the ambiguity component where the respondent states that the formal processes are used to reduce ambiguity as formal communication is used to send messages clearly. The point is well taken and has been advised by participants in the research. However, there are other sources of ambiguity which the formal processes cannot handle, which is what is not known. All comments and modifications made by respondents are shown in bold font in Table 11-6.

Table 11-5 Five general cases for use of informal processes

Use of informal processes	Remarks
Where urgency is required	
In order not to delay any works	**Sometimes has a role in delaying the work**
To reduce the preparation time through official channels	
To close the gap between information available officially and actual site conditions	
To avoid rework on changes that will be forthcoming when completed officially	
In order to gain common understanding among the participants	

Table 11-6 Characteristics of complexity and abilities of formal & informal processes to handle them

Characteristics	Process		Remarks
	Formal	Informal	
Records	Can handle well	Cannot handle well	
Control	By documents	By peers	
Uncertainty	Cannot handle well	Can handle well	
Ambiguity	Cannot handle well	Can handle well	**Formal can handle well due to the fact that formal communication use is to send the message clearly**
Task interdependence	Cannot handle well	Can handle well	
Small pieces of information	Cannot handle well	Can handle well	
Information iterations (i.e. change)	Cannot handle well	Can handle well	
Concurrency	Cannot handle well	Can handle well	

Framework for hybrid model

Characteristics of top management and individuals

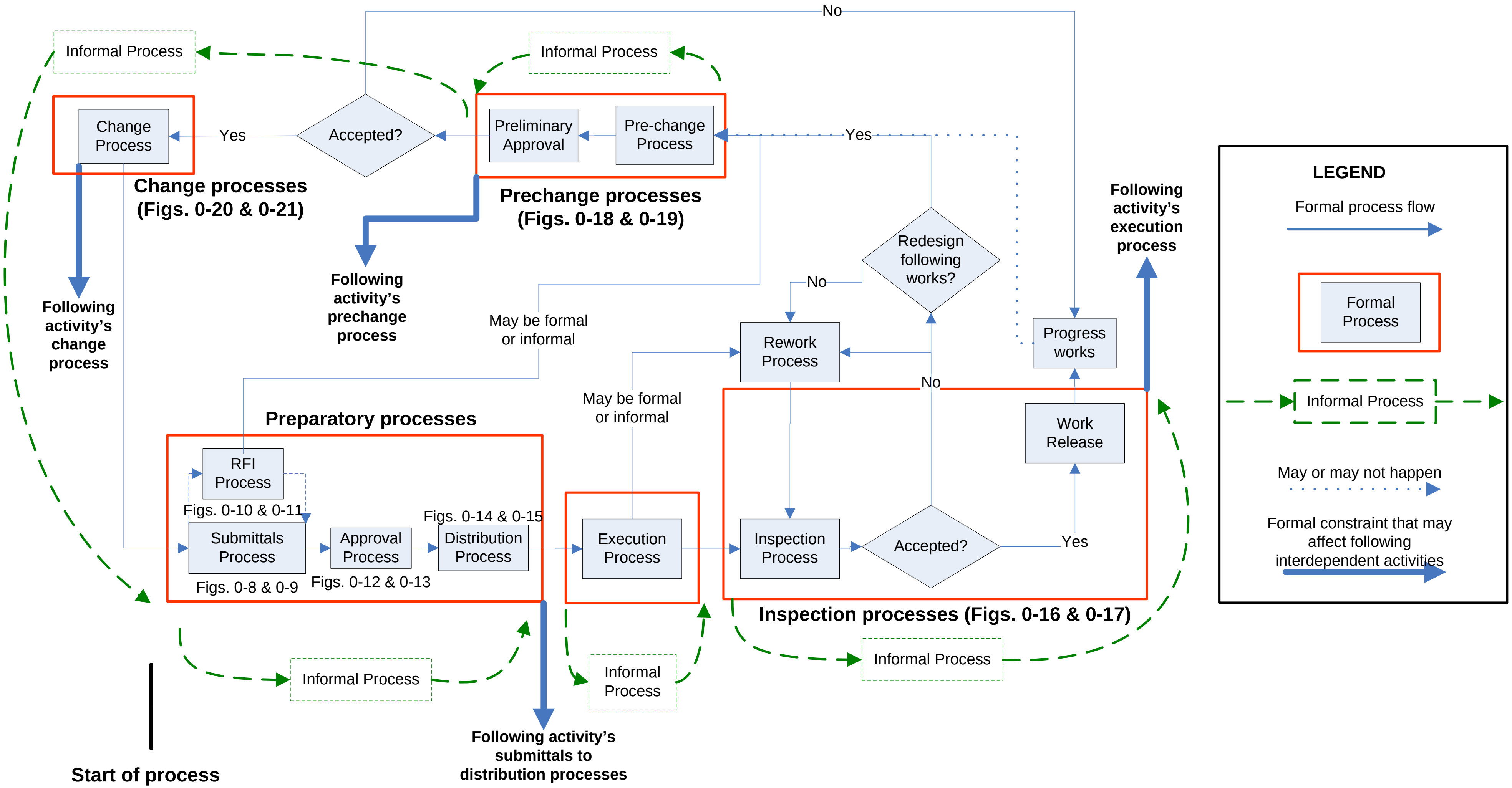
The characteristics of the top management of the main parties and individuals in the project team were provided for comments. The comments regarding the top management are shown in Table 11-7 to Table 11-10. It is noted that the client is also considered an individual and top management are also viewed as individuals.

The respondents viewed that individuals in the project team were important. In a statement made by one of the respondents that summarizes the importance of individuals:

I think that people involved in construction is a very important factor. A healthy environment between professional, capable people with established trust is very important to construction.

One of the respondents stated that an experienced individual is able to maximize the use of both formal and informal communication to the benefit of the project. Another respondent further adds that the 'collective' characteristics of individuals in the project are conducive to effective communication when they have clear roles and responsibilities defined for them within their respective organizations. There is no disagreement with the comment as implied in the framework for the model. Everyone needs to know what job is being performed and by whom. The respondent adds that individuals in the project should be empowered to take decisions with regard to issues within their specializations. Another respondent added that every team member should show flexibility in coming up with a solution during problem-solving for issues which may arise during project execution. The modifications are shown in bold font in Table 11-7 to Table 11-10.

Figure 11-3 Revised Hybrid Model of communication and information management



Note: Informal agreements should be followed by formal documentation, particularly where there are cost and time impacts.

Table 11-7 Positive characteristics of client

Description of characteristics	Remarks
Knowledgeable of the construction process	
Knows what he wants	
Has clear objectives and sends consistent message across	
Has a collaborative attitude	
Fair and reasonable	
Encouraged informal communication and processes	
Willing to take risks	
Proactive and involved	
Makes decisions and resolves problems quickly	
Accepts alternatives	
Maintains open-door policy	
Provides leadership	
Controlling	
Chooses contractors and staff well	

Table 11-8 Positive characteristics of consultant

Description of characteristics	Remarks
Lenient and reasonable	
Helpful	
Innovative and capable	
Strong and fast to react	
Quick and efficient	
Collaborative	
Technically strong	
Good problem-solver	
Good decision-maker	
Pragmatic	**Consultant normally follows the design process by the book. However, there are certain site conditions where the design prepared is not possible. In these types of situations the consultant should be pragmatic enough to adjust the design according to the particular site condition.**

Table 11-9 Positive characteristics of contractor

Description of characteristics	Remarks
Collaborative	
Self-reliant	
Capable	
Provide expertise	
Coordinates with everyone	
Works well	
Provides good supervision and skills	
Competent	
Provides staff with formal progression	
Instils learning in organization	
Stresses quality standards	
Continuously enhance themselves	
Continuous improvement in organization	
Safety conscious	
Motivates personnel	
Trustworthy	
Flexible	
Cooperative	

Table 11-10 Positive characteristics of individuals conducive to effective communication

Description of characteristics	Remarks
Committed to solving problems	
Qualified, experienced and capable	
Professional and focused on objectives of the project	
Pushing to establish trust	
Proactive and responsive	
Maintained cooperative working relations	
Were kept under pressure and able to work	
Versatile and adaptable	
Know what they were doing	
Maintained good follow-up	
Flexible	**Should have a clear role and responsibility provided by his organization**
Pragmatic	**Should be empowered to make decisions in his specialization**

Client role in establishing good communication

Respondents agreed that the client role is important in establishing good communication in the project. One respondent stated that the client role is 'very important' in establishing good communication in the project. One respondent adds that the client should always make formal communication in directing stakeholders. Table 11-11 has been modified below to reflect all the comments (added in bold font in teh table) made as a general framework for the hybrid model.

Relevance of research to construction

Respondents found that the research is relevant to the construction industry. One of the respondents viewed that informal communication should be encouraged to build positive relationships among the stakeholders of the project. The respondent adds that to handle the enormous flow of information and track and retrieve documents, an electronic management system is necessary in mega construction projects. Another respondent states that a 'good and effective' electronic IMS is essential for the delivery of a project. This is in agreement with actuality of the case study projects, despite the fact that the project management team in Project 2 not having an electronic IMS. However, in Project 2 it was observed that the Contractors and Consultants had electronic systems in place and were being used.

Table 11-11 Framework required for effective communication in projects

Characteristics of	Characteristics positively affecting hybrid model	Remarks
Client	Knowledge of construction process	
	Acknowledgement and encouragement of informal process	
	Insistence of use of formal process to follow any informal agreements	
	Knows what he wants	
	Has clear objectives and sends consistent message across	
	Has a collaborative attitude	
	Fair and reasonable	
	Encouraged informal communication and processes	
	Willing to take risks	
	Proactive and involved	
	Makes decisions and resolves problems quickly	
	Accepts alternatives	
	Maintains open-door policy	
	Provides leadership	
	Controlling	
	Good choice of individuals in project	
	Good choice of parties to the project	
Individuals	Qualifications commensurate with task	o **Should have a clear role and responsibility provided by his organization** o **Should be empowered to make decisions in his specialization**
	Committed to solving problems	
	Qualified, experienced and capable	
	Professional	
	Push to establish trust (i.e. trustworthy)	
	Proactive and responsive	
	Maintain cooperative working relations	
	Work under pressure	
	Versatile and adaptable	
	Know what they are doing	
	Have good follow-up instincts	
	Good communicator	
	Reliable	
	Good problem-solver	
	o **Flexible** o **Empowered** o **Pragmatic**	

One of the above respondents continues to state that a proper balance between formal and informal communication with assistance from an electronic IMS would have a positive impact in terms of time, cost and quality. However, another respondent adds that the new communication models introduced to the construction industry do not have a clear ‘methodology’. He adds that this is in light of the ‘chaotic’ nature of construction and states that there are a lot of improvements that can be made.

11.7 Summary of the validation process

The conclusions and Hybrid Model were provided to five managers experienced in mega construction projects for validation. Two of the respondents in the validation were informants in the case study projects. The remaining three respondents for the validation of the conclusions and Hybrid Model were chosen out of the context of the research having experience in mega construction projects in other areas of the Gulf. This was to test the generalizablity of the research conclusions and Hybrid Model and to reduce possible bias by responses of informants to the validation in the case study projects.

The validation was based on four criteria, namely: (1) confirmability; (2) credibility; (3) transferability, and; (4) dependability. The research conclusions and the Hybrid Model were evaluated based on these four performance measures. The confirmability and credibility construcs involve the researcher’s bias and believeability of findings. The steps performed during the research including conduct of the interviews, maintenance of a chain of evidence, sources of evidence and through process were outlined and described. The transferability and dependability constructs relied on the validation of the research by the five evaluators, three whom were from a different context than that of the research to perform a preliminary test of generalizability of the research conclusions and the Hybrid Model.

The responses of the evaluators validating the research findings largely confirmed the research conclusions and the applicability of the Hybrid Model to mega construction projects in Dubai. It further confirmed the possibility of generalizablity to other contexts. The evaluators added comments on the communication modes, uses and advantages and disadvantages, where the most significant was the possibility of considering emails as formal. It was added that a disadvantage of informal processes is that people may not stick to their commitments.

The formal and informal communication advantages and disadvantages and when used were presented to the evaluators of the research. Two main observations were made relating to formal and informal processes. These were the need to find a balance between formal and informal processes and that informal agreements should always be followed by a formal record. Two main disadvantages to informal processes were added. These are that informal processes result in wasted time (i.e. reading insignificant emails) and in some cases will affect negatively.

The evaluators added two main comments on the use of informal processes. The first is an additional use of informal processes, which was to gain a common understanding among participants. The second was a remark that informal processes sometimes have a role in delaying the work. An added remark is that formal processes can handle ambiguity well due to the fact that formal processes are used to send the message clearly.

The evaluators found that the Hybrid model developed reflected construction processes in practice. There were three main comments made, two which modified the Hybrid Model. The first comment was that more processes should be added to the model. This is one of the suggestions for future work. The second comment was that informal agreements should always be followed by formal processes, which was added as a note in the revised Hybrid Model. The third comment was that the RFI process may result in a change. This was an oversight by the researcher as it was shown in the rich picture diagrams but was not reflected in the Hybrid Model. An arrow reflecting this was added from the RFI process to the prechange process.

The characteristics of the main parties and individuals in the project teams conducive to effective communication, which were compiled from the data, was provided to the evaluators of the research. There was a general agreement that the characteristics of individual in mega construction projects are important. There were added characteristics to that of the consultant, contractor and individuals. Four characteristics and a comment were provided regarding the consultant including to be: (1) technically strong; (2) a good problem-solver; (3) a good decision-maker, and; (4) pragmatic. The comment was that the consultant should consider site conditions and not be following the design process ‘by the book’.

The added characteristics of the contractor were to be: (1) trustworthy; (2) flexible, and; (3) cooperative. Although, the characteristics of being collaborative was present its synonym ‘cooperative’ was added. For individuals in the project, three characteristics were added, which are to be: (1) flexible; (2) pragmatic, and; (3) empowered. An added comment regarding individuals included having clear role and responsibility provided by the organization.

11.8 Summary

The chapter presented the validation of the research and the chain of thought during the conduct of the research, data collection and analysis until arrival to the conclusions. The objectives of the validation process are presented. The justification for choice of and description of participants in the evaluation of the research is made.

It provides how each of the four main criteria for qualitative research evaluation has been met (i.e. credibility, transferability, dependability and confirmability). This included presenting the history of the research and the chain of evidence established as well as laying out the chain of thought in the research. It also presents the evaluation responses for the validation conclusions and the practical applications of the hybrid model of communication and information management. This included a preliminary test of generalizability of the Hybrid Model beyond the context of the research.

It was concluded that the model does represent construction processes and that there is a use for the conclusions and findings in practice. The conclusions and Hybrid Model are modified according to the responses of to the evaluation of the research. The modifications are presented for the conclusions and Hybrid Model. The following chapter presents how the research has achieved its aims and objectives and provides the conclusions, limitations, contributions and recommendations for future work.

CHAPTER 12 CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

12.1 Introduction and summary of research

This chapter presents the findings and main conclusions of the research as well as the implication that the model and framework developed may have within the construction industry. Future directions for research in communication and information management in mega construction projects are suggested as well as ideas improving future industry practice.

12.2 Achievement of research objectives

The aims and objectives of the research developed in Chapter One are restated in Table 12-1. Each of the objectives and aim is discussed in the following sections.

Research aim

To develop a model framework for information management systems that reflects the nature of information management in mega construction projects in Dubai that would support managers in helping to overcome the inherent characteristics of complex works.

Research objectives

The following objectives were formulated to achieve this aim:

Table 12-1 Research objectives

Research Objectives
Objective 1 To review the literature surrounding critical success factors, communication and information management, information management systems, change, socio-technical systems and human factors to identify the factors critical to communication and information management.
Objective 2 To review models that place a framework around Critical Success Factors (CSFs) to provide guidance for analyzing, investigating and establishing the CSFs that are most critical in mega construction projects in Dubai.
Objective 3 To establish the organization and work process within the case study projects from the perspectives of the main parties involved in order to map key communication and information flows.
Objective 4 To construct a new theoretical model framework for communication and information management systems in order to provide a way of understanding key formal and informal processes and interactions within mega construction projects in Dubai.
Objective 5 To verify and validate the model and the conclusions and recommendations of the research within the context of the case study projects explored in order to ensure its relevance to both researchers and practitioners.

12.2.1 Objective 1 – Literature review

The purpose of the literature review was to: (1) develop the questions to be asked during the exploratory semi-structured interviews; (2) provide guidance for the research analysis; (3) highlight the deficiencies in the communication and project management literature, especially in regards to the context of this research and mega construction projects, and; (4) provide a background for themes that developed during the analysis. A particular focus was to review the critical success factors (CSFs) which underpinned project performance.

Of the models reviewed three models provided a framework around CSFs were found to show the interrelationships between CSFs, with the FSM framework (Fortune and White, 2003) deemed to provide the most dynamic model using a systems approach. The main weakness was that the model was used for IS/IT projects and not construction projects. However, the CSF literature from the construction industry was compared to the CSFs used in the components of the model and there was a good fit between them. From the initial literature review of aspects and factors affecting communication and information management, questions for the exploratory research were developed. Additional literature included complexity, senior management influence in projects and the role of individuals (see Chapters Three and Four).

It was found that there is a need to manage complexity issues in construction project processes as it affected communication. This is especially crucial in the management of change, which was found to create information iterations that are the root cause of poor coordination and miscommunication inhibiting concurrent engineering. Change creates uncertainty and task interdependence minimizes the ability to perform tasks concurrently. Information management of these iterations, particularly during change, was found to be of crucial importance. Several models showing construction processes were identified.

Two models (Ford, 2002; Park and Pena-Mora, 2002) were further described which show the dynamics of information flow in construction processes and the effects of change. However, change is mostly described from the perspective of the formal or contractually binding process. There is a need for studying change from both the formal and informal perspective. However, it was found that the models show only the formal processes. The informal processes were not evident in these models although the authors alluded to their importance. Furthermore, there were no models showing the interrelationship between formal and informal processes. It was therefore decided to use these model concepts to develop a hybrid model for communication and information management reflecting the formal and informal processes and the interplay between them.

The third strain of literature reviewed involved the role of senior management and individuals in managing the complexity inherent in construction projects and achieving effective communication. This is reviewed in Chapter Three. The main issues reviewed included IT applications in the construction industry and their impacts. It was found that despite the successes stated, the impact of IT on information management remains in doubt. The human impact on information management was found to be a crucial component in construction projects. This was found to be critical due to the nature of construction where uncertainty and task interdependence are inherent characteristics of construction projects. These characteristics of construction projects were found to be better met by people involved in the project. However, there is a lack of research on the informal process in construction projects and how the human component is crucial in the ability to manage information. Overall, it was found that there is a lack of research of how senior management and individuals in projects may reduce complexity and uncertainty and achieve effective communications. This topic was further investigated in the research in Chapter Nine. It was found that the client played a key role in establishing effective communication. Furthermore, it was the characteristics of the client (or client representative) that were crucial. Several characteristics have been compiled. These characteristics are well suited to individuals. It was found that characteristics of individuals played a major role in the project. These characteristics were compiled and presented.

12.2.2 Objective 2 - CSFs in case study projects

From the preliminary literature review, the CSF literature provided mainly lists and guidelines. The research required the use of a framework to establish in a systematic way the crucial CSFs. The CSFs that would develop would provide guidance for the research analysis.

Several models were reviewed. Three models placing a framework around CSFs were viewed as showing the interrelationships between the CSFs and described further and critiqued in Chapter Two where the Bellasi and Tukel (1996) model was found to be static. The FSM model (Fortune and White, 2003) was found to be dynamic and uses a systems approach. The model was justified for applicability in construction projects. The FSM model was applied to the case study projects in Chapter Six to analyze and discuss the most critical CSFs. The questions of the semi-structured interviews were related to communication and information management and CSFs were derived from this model.

The analysis established the most critical CSFs in the case study projects. The results of the analysis were examined separately and via a cross-case analysis. The most crucial CSFs found in the case study projects were communication, top management support and effective change management. Although each project had different CSFs, both projects were viewed as being successful by respondents. The cross-case analysis provided the three critical CSFs common in both projects. The critical CSFs raised further questions for the research, where each CSF was analyzed in Chapters Seven, Eight and Nine, respectively.

12.2.3 Objective 3 – Establish organization and processes

The third objective was achieved during the conduct of the interviews. The organization and processes for the case study projects were sketched during the interviews as ‘rich picture diagrams’ and viewed by respondents to confirm that they accorded with their understanding. A description of the organization and processes were also provided by the respondents in each case study project. The sketches and descriptions provided the basis for presentation of the organization and processes in each case study project. All responses were compiled and compared to complete the organization and processes in the case study projects.

The rich picture diagrams were redrawn for clarity and are presented in Appendix 3. They show the interrelationship of formal and informal processes within such projects. This was confirmed in Chapter Six for communication in the case study projects.

12.2.4 Objective 4 – Construct a new model framework

Each of the CSFs identified in Chapter Six as crucial are analyzed separately in Chapters Seven, Eight and Nine. The common “thread” across all the CSFs is the formal and informal communication and information flow and client encouragement for informal communication and processes. This common “thread” establishes the importance of informal communication and processes in the case study projects.

Chapter Seven explores the importance of formal and informal communication, what they are used for, when they are used and how they complement each other. It discusses the advantages and disadvantages of each and highlights that informal communication and processes may be “chaotic”. Chapter Seven also highlights the importance of the client and provides characteristics described by respondents. Client knowledge of the construction process and client encouragement for use of the informal communication and processes are also factors found to be crucial for effective project communication and information management.

Chapter Nine describes the formal and informal processes in the case study projects. A hybrid model for communication and information management is developed and presented showing how the formal and informal processes interact. The model of the processes were developed from the basics of the Ford (2002) and Park and Pena Mora (2002) models of information iterations. The hybrid model for communication and information management is developed by applying both the formal and informal processes into the models. Additionally, the capabilities of formal and informal processes to overcome the inherent complexity in mega construction projects are presented as well as when each was particularly used and how they complemented each other.

The framework developed in Chapters Nine and Ten involves the characteristics of the client and the individuals in the project. The framework provides the most important characteristics found to positively impact the hybrid model for communication and information management.

12.2.5 Objective 5 – Validation of the research

The hybrid model for communication and information management and framework developed throughout Chapters Six to Nine are verified and validated in Chapter Eleven. The steps taken to complete the research are described in detail. The thought process throughout the research has been described. Each of the three phases of analysis is described including how each phase led to the next. The final validation is the response to the findings by practitioners with experience in mega construction projects. In order to address issues of transferability, the model and framework were presented to three practitioners in mega construction projects outside of the context of the research.

The evaluators found that the model reflected the construction processes. There was a general agreement as to the relationships between formal and informal processes and their uses. The participants provided input into the model which was further refined in accordance with their suggestions.

There was also general agreement that the findings have applicability in construction and provided comments on how it may be applied by the main parties to construction projects (i.e. client, consultant and contractor). They further agreed that the role of the client in the project was crucial to the establishment of effective communication. They agreed to the characteristics of the client required for effective communication. Furthermore, they agreed that the characteristics of individuals in the project were an important aspect to consider and that have an effect on communication. They agreed to the characteristics of individuals required for effective communication. The evaluators provided comments on the framework for the model which was refined according to their comments. The validation incorporates other aspects. The chain of evidence is presented as part of the validation. Furthermore, establishing the chain of thought was deemed necessary to validate the model and framework and has been presented.

The hybrid framework for communication and information management developed provides guidelines for researchers and practitioners. The main issue for projects in practice is to achieve project objectives. The framework provides guidelines for the use of informal processes for reduction of uncertainty and handling of interdependence in complex projects. The conscious use of the informal process would reduce iterations of information and achieve concurrency enabling projects to achieve their objectives.

Table 12-2 provides the objectives, questions developed to guide the research and the achievements. The literature advises that the nature of construction projects is inherently complex, interdependent and dynamic. Therefore, a need for an effective way to communicate in this environment is required.

12.2.6 Addressing the research aim and research problem

The literature review in the CSF literature was found to be deficient in providing a dynamic systems model showing the interrelationship between CSFs. Although, there have been some attempts in the construction industry to provide models showing the interrelationship between CSFs (e.g. Bellasi and Tukel, 1996), they were short of providing a model that is capable of producing the most crucial CSFs in any project at any time during the construction phase. The FSM model (Fortune and White, 2003) fills this gap. However, it was not applied to construction but to IS/IT projects. Therefore, checking its credibility for use in construction was performed and was found viable and applied in the research.

There have been many calls in the literature for standardization of processes (e.g. Latham, 1994 and Egan, 1998). However, standardization of processes in construction projects has been refuted by other researchers where it stifles problem solving abilities (e.g. Keating et al., 2001). It is therefore prudent to find a balance between standardization (formal) and ‘chaotic’ (informal).

The complexity and contingency theories state that there is no best way to organize but not all are equally effective (e.g. Shanhar, 2001). So how should construction projects be organized? Should there be a ‘loose’ model to allow for each project particulars? Yet the literature provides for models based solely on formal processes, neglecting the informal processes that may develop. Additionally, the issue of overcoming complexity in construction has yet to be provided.

This research attempts to ‘initiate’ filling this gap by presenting a hybrid model of construction processes that incorporates formal and informal processes and shows the interplay between them. The model also shows how formal processes incorporate informal methods. For example, the pre-change process is largely informal. Yet it is an ‘accepted’ part of the formal process. The main issue is not to attempt to build an ‘indestructible’ wall between the two. So how can a balance between formal and informal processes be achieved?

There is an additional deficiency in the literature in regards to formal and informal processes. The main deficiency is when each of the formal and informal processes is used in construction. This research has provided the advantages and disadvantages of formal and informal processes, when and how each should be used and how they interrelate. This highlights how formal and informal processes complement each other. In this regard, the research asks how can communication and information management research not incorporate both formal and informal processes?

A deficiency noted in the construction literature is the concentration on technology applications in the industry. Human impacts in construction are overridden by technology. The human impacts and particularly in the ability to cope and handle uncertainty and task interdependence is hardly addressed. This research addresses the human impact in information management related in particular to the ability to cope with the inherent characteristics of uncertainty and task interdependence in construction projects.

The informal process is described as being “chaotic”. In order to use the model to achieve project objectives, a framework was required. The research provided a framework for the model which is found to be largely based on the characteristics of the client and individuals in the project. A summary of these characteristics and their role in achieving positive project management success is described in the research, as well as the relationship to handling of complexity, uncertainty, ambiguity and task interdependence (e.g. Baccarini, 1996). This is another main contribution of the research.

The research continues to provide guidelines for a balance between formal and informal processes. It was found that the client and individuals in the project team are more important considerations than issues such as procurement methods (e.g. Stacey, 2003). The client role was found as being crucial for the establishment of effective communication in the project. The research compiles the client characteristics that are conducive to establishment of effective communication, thereby, assisting in achieving the balance between formal and informal processes.

To arrive at the model and framework in this research, an inductive, highly relativist approach has been used. This was found essential as it complemented the ‘positivist’ stance engrained in the industry (Cicimil et al., 2006). Of note also, this approach is less frequently adopted in construction management research.

The model provides researchers and practitioners a tool to guide the conscious use of the formal and informal processes. It also provides a model showing the interaction between the formal and informal processes in construction projects. This is one of the main contributions of the research.

The thesis has contributed to our understanding of the actual processes in mega construction projects. It has contributed to our understanding of how to use the formal and informal processes consciously to achieve project management objectives. It has provided a basis for the acknowledgement of and positive use of formal and informal processes in mega construction projects. It has also provided a dynamic and systems model to use to generate the most critical CSFs in construction projects.

Table 12-2 Objectives, questions and achievements

<table>
<tr><th>Objectives</th><th>Questions</th><th>Achievements</th></tr>
<tr><td rowspan="3">Objective 1
To review the literature surrounding critical success factors, communication and information management, information management systems, change, socio-technical systems and human factors to identify the factors critical to communication and information management.</td><td>Develop questions to be asked</td><td>A general overview of the communication and information management literature was made to develop the questions to be asked</td></tr>
<tr><td>Provide guidance for research analysis</td><td>The vast amount of data necessitated focus on main issues. The CSF literature provided a basis upon which to focus. In particular, the FSM model provided dynamic systems means to identify the most crucial CSFs for the context of the research.</td></tr>
<tr><td>Provide background for themes that developed</td><td>The main themes that were developing included communication, complexity, client role and importance of individual characteristics. The literature was reviewed for each topic.</td></tr>
<tr><td>Objective 2
To review models that place a framework around Critical Success Factors (CSFs) to provide guidance for analyzing, investigating and establishing the CSFs that are most critical in mega construction projects in Dubai.</td><td>What are the most crucial CSFs in the case study projects?</td><td>The literature was reviewed to search for models that incorporate the interrelationships between CSFs, provides a dynamic system and would result in the most crucial CSFs for the case study projects. This would then act as guidance to the analysis of the research.</td></tr>
<tr><td>Objective 3
To establish the organization and work process within the case study projects from the perspectives of the main parties involved in order to map key communication and information flows.</td><td>How are construction communication processes performed?</td><td>The communication processes in the case study projects were generated for each from the sketches made during the exploratory semi-structured interviews.</td></tr>
<tr><td rowspan="3">Objective 4
To construct a new theoretical model framework for communication and information management systems in order to provide a practical way of understanding key formal and informal processes and interactions within mega construction projects in Dubai.</td><td>Follows from Objective 3 and adds-How are construction processes performed in practice capturing the formal and informal components to perform the tasks required to transform and produce the project?</td><td>From the responses the formal and informal process advantages and disadvantages were developed and when each is used. This was incorporated in the model. Advancing from objective 3 both the formal and informal processes were captured. The model simplifying this complex process was created showing the interplay between formal and informal processes to reduce complexity and achieve project objectives.</td></tr>
<tr><td>What is the role of top management in construction projects and what characteristics are required for effective communication and which party is most crucial in its establishment?</td><td>The informal processes were indicated as ‘chaotic’ and the formal as a control mechanism. From the research data top management played an important role in establishment of balanced and effective communication in the project. The characteristics of the main parties conducive to effective communication were compiled and listed. The most important party was found to be the client (or client representative).</td></tr>
<tr><td>What are the characteristics of the ‘collection’ of individuals conducive to effective communication?</td><td>The individual characteristics of the individuals in the project were reviewed and compiled in accordance with the perception of their importance in the project by informants.</td></tr>
<tr><td>Objective 5
To verify and validate the model and the conclusions and recommendations of the research within the context of the case study projects explored in order to ensure its relevance to both researchers and practitioners.</td><td>Verify and validate the model and guidelines</td><td>Open discussions were made with practitioners experienced in mega construction projects following presentation of the models and guidelines. The response was that the model reflected the communication in construction projects and that there is general agreement as to the importance of the client and individual characteristics in projects.</td></tr>
</table>

12.3 Contribution to knowledge

There has been little research regarding construction projects in Dubai. There is even less research performed on mega projects in Dubai. Therefore, the research has largely been inductive to highlight the main issues in mega construction projects in Dubai as well as the processes and the most critical factors to consider in such projects. The main contribution to knowledge is in providing a model framework including both formal and informal processes in complex construction projects where previous work has concentrated mainly on formal processes.

The research also highlights the importance of the client role in establishing the culture in the project and reinforcement of the project objectives as well as overcoming the traditional confrontational culture in the construction industry. Additionally, the research highlights the importance of individuals and “collection” of individuals in mega construction projects as well as their importance in making the informal process work to achieve project objectives. The following are the key contributions of the research:

- This research has developed a practical way of understanding key formal and informal processes within mega construction projects. The overarching contribution to knowledge of this research is the hybrid model of information management in mega construction projects that reflects the nature of formal and informal information management, which may then be used to enable a better understanding of how such processes could be managed on future projects.
- The research defines advantages and disadvantages of formal and informal processes in construction projects, which are not defined in the current literature as relates to the context described.
- The research captures construction processes, formal and informal, in mega construction projects in Dubai where there are no descriptions of these processes in the literature.
- The research provides a methodological contribution using an ‘interpretive’ approach to provide a ‘tool’ for use in project management, which is to

supplement the largely ‘positivist’ emphasis within the project management literature.

12.4 Limitations of research

The research is limited to mega construction projects in Dubai. However, as a preliminary transferability verification the model and guidelines were presented to practitioners outside the context of Dubai. Their responses indicate that the model and guidelines may be transferable to other contexts. This should be tested further for use in other Gulf countries similar in nature to the U.A.E. or other contexts.

The research is limited to communication and information processes in mega construction projects. The research does not attempt to address all the problems in construction projects. However, communication and information processes are an important aspect in construction projects which was addressed in this research.

The research is based on a case study approach on a relatively small number of projects. Thereby, no claims of generalizability beyond those case studies can be made. As stated above, testing the model and guidelines are required in other contexts than that which is presented in this research.

The validation of the research conclusions and findings are made based on a small number of practitioners (two of whom were informants in the case study projects). This small number of practitioners evaluating the model, although useful, is not sufficient testing of the model. Further testing and evaluation of the model and guidelines is required.

12.5 Recommendations and future work

The following recommendations are made for future research in managing complexities in mega construction projects and communication and information management related to it:

- To apply the framework more extensively to test its effectiveness informing the management of complexity to test the theory developed in the research and the contexts within which it is applicable.
- Extend the research by incorporating more processes such as logistics and purchasing into the hybrid model framework in order to further study the interactions between the various processes and impact on complexity.
- To subject the hybrid model to computer simulation accounting for the formal as well as the informal processes. The present models show only formal processes and the impact of informal processes within the process is required.
- To research further how informal processes develop in mega construction projects to establish patterns that may assist in further understanding of the processes, which may then be applied to develop the hybrid model further.
- To investigate the applicability of the hybrid model in a different context than that from which it was developed in this research. This would provide a clear limitation as to the generalizability of the model and guidelines.
- To research how to develop current tools and applications in project management within the framework developed in the hybrid model to provide more 'practical' dynamic tools and applications for construction researchers and practitioners alike.
- To scrutinize the definitions of formal and informal processes in order to have better clarification as the difference between the two and how they may work to complement each other.
- To develop IMSs with consideration to the informal processes in complex construction projects. This would provide better IT/IS applications for the construction industry in lieu of systems that are not practical within the inherent complexities of construction projects.
- Establishing further relevance and utility of the theoretical position of the research, which is found to be scarcely used in construction research but which may shed light on issues that other research methodologies may not address.
- To investigate the effect of 'culture' (such as trust, collaboration, etc.) on the hybrid model as this seemed to be of essence in the informal processes.

Further suggestions made by particpants in the validation of the research provided two main suggestions as follows:

- Make electronic IMSs more customized to suit the ‘construction specifics’.
- To develop an IMS upon properly balancing formal and informal communication.

12.6 Comment on the world economic downturn

Since the initiation of the research the global financial crisis has reduced construction output considerably. Dubai has been suffering from project setbacks and cancellations. Many developments which had been launched have now been put on hold or cancelled altogether. However, the Dubai Government has increased its spending on infrastructure development.

Despite the bleak global economic outlook there are some optimistic signs where Christofides, Executive Director of ArabTec states, during a discussion on market challenges in Dubai as part of the MEED Mega Projects three-day conference,

Dubai went through the biggest construction boom and the fastest delivery of projects the world has ever seen. We are slowing down from extreme speed so in comparison to most other nations, we’ll still be way ahead …… Projects will continue in all sectors. Although there has been a big panic about funds and new projects may be delayed, there are a lot of ongoing projects which will complete and so we see a bright future …… We are busier now than six months ago. Clients who had a budget in 2007 couldn’t afford to build in 2008, so they are starting to come back in the market with lower costs.

During the same conference, Edmund O’Sullivan, Chairman of MEED events provided a brief overview of projects in Dubai. Included were Burj Dubai and Business Bay, Dubai World Central and Maktoum International Airport. This is in addition to the increased infrastructure development work by the Dubai Government (Gulf News, 2009; Roots Land Real Estate Development News, 2009)

APPENDICES

Appendix 1 Development of interview questions

The final questions developed to be used in the semi-structured interviews were as follows:

1. Could you provide a brief history of yourself, your experience and your work in the project?
2. Could you state what the project objectives are?
3. Could you provide a brief history of the project, including what in your opinion is done well or not done well in the project?
4. Could you describe the technical and managerial abilities and qualifications of the staff in the project, whether in your organization or outside of it?
5. Could you provide an overview of the relations between staff within and outside of your organization?
6. Could you provide an overview of the quality of work in the project and any occurrences of rework, as well as examples?
7. Could you provide a brief history regarding change orders, variations, claims, and time extensions in the project?
8. Could you describe the organization of the project and how effective it is and why?
9. Could you describe the communication in the project, including methods, between yourself and the various parties and staff and how effective it is and why?
10. Could you describe the current process of information circulation, production and distribution of the work in the project, in particular as relates to your work?
11. Could you provide an example of an information flow problem that occurred during the course of the project, what the solution was and how it was resolved?
12. What are the IT programs used in relation to communication and information transfer within and outside of your organization, in particular those that are used by you to perform your work?

13. What do you think you should be done to make the project work better in terms of communication and information, organization, process of work, human resources and IT?

However, due to the sensitivity of some project data, question number 7 above had to be changed. With agreement of the clients, the question was thereby modified to:

If any changes occur, what happens?

This was reordered to come after question 10, as it flowed better. This affected slightly the responses, but it was either that or no case study. The author chose to modify the questions to accommodate the sensitivity of the question to the clients.

Appendix 2 List of interview questions and justification

Question 1:
Could you provide a brief history of yourself, your experience & your work in the project?

Staff experience is stated as one of the success/failure factors in the literature (Assaf and Al-Hejji, 2006). Alaghbari et al. (2007) add that the lack of contractor's staff is a main success/failure factor. The first question in the interview was to get an idea of the experience of the respondent and to evaluate authority, position and responsibility of the respondent in the project organization. Additionally, it was a simple question that was placed at the start to "break the ice" during the interview with the respondent and move to the more involved questions (Davies, 2007).

Question 2:
Could you state what the project objectives are?

Fortune and White (2006) state that clear objectives of the project are crucial to project success. Faniran et al. (2001) states that crucial to the operation of any major construction project is the movement of project information amongst the professionals, all of whom have conflicting objectives. The second question was developed from this in order to provide the perceptions of the participants as to the objectives of the project. Additionally, the question was to evaluate if there are any conflicting objectives between the respondents from various parties. If there are any conflicting objectives to analyze how that affected information flow amongst project participants.

Question 3:
Could you provide a brief history of the project, including what in your opinion is done well or not done well in the project?

Satisfaction of the participants to the project is stated as one of the key performance measures (KPIs) (Chan and Chan, 2004). Checkland (1981) states that the establishment of the problem or problems is key to any Information System (IS) research. The purpose of this question is to establish if the KPIs are satisfied and to provide an indication of project performance. Additionally, the responses would provide a framework of the perception of the respondents as to what the problems are in the case study projects. This question may lead to other issues that may not have been considered at the start of the research and allowed probing further in directions the respondents would take.

Question 4:

Could you describe the technical and managerial abilities and qualifications of the staff in the project, whether in your organization or outside of it?

In addition to staff experience, Assaf and Al-Hejji (2006) state that poor site management is a success/failure factor. Fortune and White (2006) add that any project needs qualified staff, sufficient in number and skill as a team. Sun and Aouad (1999) state that different professions have different unique processes to perform their tasks, but they become reliant on information from others to perform their tasks efficiently. Bjork (2006) states that psychological and management issues, not technical issues, are the main barriers to successful implementation of Electronic Document Management (EDM) Systems. The purpose of this question is initially to evaluate the perception of the informant regarding the staff and their qualifications from the various parties in the project and to evaluate the satisfaction of the informant regarding the project team.

Question 5:

Could you provide an overview of the relations between staff within and outside of your organization?

The staff experience and qualifications is not sufficient to provide the relations between the staff in the project from whatever organization they belong to. The relations may provide significance as to the environment in the project. Fortune and White (2006) state that consideration should be given to the environment of the project including political stability, organizational culture and structure. Additionally, Ankrah and Langford (2005) add that significant cultural differences exist in task organization, sources of power and influence, control and coordination, formality, people issues and nature of the task. They continue to state that these conflicts are most likely to occur between the parties. They add that awareness of the differences may assist in achieving the right “project chemistry” when establishing the team resulting in overall project performance.

These issues have a direct impact on communication in the project, and thereby, viewed as a variable to explore in the case study projects. The research attempts to provide a view of the project environment and the political scenery in each case study project, which this question attempts to identify. The responses would provide the perception of the informant regards team relations in the project as well as relations between the parties. The relations between the staff from the various parties would be indicative of the cultural and political scene in the case study projects. Also, it may provide reasons for any differences between authority and power in the project.

Question 6:

Could you provide an overview of the quality of work in the project and any occurrences of rework, as well as examples?

Rework has been stated as an indication of poor communication and poor quality of work (Love et al., 2002). This is reiterated by Love et al. (2004) where they state that poor organizational and management practices (including lack of coordination and communication between participants) have contributed to rework in projects. Since rework and quality are results of communication this variable should be incorporated in the questionnaire.

This question attempts to see the amount of rework performed and if the cause of this rework is in poor management or poor communication. Additionally, the level of quality in the project may provide some significance as to management and communication if found to be the cause of poor quality. Also, it would provide perceptions of the staff as to the quality of the work. More importantly it may provide an indication of how good communication and information were managed in each of the incidents of change management.

Question 7:

Could you provide a brief history regarding change orders, variations, claims, and time extensions in the project?

This question was ultimately changed due to the sensitivity of the management to the question. The question was rephrased prior to start of the interviews to accommodate this sensitivity, yet gather the same data. It was rephrased to read as follows:

If any changes occur what happens?

Faridi and El-Sayegh (2006) consider change as one of the success/failure factors. This is also considered as one of the key performance indicators by Chan and Chan (2004). Change also requires iterations of information and good communication (Ford, 2002).

The purpose of this question is to provide an indication of the amount of changes during the course of the work. From this question the cause of the changes may be stated (i.e. if changes caused by owner, then there is a time extension).Additionally, it indicates if communication and information was managed well to resolve any changes quickly. Furthermore, it was to provide how well communication was managed in the project (i.e. if problems are resolved quickly then good communication).

Question 8:

Could you describe the organization of the project, how effective it is, and why?

Deficiencies in organizational structure of the system are a cause of poor project performance (Fortune and White, 2006). Additionally, they add that support from senior management is critical to success of the project. Anunmba et al. (2002) add that organizational structures affect the performance of the project and needs to be reconciled with the process, communication and coordination and human factors. The organization of the project, therefore, affects the performance as well as communication and coordination.

A question should include the organizational aspects of the case study projects. The question written aims at gathering data to initially get a general picture of the organization in each of the case study projects. The second aim is to capture the perceptions in the case study projects as to the effectiveness of the project organization. The final aim is to find the reasons as to why the respondents viewed effectiveness of the organization the way they did and what made it successful or not, such as communication with Head Office and level of top management support.

Question 9:

Could you describe the communication in the project, including methods, between yourself and the various parties and staff, how effective it is and why?

Communication is stated as one of the most important success/failure factors in construction projects. Effective communication is essential for project success (Cheng et al., 2001; Emmitt and Gorse, 2003). The question was developed to capture data on several aspects of communication. The first is to provide an assessment of the medium that are used to transfer information. Second, it will provide an indication of how well the communication channels used are commensurate with the information flow. Third, it provides the Team communication of all the parties and the nature of the communication.

Question 10:

Could you describe the current process of information circulation, production and distribution of the work in the project, in particular as relates to your work?

Better means of managing the information flow results in enhanced productivity of projects (Titus and Brochner 2005). Checkland (1981) provides several requirements for analysis of systems. These steps were used as a guide for the requirements of the research. The guide has been used to develop the question regarding processes.

The question developed aims at gathering as much information in the least amount of time available for the interviews. The question would provide the information pieces required for an informant to perform his activity and why it is required. It would also provide the owners of the information pieces required for the activities to be performed. It would provide the standardization that is used in the project (i.e. the forms). Additionally, it provides what is to be produced from each of the activities performed, as well as who is to receive the transformed information, when and why. The question would indicate the bottlenecks and difficulties that may be in the current process and would provide the areas to concentrate on when establishing a revised framework.

Question 11:
Could you provide an example of an information flow problem that occurred during the course of the project, what the solution was and how it was resolved?

This question was written to complement the previous responses. It attempts to get examples of the issues which cause information flow problems. This could be used to compare with the responses to previous questions.

Question 12:
What are the IT programs used in relation to communication and information transfer within and outside of your organization, in particular those that are used by you to perform your work?

IT has gained interest in research over the past few years. Particular interest has been in implementation of electronic information systems. It is stated that Client continuous demands must be met and improving project performance is helping drive the construction industry towards fully integrated project teams. Project participants would have instantaneous access to all project information through the use of IMSs (Moore and Dainty, 1999). Craig and Sommerville (2006) add that many major construction industry clients and main contractors are now adopting integrated construction processes using information management systems with the underlying premise being that all project participants are able to develop core skills in creating, communicating and transferring project data electronically.

The question is drafted to see where IT has been used in the case study projects and if it has been effective and reasons for level of effectiveness, in particular as relates to communication and information transfer. It attempts to provide where electronic formats are used in the information system. It also evaluates the abilities of the informant in terms of IT. It will indicate which of the parties find training useful to them. However, most importantly, the question aims at capturing the effectiveness of electronic information management system in the case study projects and what purpose was served by it. Also, it attempts to find what value these systems served and what the hurdles were in their application.

Question 13:
What do you think you should be done to make the project work better in terms of communication and information, organization, process of work, human resources and IT?

This question has been drafted to check first whether the problems stated during the interviews have solutions proposed by the respondent. It would provide the perception of the informants on their ideas. Also, differences in opinions may surface between the participants which may be of value to the research. It would provide informant opinions which may provide indications of solutions to communication and information management problems. Additionally, it provides the human aspect that would need to be considered in the information management framework. It would also indicate the most important issues that need to be addressed. It may highlight issues to be considered within the framework to be developed. It would also highlight the respondents' knowledge of IT/IS.

The questions written have been carefully drafted and checked. The questions were drafted to provide as much information as possible in the least amount of time for interviews. The most important to consider in drafting the questions is to incorporate as many variables as possible relating to communication and information in construction projects as seen from the literature review performed. The questions were also to provide a check on the other questions asked. For example, the question regarding problems would be cross-checked with the questions of suggestions. The questions were also drafted to allow the respondent leniency to go in various directions. This would allow the researcher to probe further into responses provided by asking questions not in the list.

In addition to the questions, there were three sketches to be performed during the interviews. The first was a diagram of personnel from various parties that would show communication between the various staff in the project. However, this was dropped after the pilot interviews as it was time consuming and did not provide information required. The second diagram was of the organization of the project. The third was the process in the case study projects. These were found to be relevant and consumed little time. They also provided valuable information as tested through the pilot study interviews.

Appendix 3 History of case study projects and case-by-case analysis of CSFs

A-1 History of case study projects

A-1-1 Project 1

This project is owned by a development, which is a joint venture of a foreign and local developer. The foreign developer has extensive global developments, mainly hotel and recreation developments, including a five star hotel in Dubai. The local partner is a local development firm. However, the management of the project seems to have been left entirely to the foreign partner. This may be due to his extensive global experience in developments, and particularly, these types of developments. The author did not observe any sign of the local partner in the project.

The project was quite complex. It consisted mainly of a five star 1500 room hotel, retail area and an elaborate water park as well as other buildings and facilities. The complexity of the project lies in the following features for each of the main portions of the project which are the hotel and retail area and the water park with a marine theme. The specializations required to put this project together is extensive, very specialized and in some areas rare.

The project is located on an island which is a landmark of Dubai. This landmark area was managed by a local development firm. The entire landmark area was divided and many developers were working simultaneously in their respective areas. Developments in the landmark included hotels, parks, residential areas as well as other facilities. Each developer worked in all phases of their respective developments in their areas. The main developer ensured that the utilities and facilities were provided to the sub-developers to complete their respective developments without delay.

There were some problems faced by the sub-developers, in particular the provision of utilities and services in a timely manner. This caused the sub-developers to find ways to provide their own utilities and services, at least temporarily, to avoid any delays in the construction work. Suffice it to say at this point that the main developer's management was changed several times during a short period.

The complexity of the case study project was increased with the many changes that occurred during both the design and construction phases. During the design phase the developer initially had two hotels in the initial design. At a certain point, late in the design stage, the developer decided to make one large hotel instead of the two that were initially designed. This was one of the major changes that were made late in the design stage. Additionally, the design phase was cut at a certain point, which some described as "cut short prematurely", in order to start the construction phase.

The President of the foreign developer who was managing the project had close ties with one of the major shareholders of one of the leading British construction companies. As such, the developer’s firm agreed to provide the construction documents to the British construction company to provide a lump sum price as main contractor. A price was submitted for the entire project. This price was much higher than the budget estimated and provided for the project. There were negotiations to reduce the price, but it was still too high. The foreign developer’s team had to find a way to complete the project within their budget.

Using the personal relationship between the decision makers in both firms it was decided that the best route was the construction management route. Using the relationship between the two people, it was agreed that the construction firm would provide staff to fill positions in the construction management team and construct major portions of the project, which where deemed to be “within budget” and within the “expertise” of the British contractor. This agreement was accepted by both parties.

The staffs provided by the British contractor were to be paid for by the developer as “on loan” staff for the construction management team. These staff where to be considered within the construction management team for the duration of their work in the project. The staffs were provided with one of them appointed as leader of the project. Others held big positions within the construction management team. At the time of the research 70 % of the staff in the construction management team was provided by the British contractor. The remaining 30 % were drawn mainly from other firms, including a well known British engineering firm and a reputable QS firm as well as from other sources. Others were hired on an individual basis for specialized expertise that was rare to find, including an engineer specializing in electromechanical items for water parks.

The staffs that were nominated from any source were interviewed by the developer and approved before being hired. The majority of the staff in the project that was coming from the organizations was Western, mainly from the UK. Others were from South Africa and other countries. The administrative and supporting technical staffs were largely Indian and Pilipino, with some from other countries. Overall, the staffs were multi-national with substantial expertise in various fields.

Having a newly founded construction management team, the developer started to search for specialist contractors to construct portions of the work suited to their expertise. With the newly founded construction management team, the developer started to make packages of works. These packages included the specifications, drawings, BOQ and scope of work. These packages were then sent to nominated contractors as a tender package. Contractors were nominated on the basis of their specialties, expertise and reputation, and as much as possible, their ability to perform the work at the required time. This was at times difficult due to contractors being very busy. Each package had a “Works Package Manager”, WPM, who was responsible for the package from tendering stage to recommending award of tender, to execution of the package, including coordinating with other packages overlapping with it.

The British contractor aforementioned was awarded the concrete works, façade, block work and later bathroom pods. The concrete works alone was the second largest package in terms of cost. It was also critical for the progress of the project.

A-1-2 Project 2

The project is owned by a local development firm. The development firm was provided an area by the main developer as part of a master plan. Other sub-developers were provided areas to develop. Developments included parks, hotels, residential areas, as well as other facilities. The overall development was rather large and new ideas were encouraged. This is shown in the architecture in the area and the large number of amusement parks with various themes, as well as vast sports areas for various sports.

The project was not as complex as Project 1. The project included hotels, malls, vast residential areas, a race track and an amusement theme park, which was of limits to the research. At the time of the research the hotel was awarded to a contractor currently working in the development. The contractor was awarded the hotel based on negotiations.

The overall project was a two billion dollar venture located in the middle of a desert area with extensive development. The developer appointed a project management firm to manage the design and construction phases. The project management firm was part of the group which the developer was part of.

The project management firm hired a reputable consultant from the US with extensive experience and presence in Dubai. The consultant was an architectural firm. As such, they brought on board two specialized consultants, one for structural works and the other for electromechanical works. During the design phase, the project management firm appointed their own staff to oversee the design phase. Many of them continued into the construction phase.

When the tender documents were completed, the project management firm divided them into separate self contained areas and one for the infrastructure works. This was not put out to tender. Instead, the project management firm and client, decided to invite only reputable contractors for each area and for the infrastructure of the entire area. Preference was given to the contractors who had previously worked with them before and were satisfied with their experience with them. Out of the three main contractors invited to tender, two had previously worked with the same client. It was also stated by one of the main contractors that both the client and they were hoping for a long term relationship. The contractors have stated that the client has involved them in a future project at its design phase to avoid problems faced in this project, where design changes were made during construction.

At the start of the construction of the projects, all the contractors proposed changes to the designs. The main changes proposed were to substitute the cast in situ slabs with pre-stressed concrete slabs. This change was proposed by the contractors, it seems, to reduce the scarce labour resources required, as well as for speed of construction and cost savings. The client accepted due to cost savings and for time.

The staffs of the project management firm were their own, unlike Project 1. However, the staffs working in the project of both the consultant and the QS firms were subject to their approval. The majority of the staff in both the project management firm and the consultants was of Middle Eastern origins. The administrative staffs were mainly Pilipino and Indian. The contractors' staffs were mainly Westerners from whatever origin the contractor was from. However, their administration staffs were mainly Pilipino and Indian.

A-2 Application of FSM model in case study projects

Each case study project shall be applied into the FSM model to provide the most critical CSFs from the data collected and observations by the researcher. Each of the components and subcomponents of the CSFs shall be discussed in detail. The final results shall be provided from this analysis.

The CSFs and FSM model provide some interesting findings that are discussed below. This section discusses the CSFs and their applications to the FSM model. The discussions follow the components of the model and the CSF attributes as related to the case study projects. From the discussion the following section will compare between the case study projects.

A-2-1 Goals and objectives

There are two critical success factors for the goals and objectives. The first is clear realistic objectives. This is stated in the literature as one of the most critical factors in any project (e.g. Clarke, 1999). If projects are unclear as to objectives, there will be confusion. The second CSF is a strong business case/sound basis for project. In both projects both critical success factors were considered and faith in the developers' business sense was evident.

A-2-1-1 Clear realistic objectives

Project 1

In Project 1, the objectives were made clear to all. The statements made by interviewees in response to the question presented during the interview shows clarity of objectives to the project team. The objectives stated were the same as the client's objectives as stated by the project managers.

Most of the responses, despite coming from members of various parties in the project, stated client satisfaction within their statements in addition to quality, budget and time. The client in Project 1 was clear that time, quality of visible portions and remaining within the budget was crucial. It was clear that the objectives were made known to all.

The objective of delivering the project on time was stated as very difficult by some of the respondents. They also added that although it was a difficult task it was not impossible. Additionally, the majority stated that despite the difficulties the project was on time and within budget.

Project 2

In Project 2, the objectives were clear by the members of the project, whichever party they belonged to. Again, client satisfaction was stated in many of the objectives, particularly of the top management from each party. As a property development the client was anxious to get the project delivered within time and budget and in an acceptable quality. The project objectives regarding time, budget and quality was stated by most as realistic. Additionally, despite the changes made to the designs, most of the areas were progressing ahead of time and remained within budget.

A-2-1-2 Strong business case for project

Project 1

Project 1 is a tourist development, which offered a new perspective on entertainment. The foreign partner of the development has extensive experience and was very successful in all previous developments.

Project 2

Project 2 is largely a property development that offered the booming Dubai property market a variety of properties that could be purchased. This is a very lucrative business as the cost of properties in Dubai was sky rocketing at the time and forecasts showed no abating to the climb in the near future. Project 2 had an entertainment component in the form of entertainment parks and hotels. Unfortunately, the entertainment park was off limits to the research and was considered confidential.

A-2-2 Performance monitoring

There are two CSFs in the performance monitoring component of the FSM model. The first is effective monitoring/control in the project. In both case study projects it is found that there are effective monitoring and control systems. However, the second CSF, planned close down/review/acceptance of possible failure, it was found that this CSF was not considered a high priority. This may be due to the phase in the projects that the research was performed.

A-2-2-1 Effective monitoring/control

Project 1

Despite the complexity evident in the project, it seems that Project 1 was very controlled. This is seen from a statement made by one of the staff in the project, who had extensive experience in mega projects, who stated:

This project is the most controlled of the projects I've worked in. So I believe there is something done right here. The professionals in other projects were protecting their turf and communication was with those around them. It's not about a good computer system. It's about encouraging communication and cooperation and that is what's here in this project. ***Consultant-Project 1***

The statement is clear as to how effective the monitoring and control was in Project 1. Additionally, he attributes that to the cooperative environment and good personal communication within the project. There were voices that had been raised regarding the lengthy formal procedures imposed by the client. However, these procedures were allowed to be circumvented in many instances simply based on the cooperative environment in the project. This will be discussed in a separate section.

Project 2

Project 2 had a good and effective monitoring and control system. This was visible from the formal process, where everything was controlled by the SPMs for each respective area. Additionally, each SPM was the focal point through which all information passed between contractor and consultant, and thereby, he could monitor whether any information would affect project cost or time. The following statement summarizes the monitoring and control of Project 2:

We worry a lot about cost and time. Cost and time that would come from responses, from design Consultants on shop drawings or request for information or any other instruction might the Consultants give the Contractor. If it doesn't go through Project Management firm, where we get to stop it or block it before it goes to the Contractor, then we will be hit a lot of claims in terms of cost and time. ***SPM-Project 2***

A-2-2-2 Planned close down/review/acceptance of possible failure

Project 1

In Project 1, none of the WPMs had stated much regarding the commissioning and handover stages. In fact, there was no information in that regard. A statement made in that regard shows this neglect:

At the end of the project there obviously has to be a taking over certificate for each package. Everything's got to be signed off, that has been done, that has been done, got the keys for this, you got that, you got your spare parts, you got your work manual. Now I would ask if anybody in this building knows what we're chasing. ***Document Control-Project 1***

It was obvious that the WPMs and everyone else were so caught up in the performance of the work that this issue was not a priority. It may be that the stage the project was at, which was in the early finishes stage, did not warrant the urgency.

Project 2

There was no evidence in Project 2 regarding commissioning and handover stages. There was no indication that close-out issues were planned. Everyone was busy getting the job done that this task seemed far away and could be delayed. Additionally, Project 2 was still in the earlier stages of project execution.

A-2-3 Decision-maker(s)

The decision-maker(s) component of the FSM model involves the overall management of the project. The CSFs included are the support from senior management, competent project manager, strong/detailed plan kept up to date, realistic schedule, good leadership and correct choice/past experience of project management methodology/tools. Each is discussed below for each of the case study projects.

A-2-3-1 Support from senior management

Project 1

Project 1 was supported by senior management of all the main parties. The client senior management gave full support to the construction management team representing him. This is seen from the level of client staff on site. The client President and several Vice-Presidents were physically on site. Any decisions regarding any issues were swiftly resolved by the client staff. This was stated as key to the success of the construction project; despite the fact that some stated that it was also an added pressure since they were involved on a daily basis. A statement to that effect shows the meaning:

The type of client we have as well, that wants to be involved. It's sometimes a disadvantage but most of the time its an advantage,…... I think that's, that's pretty key and I don't think that you'd get that with other clients. ***WPM-Project 1***

However, it was generally recognized that senior staff of the other parties, particularly those with critical tasks, needed to be supportive of their teams and of the project as a whole. Additionally, the way senior management dealt with each other was mirrored throughout the project. This was voiced by many of the staff during the interviews. A statement that summarizes this is:

…., this collaborative relationship …... it depends on a couple of things; it depends on the attitude of the directors of (one of the main contractors) , and the attitude of the President of (the client) in wanting to resolve and wrap up in a quite and tidy manner the project, and the way that those two people deal with each other then is filtered down on every level to everybody else,… ***WPM-Project 1***

The environment in the project was described as collaborative. This was mainly true for the relationship between the client and contractors. However, when respondents talked about the consultant, and largely the main consultant, the attitude changed considerably. There seemed to be some bitterness when talking about the consultant. An adversarial attitude was present between the main consultant and the rest of the project team, namely the client, contractors and construction management team, which itself was composed largely of contractors' staff on loan to the client. Following are some statements that highlight this adversarial attitude:

Given the consultant who has been quite slow to react at times, I think (construction management team) have done quite well. And (consultant), as a typical consultant, they're never quick enough for the contractor. ***Contractor Project Coordinator-Project 1***

To be fair, I think (consultant) were understaffed to start with. We didn't get decisions on the drawings. ***Contractor Project Leader-Project 1***

You could change the consultant and get him a little bit more working on your side. That's created a lot more conflict than was necessary. ***WPM-Project 1***

The above statements were made by all the main parties to the project. However, when studying this more deeply, it is evident that the main reason for this adversarial attitude lay in several causes. The first is that senior management of the main consultant was not very supportive of the Project Director. Their team was understaffed from the start. Additionally, senior management of the consultant did not develop a collaborative relationship with the client similar to that between the client and the contractors. It seemed through observation that even senior management had developed an adversarial attitude. This was considered a hurdle and was dealt with by loading the construction management team with more work; another reason for the adversarial attitude.

It is therefore important to establish the senior management support for the respective teams and the project as a whole. The environment in the project relies heavily on the attitude of senior management of the parties towards each other. This is done in a top down fashion.

Project 2

The project management team managing Project 2 was a member of the client group and the CEO of the client, and head of the client board of directors, was continuously observed meeting the Project Director. Support for the project management firm representing the client in the project was unquestionable. The support started from the design stage of the project through to construction, thereby providing continuity throughout the project phases.

Senior management of the client had hand picked the contractors that would be invited to bid for the various parts of the projects. One contractor was chosen for each part, many of whom had worked with the client previously. The contract for each part was then awarded by negotiations to each contractor. This created a collaborative attitude between the client and the respective contractors. This was certainly observed in the project and through the interviews.

The consultant in Project 2 was contracted by the client directly. There was no bid for the relevant works. It seems the client had chosen them based on their reputation and abilities perceived. The consultant was an American firm. The consultant team on site had continuous access to the staff in the US through their web-based system. They could send and receive emails or simply chat on the web regarding any concerns. The support for the team on site was observed to be evidently present.

A-2-3-2 Competent Project Manager

Project 1

In Project 1, the project managers or leaders of the larger contractors were well qualified and experienced as evident from their previous work. This was supported by responses from other interviews. However, the responses also highlighted that there was a problem with competency of the project managers of the smaller contractors. In general it was found that the smaller contractors had management problems from production of shop drawings to actual supervision and construction. The result was that the construction management team staff had to push the smaller contractors and provided an added assistance to keep them working.

The consultant Project Director was very competent. However, it was observed that the project circumstances seemed stressful. Additionally, it seemed that the support by the main consultant senior management was not sufficient for the Project Director.

Project 2

In Project 2, the project managers and directors of the contractors were competent and qualified to perform their respective tasks. Again, this was seen from the summary of their experiences, which was supported by the responses in the interviews. Unlike Project 1, the projects were awarded on the basis of a main contract. Additionally, the MEP subcontractor was a member of the client group, which proved to be an advantage for the main contractors of the respective portions of the project. There were no problems that were stated in regards to the main subcontractors.

The consultant Senior Resident Engineer was competent and experienced in projects of a similar nature. The SRE was supported by the consultant senior management in the U.S.A. Additionally, the level of complexity provided for less uncertainty and there were no continuous changes during the project at the time.

A-2-3-3 Strong/detailed plan kept up to date

Project 1

In Project 1, the plans were kept up to date through weekly meetings between the project planner with contractors and the respective WPMs. However, due to the difficulty of the software and the size of the plans, many of the staff was content to get a print out of their respective portions and use that. In Project 1, the project managers actually never used the plan as it was too complicated for their usefulness. They used a curve instead.

Project 2

In Project 2, the plans were kept up to date through a weekly meeting between the planning engineer and the respective contractors and SPMs of each area. The planning department continuously updated the plan following these meetings.

A-2-3-4 Realistic schedule

Project 1

The work schedules for Project 1 was in reality, as originally designed, not a realistic schedule. It was previously indicated that there were some major changes in the method of construction of the project. The major changes:

- Constructing the reinforced concrete frame by using the “slip-form” method.
- Making the bathrooms pods to be slipped into the concrete frame.
- Making a precast façade in lieu of the previous system requiring blockwork.
- Replacing blockwork with precast panels wherever possible.

These changes made the original schedule possible. If these changes were not proposed by the contractors and agreed by the client, it was very possible that delays would have occurred as well as an excessively large force of skilled masons and unskilled labour, all of whom were scarce in Dubai. Following is a statement that shows how this provided the project with the possibility of completing on schedule.

Without those things it would’ve been very, very difficult to be on program by now. ***WPM-Project 1***

Therefore, the original work schedule was not realistic at the start, but was made realistic by the changes made during construction.

Project 2

The work schedule in Project 2 was realistic. There was sufficient time to complete the project as designed within the constraints of Dubai. This is evidenced in that most of the parts of the project were ahead of schedule. However, it was made slightly less realistic by introducing the major changes, which were changing the slabs to precast and providing precast facades in lieu of blockwork, among others. The constraint was the approvals of the redesigns by the Authorities, which took a longer than anticipated time.

A-2-3-5 Good leadership

Project 1

Project 1 had good leadership. This was stated by several of the staff from different parties.

Project 2

Project 2 had good leadership. This was stated by several of the staff from different parties.

A-2-3-6 Correct choice/past experience of project management methodology/tools

Project 1

The project procurement route was originally planned as a traditional main contractor route. However, finding the prices considerably above the budget, the client decided to change the procurement route. The client established a construction management team to run the project, where the majority of staff in it was actually from the contractor, QS firm and an engineering firm, on loan to the client. The project was divided into packages and each was tendered to qualified contractors. Much of the construction management staff came from organizations that had large portions of the work awarded to them in the same project.

This construction management team was not tried in Dubai. There were several aspects that added to the “strangeness” regarding the construction management team. First, this is usually given to a specialist construction management team. This was a construction management team that was established by, and for, the client. It was not a construction management firm. Secondly, the staff of the construction management team came largely from contractors who were awarded large portions of the work. It was strange for colleagues from the same organization to be on "different sides of the fence".

Our relationship with the guys over there is slightly unusual in that some of the guys over there are, guys in that team, work for my company. So while the focus of the concrete frame is to build the concrete frame, within budget, to program and to make our margin, the guys over there who work for the same company who have a different interest who are looking for us to do what we haven't scoped that they don't want to pay us for. There's a guy over there who will look for us to build to a quality that we don't feel is appropriate, we haven't priced. So, there's a .. there's always conflict on a construction site .. It's different because the guys you were working with you're now .. opposition is a strong word .. you now have different interests in terms of this project. ***WPM-Project 1***

It was bespoke in Dubai. It was never tried and it was not planned prior to start of the project. Was it successful? It seemed so as seen on site and from the response of the majority of respondents.

When we were brought on board initially, there is no doubt that there was a paradigm, there was a model in peoples' heads on how this would work, and I think we've changed that into a more realistic picture, and its changing that paradigm. We've been hugely successful, there's no doubt about that, and we are probably, we are hiding that, we are probably the leading project in Dubai, possibly in the Middle East. And that's whether it be time or whether it be safety, we are probably one of the leading projects in the Middle East. ***Project Leader-Project 1***

Project 2

Project 2 had a project management firm acting as client representative on site. They were controlling the project and ensuring that the project was completed within time, within budget and in the right quality. The project management firm would report back to the client. The client was not directly involved in the operation of the project.

This method of procuring the project was suitable for Project 2. It was not a very complex project. There were only major changes in the structure at the start of the project, but no continuous changes during the progress of the project. The client did not have to become very involved in too many things in the project. Additionally, project management procurement routes have been tried in Dubai and generally accepted. Despite that, some respondents stated that there was a lack of clarity regards responsibility and authority since they were not used to it. Overall, the project management choice seemed to be correct for the.

A-2-4 Transformations

The transformation component in the FSM model is where inputs are changed to outputs. This is where the project is built to achieve its objectives. It is interesting to note that only one CSF is in this component which is skilled/suitably qualified/ sufficient staff/team. The CSF is a “people” factor.

A-2-4-1 Skilled/suitably qualified/sufficient staff/team

Project 1

The problem of manpower availability is a common problem in Dubai. It was very difficult to get sufficient qualified manpower, whether staff or labour, to complete projects due to the high demand, which was an outcome of the construction boom. It was a complaint heard from many of the respondents during the interviews.

Although this was a common problem for all projects it didn’t seem to tremendously affect the case study projects. The reasons were the changes that were made for both projects, which reduced the requirement for manpower, particularly skilled labour and junior engineering staff. The changes have previously been described and its effect on the logistics of the project was highlighted.

The changes were proposed by the contractors which the client then accepted. In both cases the risks for the changes were identified and assessed along with the benefits to the project. It seems that the client’s attitude played a major role in assisting the successful completion of the project.

Project 2

The problem of manpower availability is a common problem in Dubai, similar to Project 1. Again, this was a common problem for all projects and it didn't seem to tremendously affect the case study project. The results are consistent with those of Project 1.

A-2-5 Communication

The communication component in the FSM model is not evident in the model. Additionally, it is only one CSF which is good communication/feedback. The reason for this is that communication is intangible and is inherent in all other components of the model and between them. Communication in the case study projects will be discussed below but a separate chapter will discuss details.

A-2-5-1 Good communication/feedback

Project 1

Communication was highlighted as a critical issue by respondents in both projects. Top management of both the client and construction management team encouraged informal communication in the project. It was observed that informal communication was used extensively. Respondents stated that this had to be done to manage issues. The formal system, which in fact was a web-based system, was used as a document management system. Respondents complained that many times problems would occur on site because information was not coming in time through the formal system. The system was viewed as slow and site works were progressing faster than the "formal" system could supply. Therefore, respondents viewed the informal system as necessary.

Informal communications was highlighted by respondents as crucial for progress in Project 1. The respondents also stated that the informal system allowed them to communicate with whomever they wished to get responses or answers. It resolved problems quickly by going directly to talk with the person concerned. Decisions could be made easily and the staff could get "informal" approvals prior to final submission of documents, thereby avoiding iterations through the formal system. It was also stated that the informal system was very useful during change where decisions would be made verbally to be followed by documents through the formal system. At times it was stated that the informal system managed change better, especially during critical times. The feedback was much faster through the informal network.

Project 2

Communication was highlighted as a critical issue by respondents in Project 2. Informal communications was highlighted by respondents as crucial for progress in Project 2. The formal system, which was manual and relying solely on document transfer, was stated as being slow. The respondents also stated that the informal system allowed them to communicate horizontally, thereby resolving issues directly with the person concerned. This in turn allowed the staff to get "informal" approvals prior to final submission of documents, thereby avoiding iterations through the formal system. It was also stated that the informal system was very useful during change where decisions would be made verbally to be followed by documents through the formal system. The project management team encouraged informal communication and was used extensively.

A-2-6 Environment

A-2-6-1 Political stability

The political scene in Dubai is very stable. There was no effect of political stability on either case study project.

A-2-6-2 Environmental influences

Project 1

In Project 1 at the start of the project, there was a tunnel that should be completed to give access to the project. This was not done at the start of the project. It was ongoing and the client had even made plans to move materials and equipment by an alternative route. The main developer then made a temporary access over a dyke during the construction of the tunnel. However, this problem was persistent with utilities and other infrastructure work. These issues involved Authorities.

Authorities were overwhelmed at the time by the amount of work during the construction boom. Their efficiency and ability to react was hampered by this.

Additionally, the construction regulations in Dubai were strict and Authorities had to approve structural shop drawings and had to be present during any cast of structural concrete. This was another constraint imposed on the project. However, due to the high profile nature of Project 1, the effects may have been minimized, whereby both the main developer and the Authorities may have given priority to this development as stated by some respondents.

Project 2

In Project 2, approval for the revised drawings for the structure was not forthcoming. This caused a delay in start of construction for one of the areas. In this case it was up to the contractor to increase progress of works since it was his responsibility. He had provided the proposal for the change and the client approved.

A-2-6-3 Past experience (learning from)

Project 1

From two of the questions in the interview it was evident that the staff was experienced and qualified for their various tasks. The brief introduction made by each respondent of their experience indicates an experienced team. Additionally, respondents from all parties in Project 1 viewed their counterparts positively and described them as experienced, qualified and able to perform their tasks. This is despite some comments made regarding the consultant and the smaller contractors.

Project 2

Respondents from all parties in Project 2 viewed the management as experienced, qualified and able to perform their tasks. From the staff introductions it was evident that they had experience. Furthermore, respondents viewed their counterparts positively.

A-2-6-4 Organizational adaptation/culture/structure

Project 1

Project 1 had started as a traditionally procured contract with a main contractor whom the President of the client knew and negotiated with. Finding that the price from the main contractor exceeded the budget, it was decided to create a construction management team for the client. The friendship between the President of the client and the CEO of the main contractor proved invaluable for developing a cooperative culture throughout the project organization. Despite the fact that the contract as main contractor was not awarded to the contractor, several main portions of the project were awarded to the contractor. Additionally, the contractor supplied the majority of staff for the construction management team for the client. This cooperative relationship between top management of the contractor showed its way into the project organization as a whole.

The relationship between the client and consultant was not as collaborative as between the client and contractor. There were two main reasons for this. The first and main reason seems to be the change of procurement route. As stated previously, the original intent was to procure the contract in a traditional manner through a main contractor. It seems that the consultant had provided a number of staff sufficient for that procurement route since the coordination effort would rest on the contractor. The construction management route would require a considerable coordination effort by the consultant. However, when the change to a construction management route occurred, the contract between the client and consultant was not modified to suit the new route. It seems the client had not assessed the additional coordination effort of the consultant correctly. This ultimately resulted in an adversarial attitude between the client and consultant. It was obvious from the responses of many regarding the consultant.

Another main reason for this adversary may have been the bias of the client. The President of the client was a constructor himself. The well known “adversary” between consultant and contractor seems to have spilled over into the project. Additionally, the vast majority of the client staff and construction management team were from contractor backgrounds, they were builders.

I’m probably safe in saying that no contractor would ever pat be consultant on the back ***Contractor Project Coordinator-Project 1***

Despite the adversarial attitude between the client and the construction management team and the consultant, the environment remained collaborative. The adversarial nature remained in the background. This was confirmed by the responses of the vast majority from all parties.

The construction management team took the responsibility for managing the project, which was divided into two main parts, the hotel and the park. The organization structure was a matrix structure, which seemed to suit the size and complexity of the project. Within that matrix structure the organization was rather loose. In fact, there was no official organization structure posted. It seemed that management had wanted it this way and a decision was made not to post an official organization structure. Despite that it seemed that everyone knew what to do and where to go to for solutions. The exception was the newcomers during the first few days on the job. Following is a statement by one of the respondents:

I'm very, very comfortable when I've got a very clear organization that's pinned on the wall, everybody knows chuchuchu that's me, that's me, that's me because you know from our first conversation we don't even have a current organization chart, formal organization chart on this project. That's not my decision; that's somebody else's decision. Does it work? Interestingly, yes it does, and it's fascinating. I wouldn't .. you will not find it in any management books, and you definitely will not find it in any project management books, but it works. Everybody knows what they're supposed to be doing. They're not looking at their job descriptions and they're not looking at the organization chart and they know what their job is, and it functions pretty well. ***Project Leader-Project 1***

It seemed that the organization was quite adaptable. It changed during the course of the project. Some respondents complained that the organization was changing all the time. This was in the construction management team. The consultant and contractor organizations were rather traditional setups. The focal point for the project was the Work Package Manager (WPM) for each respective portion of the work. The WPM was the person between the contractor and consultant to ensure the contract was completed as required. Figure 0-1and Figure 0-2 show the organization structure of the project.

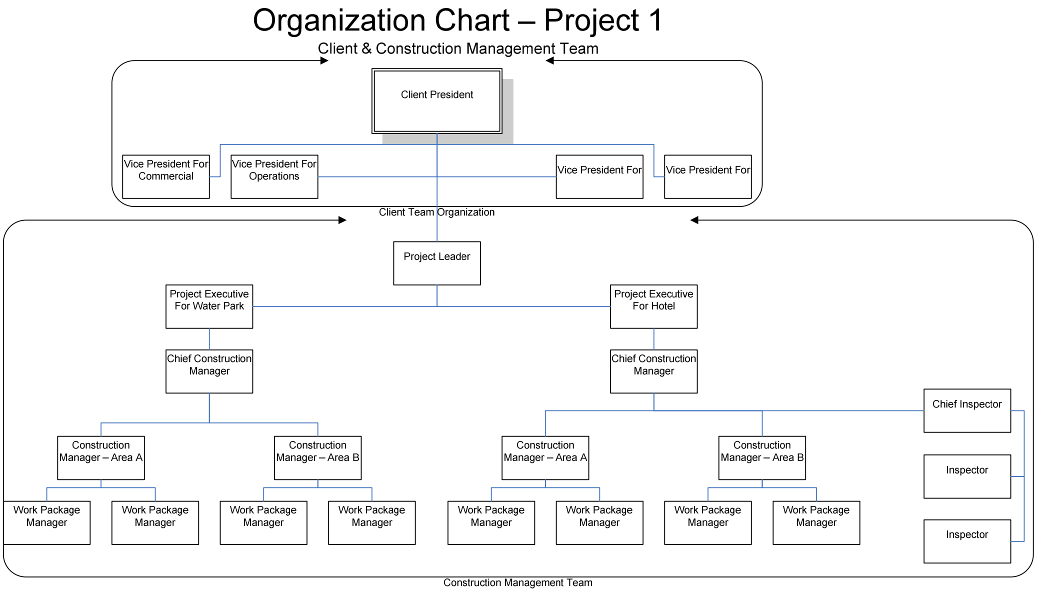


Figure 0-1 Organization chart for client and construction management team in Project 1

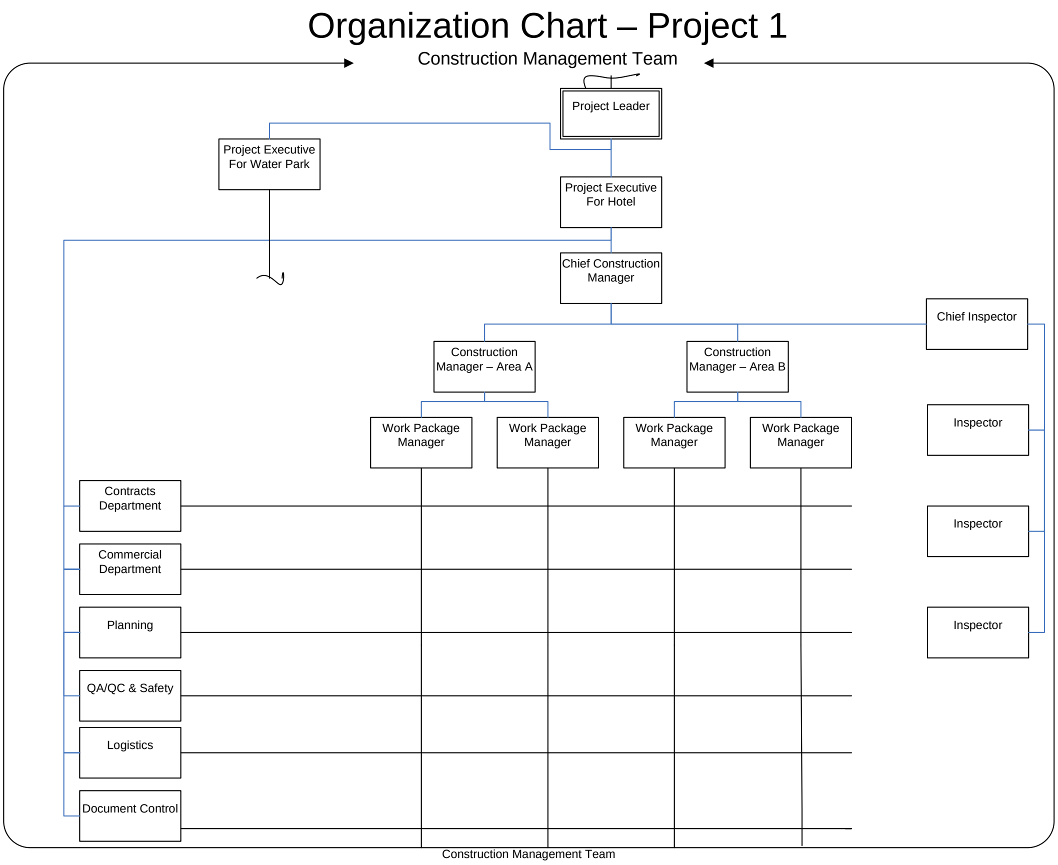


Figure 0-2 Detailed organizational chart for construction management team in Project 1

Project 2

Project 2 used a project management firm to oversee the construction of the project as client representative. This seemed suitable for the project. Additionally, the various organizations to the project were no strangers to each other. The project management firm was involved with the consultant in the project from the design phase. Some of the contractors had worked previously with the client. The contractors who were newcomers were chosen by the client and the contract was awarded based on direct negotiations. This seemed to have a big impact on dissolving cultural differences between the organizations.

The structure of the project organization was rather traditional. Figure 0-3, Figure 0-4 and Figure 0-5 show the organization structure of the project for each of the parties. The project management firm was below the client and was managing the project by having the consultant and QS firm as their extensions in technical and cost aspects. They were then formally separated from the contractors by the project management firm and formal communications was through the project management firm. The reason was that in this manner no "hidden claims" would surface through direct correspondence between the consultant and contractors. For example, the response of the consultant on shop drawings or RFIs would be checked by the relevant SPM to make sure that there are no time or cost impacts. If there are, the SPM discusses it with the consultant and a decision is made before it reaches the contractor.

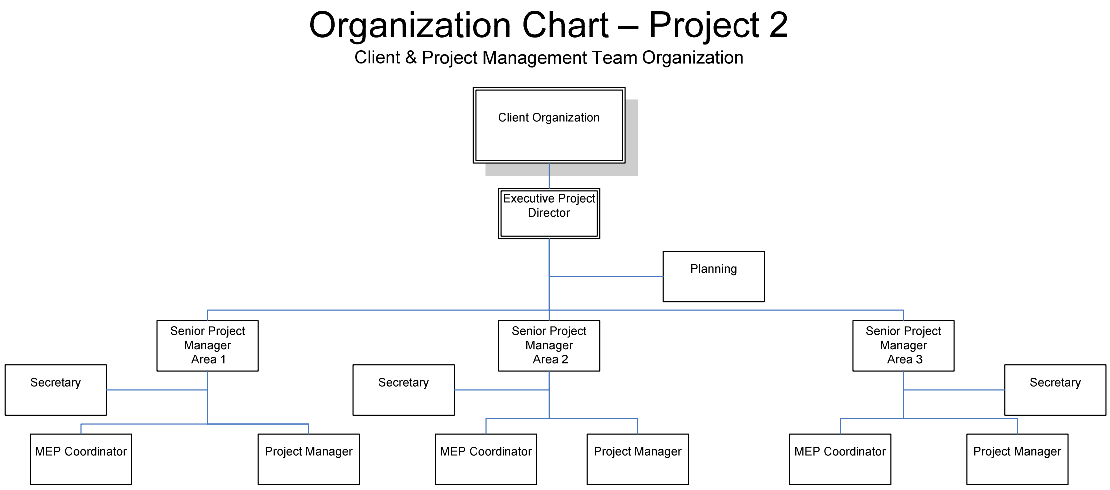


Figure 0-3 Organization chart for client and project management team in Project 2

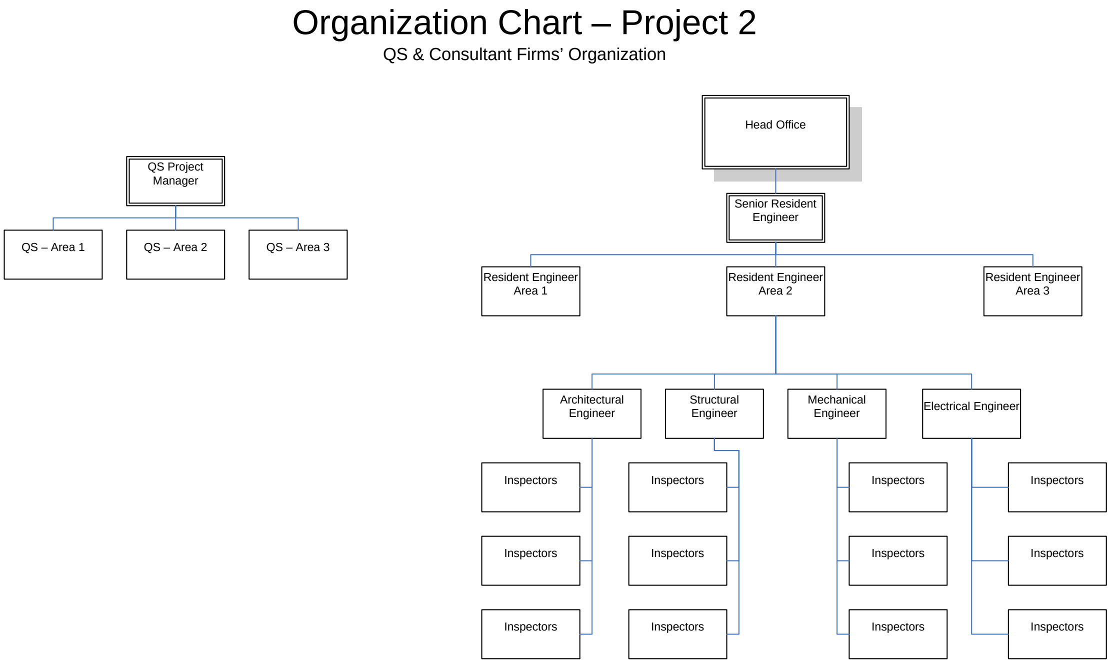


Figure 0-4 Organization chart for QS and consultant firms in Project 2

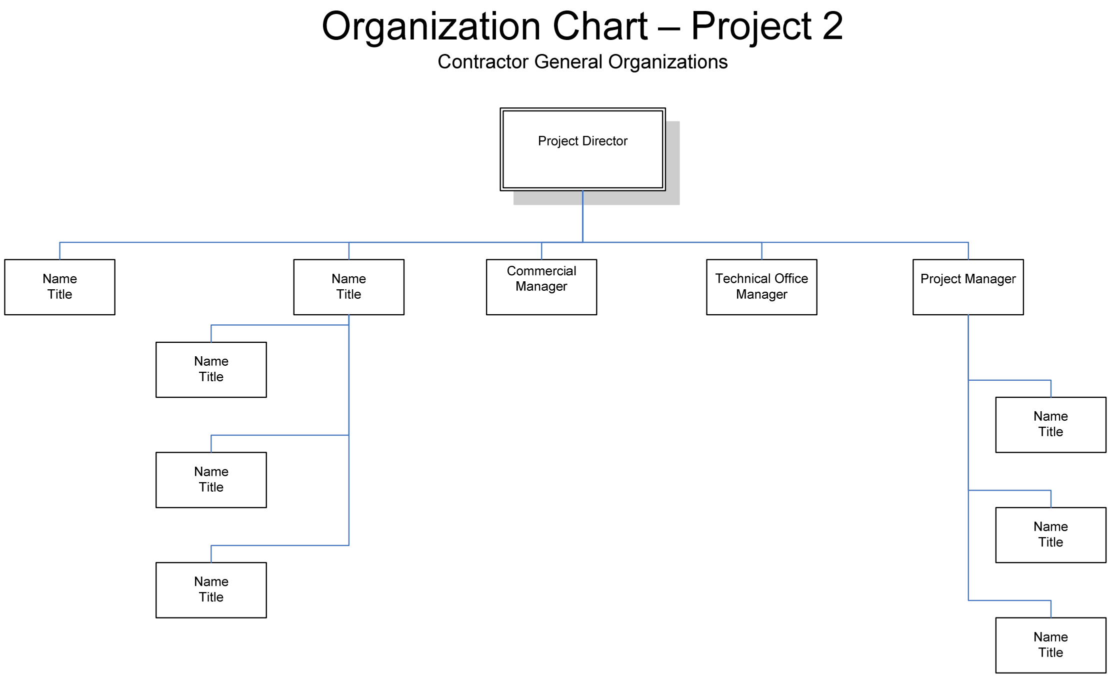


Figure 0-5 Organization chart for contractors (general as each contractor differed slightly)

A-2-7 Boundaries

A-2-7-1 Project size/level of complexity/number of people involved/duration

Project 1

Project 1 was a very complex project of a value of approximately 1.5 Billion US Dollars. There were many specialization required to complete the project. These included very specialized works, which are not normally seen in other projects. The number of people involved was very large, including the staff in the construction management team. The duration of the project as envisioned from the method of works was very tight. However, as stated earlier, this added complexity was relieved by changing the construction methods.

Project 2

Project 2 was a big project of approximately 2 Billion US Dollars. However, the observation of the researcher is that it was not a very complex project in the sense that the number of specializations was similar to any normal building. Its complexity seemed to be in the logistics. However, the researcher was not allowed to include the amusement park, where it seems the complexity would include various specializations.

A-2-8 Resources

The resources component in the FSM model is requirements for the transformation of the project. The CSFs in this component of the model are adequate budget, sufficient/well allocated resources, training provision, proven familiar technology and good performance by suppliers/contractors/consultants. These CSFs are discussed as relates to the case study projects.

A-2-8-1 Adequate budget

Project 1

In Project 1, there was a cost control system that seemed to work well. The staffs running the cost control was the QSs who were from a different company on loan to the contractor. The client Vice President for finance was on site to oversee and approve all expenditure. The budget for the project seemed to be sufficient for the procurement route taken.

Project 2

The budget for Project 2 was sufficient but could not be described as generous. The management had to be careful of costs and to control expenses well. This was done. Project 2 also had a cost control system run by an independent QS firm contracted to work with the project management team. The project management team was controlling the costs and the budget. In fact, it was viewed that the good SPM was the one that was able to complete the project within budget by knowing where to cut costs from when there was a change that increased the costs.

A-2-8-2 Sufficient/well allocated resources

Project 1

Project 1 seemed to allocate its resources properly. From the start of the project, the procurement route was changed in order to remain within the budget allocated. However, human resources were scarce and particularly skilled human resources in Dubai in general. The main contractors proposed big changes in construction method in the project to counter the human resource requirements and to save time, which was viewed favourably by the client. The changes reduced the logistics and the risk of insufficient labour resources.

Project 2

As stated previously, the budget was sufficient and seemed to be allocated properly in Project 2. The problem was not in the allocation of the resources but the resources themselves; particularly human resources which were scarce and particularly skilled human resources in Dubai in general. The contractors in Project 2 were aware of this problem, and therefore, proposed to change structural components to precast to reduce the logistics effort and to reduce the risk due to unavailable skilled and unskilled labour. Project 2 had main contractors for each area and the risk was entirely on them.

A-2-8-3 Training provision

Project 1

It was stated that the staff were trained to use the web-based IMS in Project 1. No other training was evident. In order to counter the lack of skilled labour, teams of one highly skilled labour with some semi-skilled labour were mixed in order for the skilled labour to train the others. The idea was the skilled labour would train the semi-skilled labour and hopefully get them to a higher skill level quickly. This may be due to the lack of time to train and qualify the labour.

Project 2

There was no visible training for staff in Project 2 on site. However, it was stated that the project management team provides its staff with training courses to enhance their managing abilities. Additionally, it was stated that the staff was trained to use ACONEX, an electronic IMS, which was then abandoned on account of coming late in the project. Training was largely performed on the job by and between staff and labour between them. It seems time constraints is the major cause for this.

A-2-8-4 Proven/familiar technology

Project 1

Project 1 had an electronic database for the project. However, there were many complaints that the system was slow, didn’t provide anything but a historical record. The problem was that despite some training no one used it in the way it was envisaged. This problem may have been due to different systems used by contractors, which was not compatible to the system used in the project. Additionally, the consultant had a different system that was used by the consultant team and their sub-consultants for design. This meant that any transfer had to be sent by email and then it was downloaded to the project system. Despite the availability of both systems, the electronic formats were not officially recognized documents and hard copies were the only officially recognized correspondence. Within the system everyone with access rights was able to tap into it and download what was needed. However, many of the problems were due to staff from all parties not opening their emails on the system or searching for the latest information.

Project 2

The technology used was nothing extraordinary. Project 2 did not have an electronic database for the project. There was an idea to use ACONEX, an electronic database and some of the staff was trained on it. However, it was abandoned on account that the project was ongoing and the wisdom of using the system at that point was disputed. Therefore, all documentation for the project was made on paper and was transferred in that manner. However, some of the main contractors had an electronic database that was used solely by the contractors themselves. Hard copies were the official and only recognized information transfer in the project. There was a network for the project management team. Email was provided and there was internet access for all.

A-2-8-5 Good performance by suppliers /contractors/ consultants

Project 1

The respondents in Project 1 had complained of the consultant performance. This complaint was voiced by some respondents, largely from the other parties. However, this complaint was many times in tandem with the pointing out of the many changes that occurred during the construction phase of the project. The other complaints made were of the smaller contractors who did not have qualified supervisory staff and were content to provide an English speaking supervisor who may not be qualified.

Project 2

Project 2 responses provided that all parties involved were good performers. Each party largely thought well of the others and described them positively. The only bad performer that was stated was the initial QS firm on the project that was replaced with another whom the project management firm was content with.

A-2-9 Continuity

The continuity component of the FSM model involves ensuring that the project is “steered” properly. The only CSF in this component is risks addressed/assessed/ managed. This is discussed as relates to the case study projects.

A-2-9-1 Risks addressed/assessed/managed

Project 1

The main risk in Project 1 described in the background of the project was the change of procurement route just before the start of construction. As stated previously, it was decided that the procurement route would be a construction management team led by the client and working on his behalf. The decision was based on budgetary constraints where the main contract route was estimated over budget of the contract. Time limitations seem to point to the fact that this risk was not assessed correctly. A case in point is that the consultant contract was not modified to reflect this change in procurement route. Another risk not assessed is that of human resource scarcity. The main contractors, particularly the concrete contractor, suggested changes in construction methods to alleviate that problem. Despite the major changes suggested, it seems the contractors had assessed the risks correctly. Additionally, any major changes proposed were to include the risks in the estimate of the change, which went to the client for approval.

Project 2

The risks in the execution of Project 2 were borne by the main contractors for each area. The biggest risk that faced the contractors was the availability of skilled human resources. This risk was assessed by the contractors when they were on board for each area. They proposed to change the construction methods to reduce that risk, despite the major redesign effort required and the lengthy approval process of the Authorities. Any delays to the project would be the contractor’s responsibility since the changes were suggested by them. However, it seems that the contractors were well aware of the risks involved and accounted for it.

A-2-10Other Critical Success Factors

A-2-10-1 User/client involvement

Project 1

The client in Project 1 was very involved in the every day management of the project. This was done at the highest level where the President of the client was on site, along with several Vice-Presidents and the Operations arm of the client. They were all involved in the project. At times there were disadvantages because there would be changes due to oversight during the design phase or an after thought during construction. However, it was largely stated as an advantage because decisions were made quickly. Following are some statements:

Client is very good. I've enjoyed working with them; hopefully I work with them again, very proactive. ***WPM-Project 1***

The relationships have been excellent, there is no doubt about that. We have a client who is interested in getting the project built, which is basically 50 % of the battle at the start. When you have that attitude from the client's side then there is no doubt it makes everybody's life a lot easier. ***Project Leader-Project 1***

Project 2

In Project 2, the client was involved only with the Project Director. They were not as hands on as the client of Project 1. However, the project management firm was present on site as client representative and were very involved in the project and made decisions quickly. However, the users were not involved since it was a development for sale after completion. Following are some statements by respondents:

…, it is the first project for me where the Client representatives are all the time with us on the site, taking care of the problems, interested with the problems, trying to sort out whatever it is within their expertise and scope, to move forward the project. ***MEP Consultant Engineer-Project 2***

We do have like an off course we do have an open door policy. Whenever there is a problem, whenever there is something or there is an issue, they can drop in, sit down, call for meeting, get every body together sort out the problem and off you go. ***Project Director-Project Management Firm-Project 2***

A-2-10-2 Different viewpoints (appreciating)

Project 1

In Project 1, the viewpoints of the operator were considered at design stage. Despite that, there were changes made by the operator because they could not envisage the reality from the design. The portions of the project to be rented out were done late in the project. This resulted in changes to suit the operators of those portions. The viewpoints of the end users were not considered since this would not be possible due to the fact that it was a hotel and amusement centre. However, the client owner had a tack record of successful developments and was viewed by the respondents as able to sense what customers wanted and provided it. Additionally, the viewpoints of the contractors were considered and often accepted.

Project 2

In Project 2, the viewpoints of the end users were not taken into account since it was mainly a real estate development for sale. The end users came after and not before the designs. The viewpoints of the contractors were considered and many times accepted. This is seen in the changes proposed by the contractor and accepted by the client.

A-2-10-3 Project sponsor/champion

Project 1

The owner of the client was stated to be very active in the project. In fact, he was stated as coming to site at least once a month to see the project and provide comments. Additionally, he had placed the President and several Vice Presidents of the company on site. This was sufficient to show the commitment and sponsorship of the owner to the project.

Project 2

The client head of the board was observed several times on site meeting with the Project Director of the project management firm. The researcher had met him prior to the start of the research to summarize the purpose of the research and to obtain his approval. The support of the entire Board of Directors of the client was stated by the management of the project management team that were interviewed. The entire board and the head of the board were project champions for Project 2.

A-2-10-4 Effective change management

Project 1

The “formal” change management system in Project 1 was lengthy considering the many changes and the number of signatures required from all parties, particularly the client that it had go through. Many times this “formal” change process was bypassed by the informal system to expedite the process by getting “informal” approvals to be followed by the official process. One respondent even stated that the change process should be reviewed fro future projects.

Project 2

The change management system in Project 2 was viewed by respondents to be lengthy considering the time it took, particularly if it had to be approved by the client who was not on site and at times took more time for review than wished for. There were some criticisms of the “formal” change process. However, like many of the other official processes, it was many times overridden by the informal system and followed by the official process in order to expedite the process.

A-2-11Summary of CSFs in case study projects

Project 1

The application of the FSM model to Project 1 is shown in Figure 0-6 and Table 0-1.

Project 2

The application of the FSM model to Project 2 is shown in Table 0-1 and Figure 0-7.

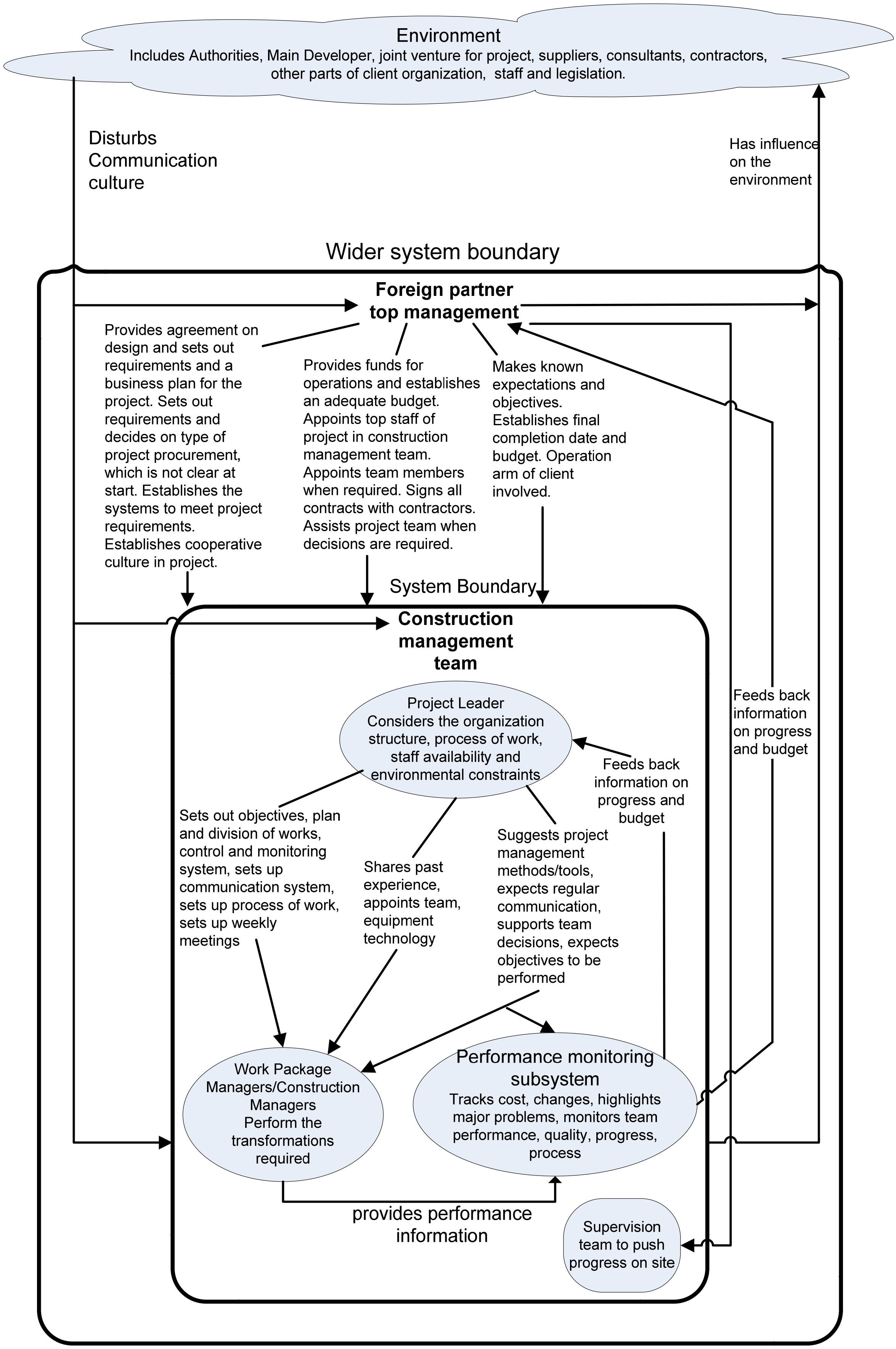


Figure 0-6 FSM for Project 1

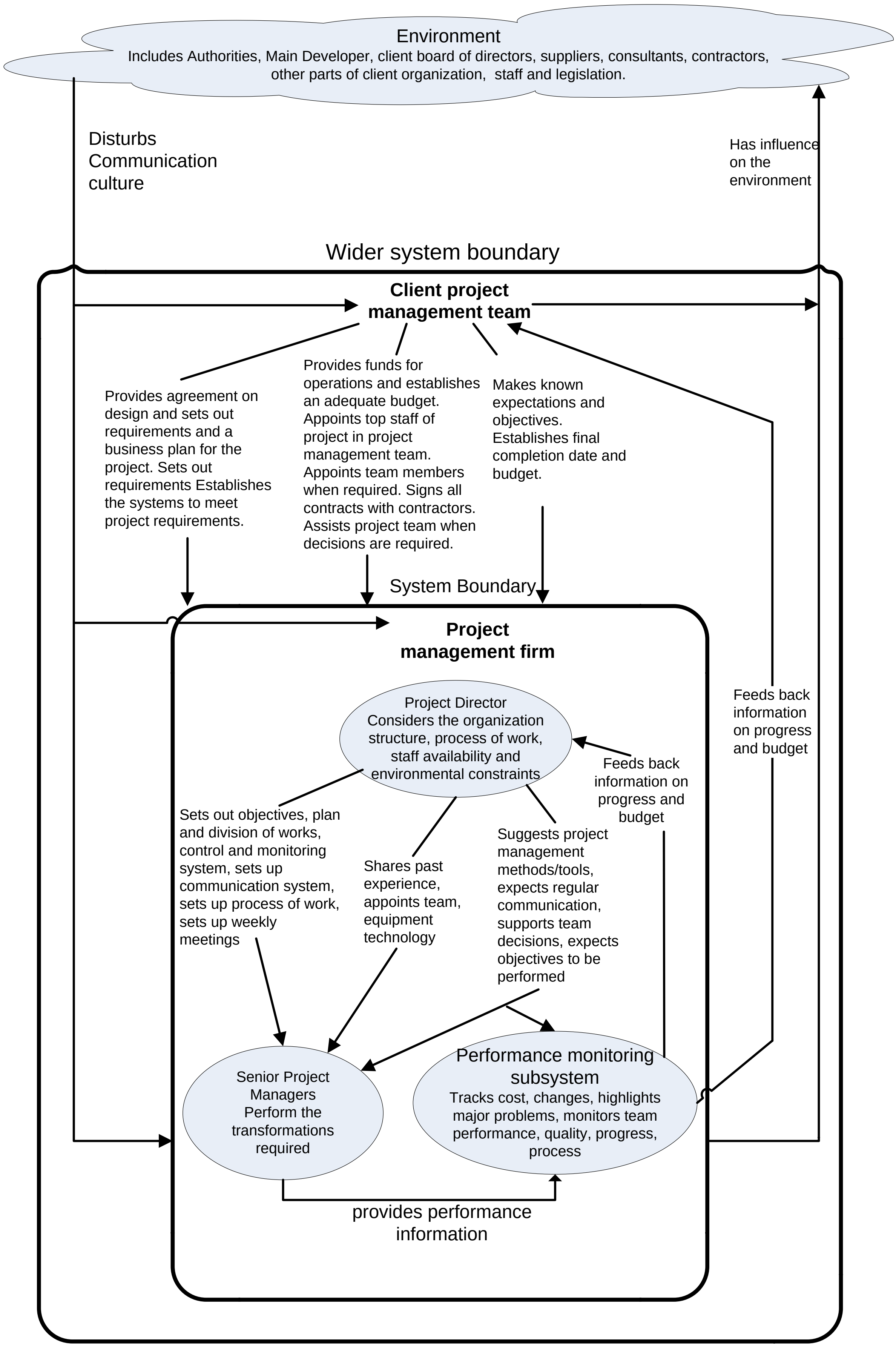


Figure 0-7 FSM for Project 2

Table 0-1 An evaluation of Projects 1 and 2 in relation to the CSFs identified in Table 4-8

Component of FSM / project attributes	Critical Factor	Project 1		Project 2	
		Taken account of	Comments	Taken account of	Comments
Goals and objectives	Clear realistic objectives	yes	The project requirements were clear to all. This is shown from the response to question no. 3 of the interviews. However, the majority found that the task is difficult but not impossible.	yes	The project requirements were clear as shown from the responses to question no. 3 of the interviews. Additionally, they found the requirements reasonable. Unlike Project 1, the complexity was less.
	Strong business case/ sound basis for project	yes	The project seemed to provide a haven for families from the entire region. It offered a vast range of new things in entertainment, which are not available.	yes	The development is largely for resale as properties at this time were selling quickly and for large sums. It catered to the requirements of the booming property market in Dubai.
Performance monitoring	Effective monitoring/ control	yes	There were many meetings for the control of the project. Additionally, the budget was closely monitored.	yes	The cost and time were closely monitored by the project management team with the SPMs leading the control for each section of the project.
	Planned close down/ review/ acceptance of possible failure	no	There were no plans made for closedown and there were complaints that no one had thought about this. It was stated that they were too busy completing the job and forgetting about this part.	no	There were no plans for close down at the time of interviews.
Decision-maker(s)	Support from senior management	Yes	The foreign partner of the joint venture was physically present at site, including the President and several vice presidents.	yes	The board of the client was in support of the project but were not hands on as much as in Project 1. The CEO of the project management firm was the same for the client.
		yes	The top management of the main contractors were supportive of their project managers in the project.	yes	The top management of the main contractors were supportive of their project managers in the project.
		no	The top management of the main consultant was not as supportive of their project director as the client would have liked. The project manager of the main consultant was left largely on his own, except for some technical assistance from the Head Office.	yes	The top management of the main consultant was supportive of their Resident Engineer. Any staff could receive any assistance at any time. Additionally, the top management was closely following up activities on site.
	Competent project manager	yes	The project managers in the project were very competent and had worked in projects of a similar nature. This is the case for all the project leaders in the majority of the parties in the project. The only incompetence was stated as those of the smaller contractors.	yes	The project leaders in the project were competent and had worked in similar projects. This is the case for all the parties in the project.
	Strong/detailed plan kept up to date	yes	A plan was formulated at the start of the project and was continuously monitored and updated through weekly meetings between the planners and the contractors and the WPMs. This included major changes made to the project. Any discrepancies were followed up.	yes	A plan was formulated at the start of the project and was modified to incorporate the changes made to the project. The planner had weekly meetings with each of the main contractors to maintain the plan and follow up any delays.
	Realistic schedule	no	The original schedule was not realistic had the project been performed in its original state, which was cast-in-situ and block work. It was the changes that were suggested by the contractors and accepted by the client that had made the duration more realistic.	yes	The original schedule was realistic in regards to the cast-in-situ design of the project.
	Good leadership	yes	The project managers for the construction management team as well as the parties had good leadership skills. This is except for some of the smaller contractors who were led by the construction management team.	yes	The project leaders of all the parties had good leadership skills.
	Correct choice/ past experience of project management methodology/ tools	no	The construction management route chosen was not tried and that created a lot of uncertainty for all that came on board. However, it did prove successful.	yes	The project management route seemed a good choice for the project. It was also tried in Dubai. Furthermore, the client and project management firms belonged to the same group.

Component of FSM / project attributes	Critical Factor	Project 1		Project 2	
		Taken account of	Comments	Taken account of	Comments
Transformations	Skilled/ suitably qualified/ sufficient staff/ team	yes	The management teams in the project were stated as qualified and sufficient in numbers. However, for the smaller contractors there was a problem regarding the quality of the staff. Additionally, skilled labour was a big problem in Dubai.	yes	The management teams in the project were stated as qualified and sufficient in numbers. However, there was a problem regarding the quality of junior staff and skilled labour was a big problem in Dubai.
Communication	Good communication/feed back	yes	The client was on site and hands on in the project. Although, there was some criticism regarding over involvement of the client, the majority found that this assisted the project tremendously.	yes	The Project Director and CEO of the client were continuously meeting as observed by the researcher. Additionally, the Project Director and his team were continuously meeting and maintained an open door policy for all.
Environment	Political stability	yes	Political stability in Dubaican be seen by the heavy investment that was attracted to the city.	yes	Political stability in Dubai can be seen by the heavy investment that was attracted to the city.
	Environmental influences	yes	Any influences on the project were dealt with swiftly. There was a team for dealing with environmental influences that arose.	yes	Any influences were taken care of quickly.
	Past experience (learning from)	yes	It was very evident that the management team had used their past experience to deliver the project, despite the new management method used in the project.	yes	It was evident that the project team used their previous experience in completing the project.
	Organizational adaptation/ culture/ structure	no	The project contract was initially to be a traditional main contract but was changed to a construction management team for the client to reduce the cost. The organization was a matrix structure that fit the requirements of the project but was rather loose. A cooperative culture was built with the contractors since the main contractor CEO and the President of client knew each other previously. This was not the case with the consultant.	yes	The project management structure fit well with the project complexity and division of the project. Although portions were awarded to main contractors, it was negotiated and this established a culture of cooperation in the project. Furthermore, the client and project management firms belonged to the same group and knew each other.
Boundaries	Project size (large)/ level of complexity (high)/ number of people involved (too many)/ duration (over 3 years)	yes	The project size was large, the level of complexity high, the number of people large but duration of construction of the project was less than 2 years.	yes	The project was divided into smaller portions each headed by an SPM. This made each section of the project smaller with fewer people involved. Additionally, complexity was not high for the project. The duration was less than 3 years and was sufficient for the project.

Component of FSM / project attributes	Critical Factor	Project 1		Project 2	
		Taken account of	Comments	Taken account of	Comments
Resources	Adequate budget	yes	The budget for the project seemed to be sufficient and no complaints were voiced regarding insufficient funds.	yes	The budget for the project seemed to be sufficient and no complaints were voiced regarding insufficient funds.
	Sufficient/ well allocated resources	yes	The resources were sufficient but not abundant as a strict budget was maintained. Resources seemed to be well allocated.	yes	The resources were sufficient but not abundant as a strict budget was maintained. Resources seemed to be well allocated.
	Training provision	no	No training provision was made for any of the staff. What was required were trained professionals.	no	No training provision was made for the project. It was expected that the staff would be qualified.
	Proven/ familiar technology	no	The project was managed in a system that was new in Dubai. Additionally, the construction management team was developed by the client mainly from the main contractors in the project, which was also something new.	yes	The project was managed by a project management firm, which was part of the client group of companies. The method has been tried and tested in Dubai and was not new.
	Good performance by suppliers/ contractors/ consultants	yes	The performance of the main contractors was described as excellent. However, there were problems with the smaller contractors whom they had to push.	yes	The main contractors were chosen carefully by the client. Their performance was described as very good.
Continuity	Risks addressed/ assessed/ managed	no	The risks were not assessed well in the design phase and early construction phase. It is evident from the change in procurement route in the project and also from the main changes that occurred during project execution that caused the realization of the schedule.	yes	The risks were assessed well for the project at the design stage, which the same project management firm was involved in. The procurement route was not changed, despite the main changes that occurred during the execution of the project.
Other	User/client involvement	yes	The client was hands on in the project. Additionally, the vice president of operations for the client was on site. Many of the changes were made by either them or the ultimate operators of certain portions of the project.	no	The client was involved in regards to progress and budget and the main design. However, the users were not involved as it was largely a development for sale to the public.
	Different viewpoints (appreciating)	no	Viewpoints of the operator were considered but end users were not considered since they were not on board at the time. However, the operator kept making changes because they could not envision the project on paper despite their agreement to the designs. Additionally, the project team was not established at the start to consider any of their viewpoints.	no	Viewpoints of end users were not considered since they were largely unknown. The users were largely people who would buy the properties after completion of the project.
	Project sponsor/ champion	yes	The client placed his top management on site to ensure that the project ran smoothly. The owner of the foreign firm of the joint venture was continuously on site visiting the project.	yes	The client board assigned one of its members to follow up the project and made a critical decision not to bid the contract but to negotiate it with one chosen contractor.
	Effective change management	no	The formal change management system was lengthy and was not suitable for the complexity of the project and the duration. It was stated by the majority that the change management system was sidetracked unofficially to get things done.	yes	The change management system was lengthy but it seems it was sufficient for the project, which was not very complex. Despite that it was stated that the change process was sidetracked at times of urgency.
	Counts of "yes"	19		25	
	Counts of "no"	10		4	

A-3 Processes in case study projects

The processes in both case study projects have been described from the perspective of the formal process and formal organization. However, the reality included two main processes and organizations. In this research the organization and process will be considered the same based on Balle's (1996) description. There are two main processes in the case study projects, namely the formal and informal. The processes shall be presented for each case study. The differences and similarities in each of the processes between the case study projects shall be highlighted.

The submittal process and the RFI process are interdependent as shall be seen from the processes. The RFI process is the Request for Information (RFI) process. The RFI process shall be described in the following Section A-3-2.

A-3-1 Submittals process

Introduction

The initial work to be performed following start of the project is the submittal process. The submittal process includes the preparation of the shop drawings, material submittals etc., which is prepared by the contractors and their subcontractors. The submittals process involves the preparatory work for the purpose of translating the construction documents received from the client into working documents. This includes preparation of the shop drawings, material submittals, method statements, quality control documents, etc. These generally followed the same process.

Project 1

The submittals process for Project 1 is presented in Figure 0-1. The process starts with documents received from the client officially through document control for each party. The technical staff of the contractor review the documents submitted. The technical staff may forward copies of the documents to relevant subcontractors for preparation of the working documents through document control of each party. The subcontractor staff reviews the documents and prepares working documents. These are then submitted to the contractor through the document control of each party. The contractor staff reviews the working documents received from the subcontractor. If there are any discrepancies notes are made and the process starts again. Once the submittals are ready they are sent from contractor document control to the construction management team (CMT) document control, where it is forwarded to the Work Package Manager (WPM) and then to consultant for review and approval.

Project 2

The submittal process for Project 2 is shown in Figure 0-2. The process starts with documents received from the client officially through document control for each party. The PMT document control sends the construction documents to the contractor document control. These documents are provided to the technical staff of the contractor to review the documents. The technical staff may forward copies of the documents to relevant subcontractors for preparation of the working documents through document control of each party. The subcontractor staffs reviews the documents and prepare working documents. These are then submitted to the contractor through the document control of each party. The contractor staff reviews the working documents received from the subcontractor. If there are any discrepancies notes are made and the process with the subcontractor starts again. Once the submittals are ready and reviewed they are sent from contractor document control to the project management team (PMT) document control, where it is forwarded to the Senior Project Manager (SPM) for review and approval through his document control.

Figure 0-1 Submittals process for Project 1

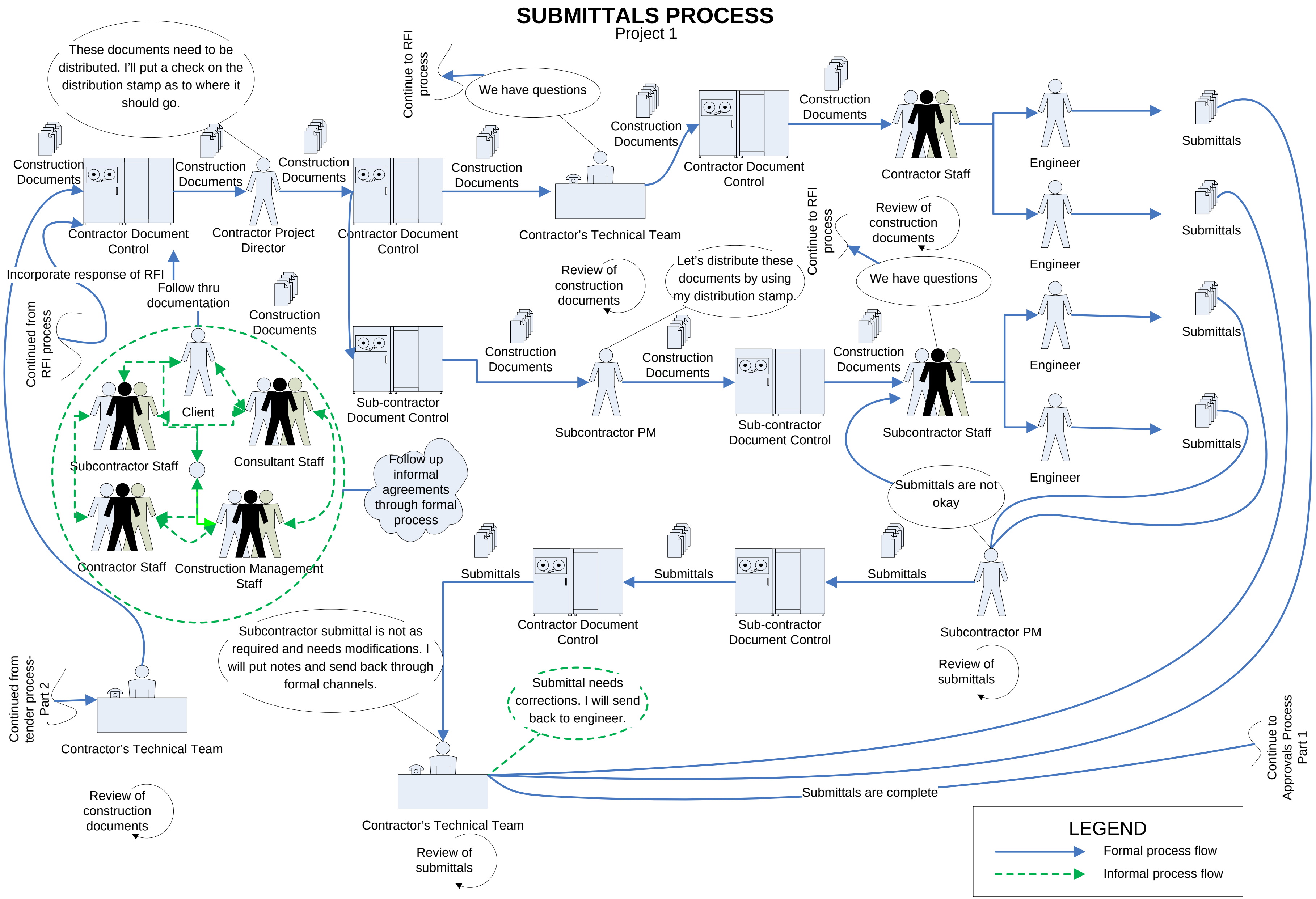
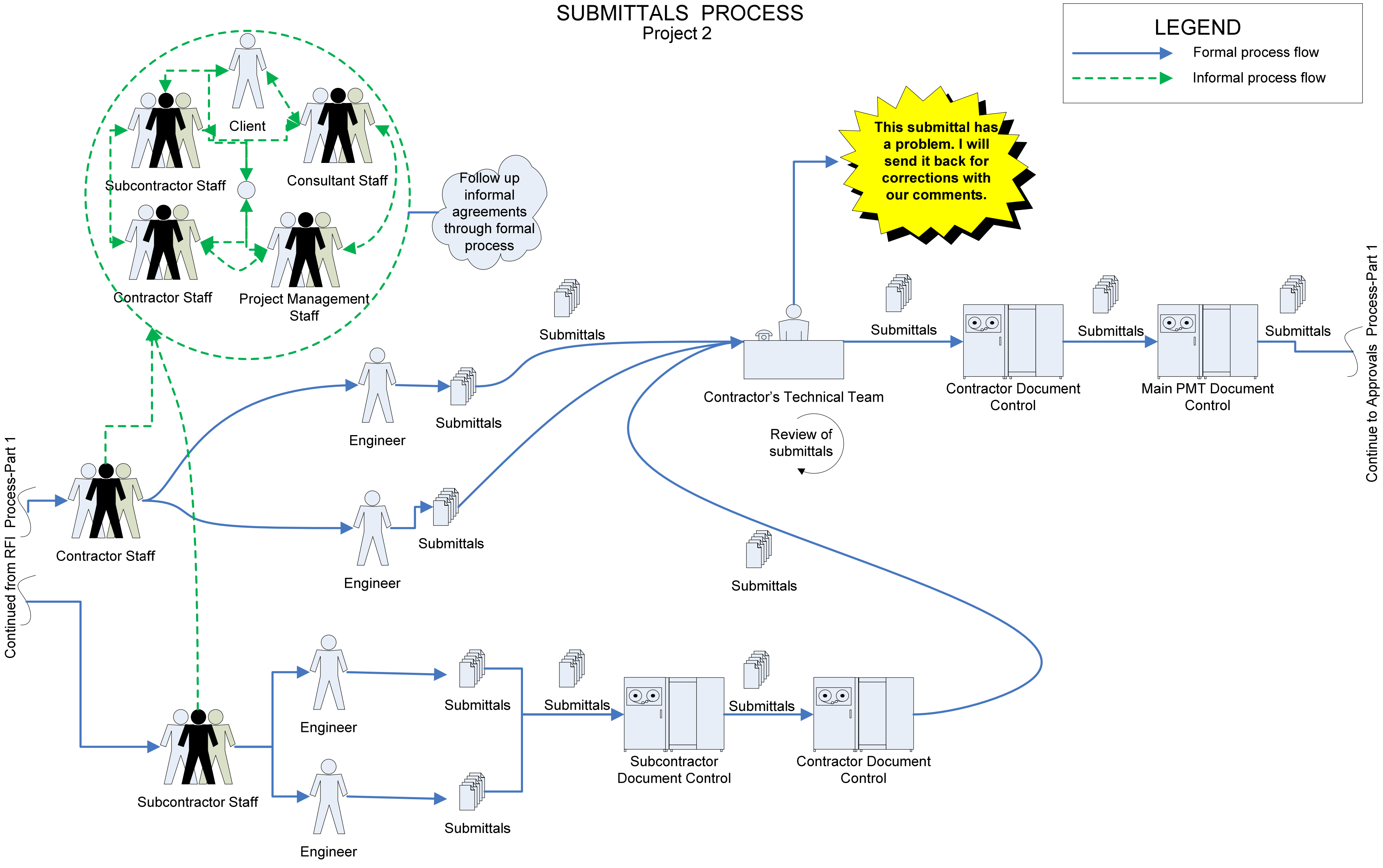


Figure 0-2 Submittal process in Project 2



A-3-2 RFI process

Introduction

During the submittals process, there may be queries or clarifications required by those preparing the working documents. This is called the Requests for Information (RFI) process. The submittal and RFI processes are interdependent as the clarifications may be required for the submittals. These two processes overlap and precede the approval process, which involve mainly the construction or project management teams and the relevant consultants and sub-consultants. These processes constitute the initial preparation to start of the task required to be performed. The rate at which the preparation is performed affects the progress of the task as well as other tasks relying on the progress of it.

Project 1

The RFI process in Project 1 is presented in Figure 0-3. The RFIs may come from several sources. It may even be initiated by the WPM. However, the majority of RFIs came from the contractors as advised by respondents. The RFIs are produced after the contractor has reviewed the construction documents. The RFI is sent through contractor’s document control to the CMT document control. The RFI is then sent to the WPM who reviews it. If there is a time or cost impact it is sent to the WQS for checking who provides feedback to the WPM for action. He may place comments and send it across to the consultant through the CMT document control to consultant document control. The consultant Project Director receives the RFIs, distributes them to those who should respond. Sometimes the response concerns several disciplines and in this case the RFI is sent to several people for response. The RFI may also concern a subconsultant, where the RFI is distributed through the main consultant document control to subconsultant document control. The subconsultant reviews the RFIs and answers it and sends it back through their document control to consultant document control. The responses are reviewed by main consultant and if response is agreeable it is sent through consultant document control to CMT document control. The RFI is sent to WPM for review. The WPM may comment on the RFI and his comment overrides that of the consultant. If there is any possibility of time or cost impact, the response on the RFI is sent to the WQS for input. The RFI is then sent to the contractor through CMT document control and contractor document control. If the

RFI responses are not approved at any point, the RFI goes through the whole process again from where it was not approved.

It is interesting to note that despite the formal RFI process, it was not contractually binding. If there are any changes that have a time or cost impact it is not recognized by the client as it is not a contractual document. The contractor would have to get approval from the client before application of the response on the RFI. There were several instances where problems occurred on this account. Despite the RFI process not being contractually recognized, it was used extensively by contractors requiring clarifications. It seems that there was some value in having a response recorded.

The informal process was quite different. What the contractor staff would do is go to the WPM or consultant, or anyone else for that matter, to get clarifications on any issue of concern. An agreement would be reached and the “formal” RFI is initiated by the contractor through the formal process. The informal process was used to enable completion of submittals to move to the approval process. Additionally, if there was an urgent RFI required the contractor would either go or ‘sit’ on the consultant’s head until he gets a response or go to the client to move the RFI from the bottom of the pile of RFIs to the top. The importance of the informal process was in getting an answer, even informal, which would enable progress of work whilst the formal process is ongoing.

Project 2

The RFI process in Project 2 is presented in Figure 0-4. The RFIs may come from several sources. The RFI may even come from the SPM or one of his assistants (i.e. the Project Manager or the MEP Coordinator). However, the majority of RFIs came from the contractors and their subcontractors through them. The RFIs are produced after the contractor and his subcontractors have reviewed the construction documents. The RFI is sent through contractor’s document control to the PMT document control. In the case it is initiated by a subcontractor, the RFI is sent from subcontractor document control to contractor’s document control.

The RFI is then sent to the SPM through his document control. The SPM distributes the submittals to the main consultant through their respective document controls. The

Senior Resident Engineer (SRE) of the main consultant then distributes the documents as required to the respective Resident Engineer or the subconsultant Resident Engineers through each of their document controls. Sometimes the response concerns several disciplines and in this case the RFI is sent to several people for response. The RFIs are reviewed by those it was sent to and the responses are sent through the document control of each person to the main consultant document control. The responses are reviewed by the Senior Resident Engineer (SRE), and if response is agreeable, it is sent through main consultant document control to PMT document control. The RFI is then sent to the respective SPM for review through PMT document control to his document control. The SPM reviews the RFI and may comment on it and his comments override that of the consultant. This was stated as ensuring that the comments provided by the consultant do not have any “hidden” changes that would surface later. The SPM may forward that to his Project Manager and MEP Coordinator for review and comments. If there is any possibility of time or cost impact, the response on the RFI is sent to the respective QS for input. This again involves moving the RFI through SPM, PMT and QS firm’s document controls. If there is no time or cost impacts, the RFI is sent back through QS document control to PMT document control and then to SPM’s document control. If there is time or cost impact, the SPM may ask for a clarification from the consultant and either agree or disagree with the impacts. If the impacts are agreeable, the prechange process is initiated. If not the SPM rejects the response made by the consultant and returns it to him for change of comment, again through the respective document controls. Once the RFI response is found to be agreeable to the respective SPM it is sent to the contractor from SPM to PMT to contractor document controls.

The informal process was quite different. What the contractor staff would do is go to the SPM, Project Manager, MEP Coordinator, or consultant, or anyone else for that matter, to get clarifications on any issue of concern. An agreement would be reached and the “formal” RFI is initiated by the contractor through the formal process. The informal process was used to enable completion of submittals quickly to move to the approval process. The importance of the informal process was in getting an answer, even informal, which would enable progress of work whilst the formal process is ongoing. The informal RFI process is much faster and reduces uncertainty by getting clarifications quickly.

Figure 0-3 RFI Process for Project 1

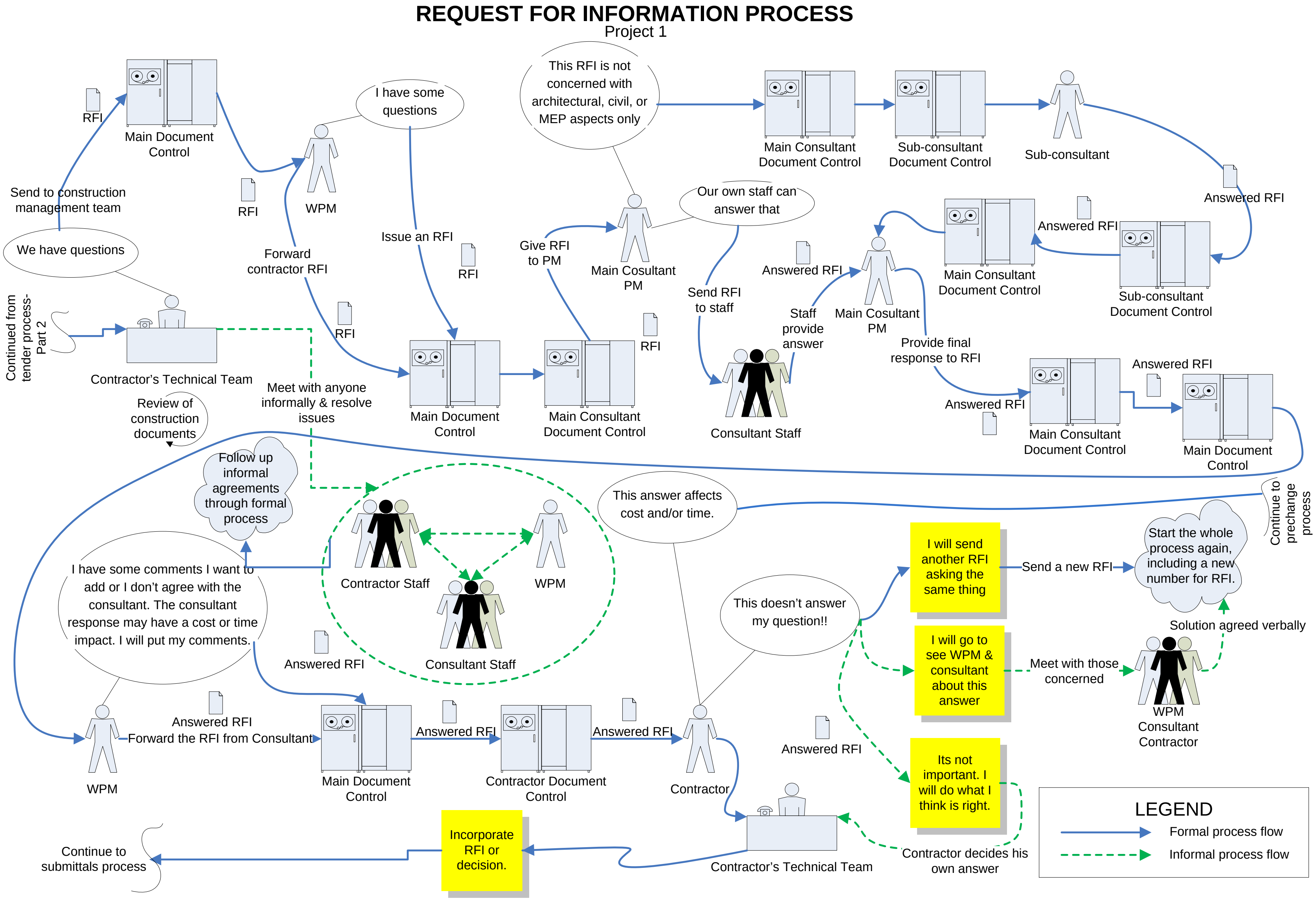
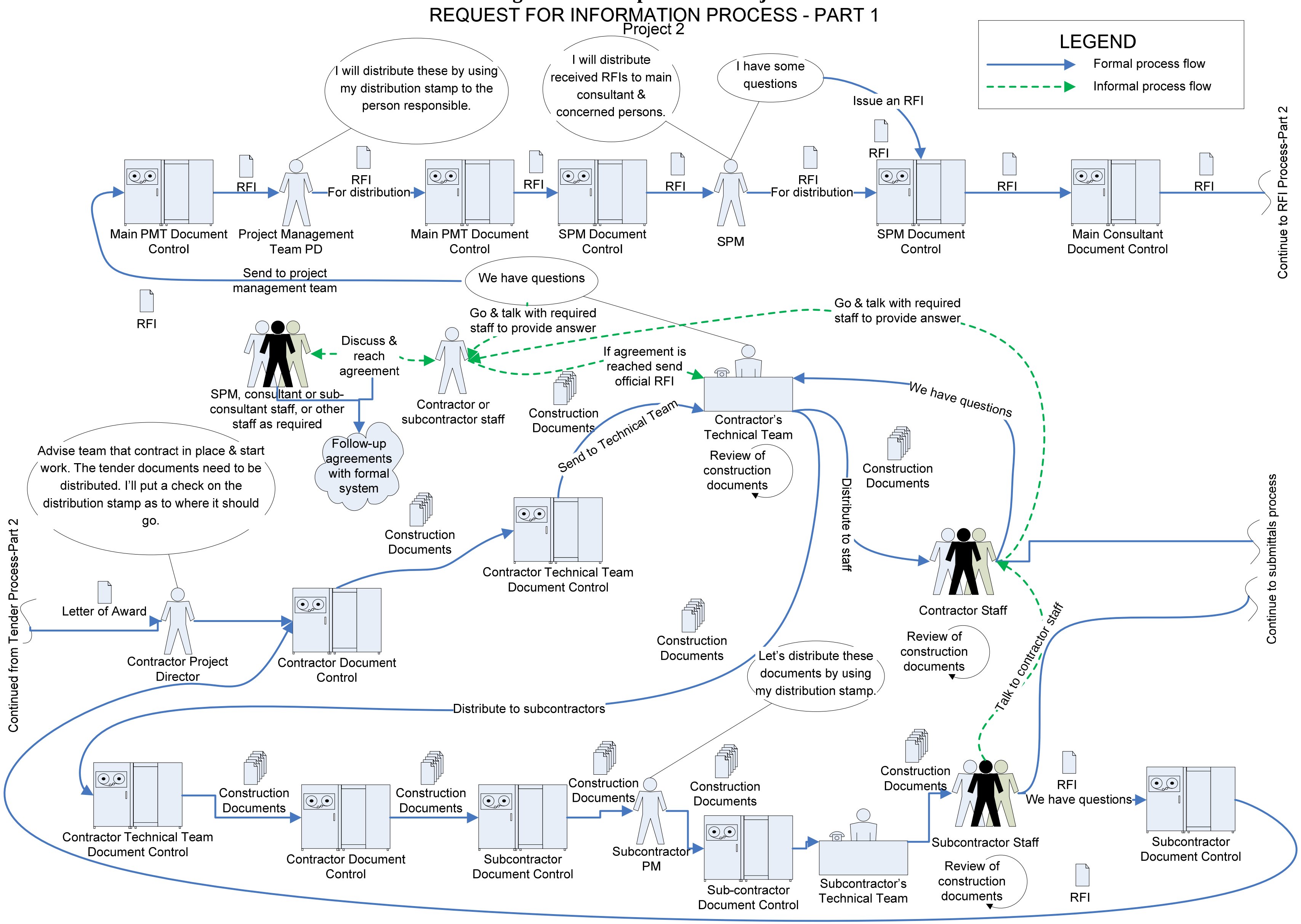
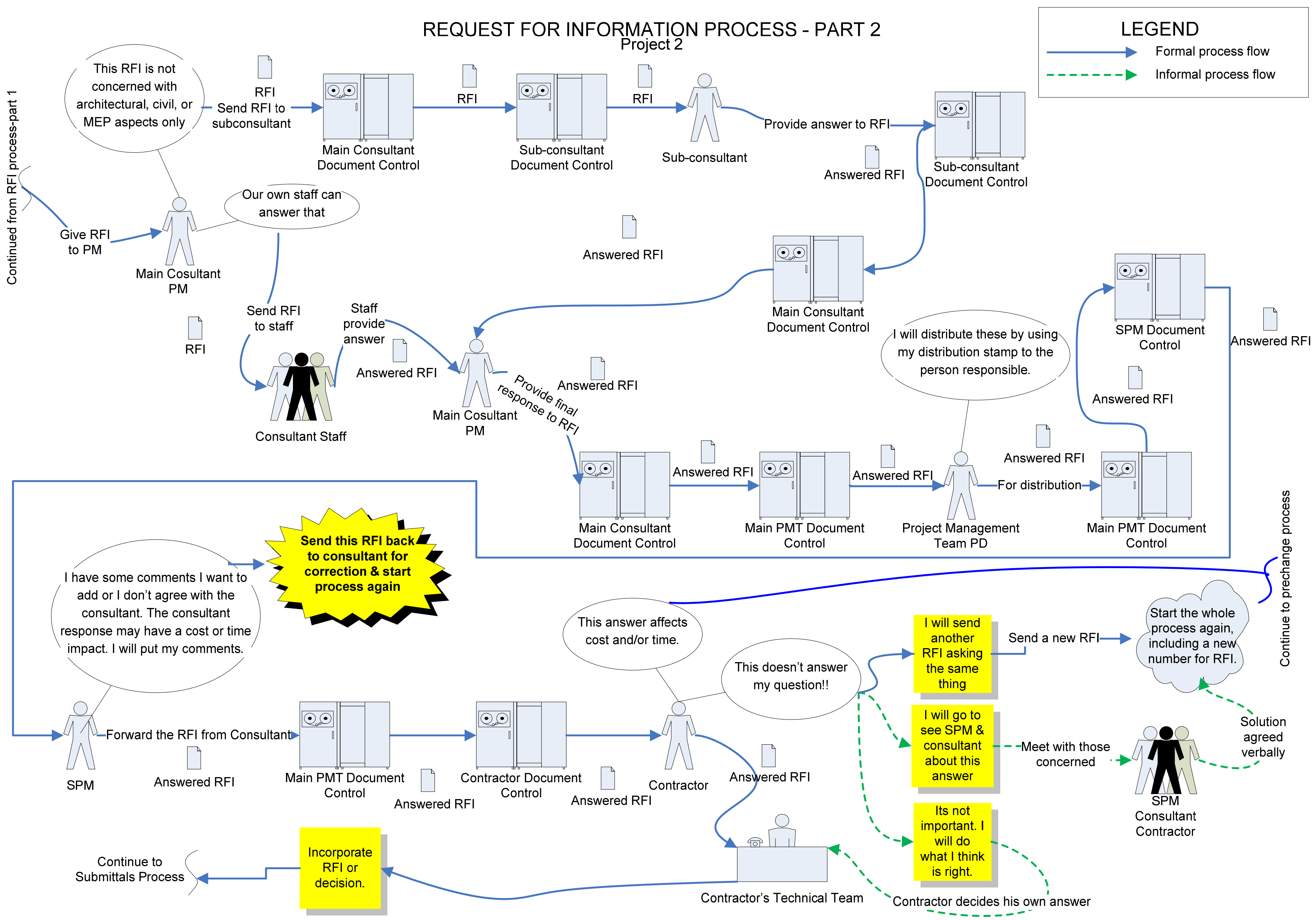


Figure 0-4 RFI process in Project 2




REQUEST FOR INFORMATION PROCESS - PART 2
Project 2
LEGEND
Formal process flow
Informal process flow
Continued from RFI process-part 1
Give RFI to PM
Main Cosultant PM
This RFI is not concerned with architectural, civil, or MEP aspects only
RFI
Send RFI to subconsultant
Main Consultant Document Control
RFI
Sub-consultant Document Control
RFI
Sub-consultant
Provide answer to RFI
Answered RFI
Sub-consultant Document Control
Our own staff can answer that
Answered RFI
Main Consultant Document Control
Send RFI to staff
RFI
Staff provide answer
Answered RFI
Consultant Staff
Main Cosultant PM
Provide final response to RFI
Answered RFI
I will distribute these by using my distribution stamp to the person responsible.
SPM Document Control
Answered RFI
Answered RFI
Answered RFI
Main Consultant Document Control
Answered RFI
Main PMT Document Control
Answered RFI
Project Management Team PD
For distribution
Main PMT Document Control
Send this RFI back to consultant for correction & start process again
I have some comments I want to add or I don't agree with the consultant. The consultant response may have a cost or time impact. I will put my comments.
This answer affects cost and/or time.
This doesn't answer my question!!
I will send another RFI asking the same thing
Send a new RFI
Start the whole process again, including a new number for RFI.
Continue to prechange process
I will go to see SPM & consultant about this answer
Meet with those concerned
Solution agreed verbally
SPM Consultant Contractor
Its not important. I will do what I think is right.
Contractor decides his own answer
SPM
Forward the RFI from Consultant
Answered RFI
Main PMT Document Control
Answered RFI
Contractor Document Control
Answered RFI
Contractor
Answered RFI
Contractor's Technical Team
Incorporate RFI or decision.
Continue to Submittals Process

A-3-3 Approvals process

Introduction

Once the submittal and RFI processes are completed and submittals have been prepared they are sent through the approvals process. The approvals process is to check that all the submittals are according to original design intent or the change made. This is largely to maintain control over what is actually being constructed.

Project 1

The approval process for Project 1 is presented in Figure 0-5. The submittal is sent from contractor document control to CMT document control and is sent to the WPM. The WPM reviews the documents and if he has comments he sends it back to the contractor through CMT document control and the process starts again. If the documents are concerned with time, cost or quantities it is sent to the relevant QS for review. The QS reviews and if he has comments he returns it to the WPM. The WPM may agree with the changes, and may go through the prechange process, and subsequently lead to a change. If the WPM does not approve any time or cost implications, the WPM returns the documents to the contractor through CMT document control. Again, the whole process starts again. If the documents are found to be complete according to construction documents, and do not have time or cost impacts visible, the WPM forwards them to the through the CMT and consultant document controls for review and approval.

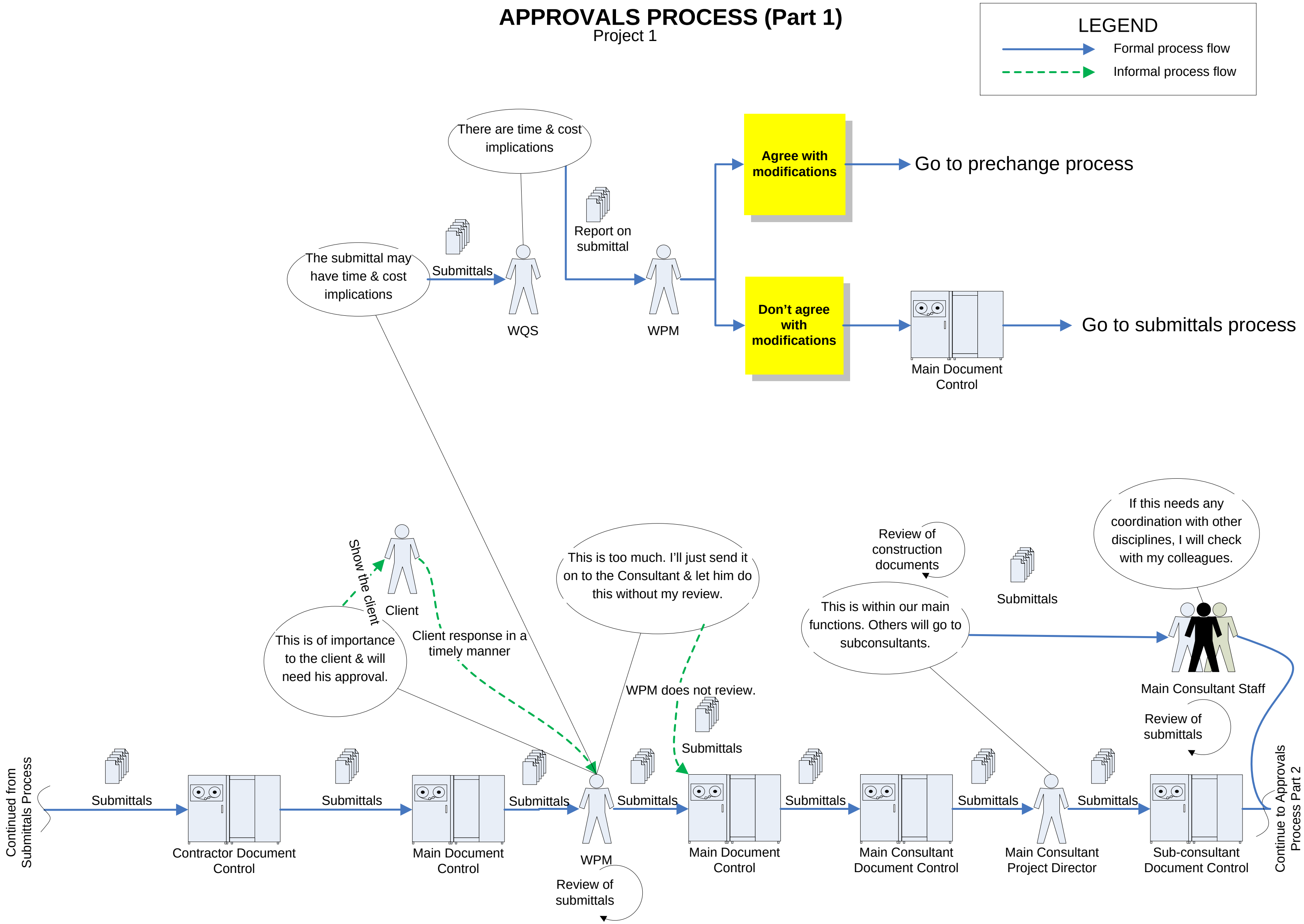
The consultant Project Director distributes the submittals to those concerned. Sometimes the review concerns several disciplines and in this case the document is sent to several people. The submittal may also concern a subconsultant, where the submittal is distributed through the main consultant document control to subconsultant document control. The subconsultant reviews the submittal and answers it and sends it back through their document control to consultant document control. The responses are reviewed by main consultant and if response is agreeable it is sent through consultant document control to CMT document control. The submittal is then sent to WPM for review. The WPM may comment on the review and his comment overrides that of the consultant. If there is any possibility of time or cost impact, the response on the submittal is sent to the WQS for input. The submittal is then sent to the contractor through CMT document control and contractor document control. If the submittal is not approved at any point, the submittal goes through the whole process again from where it was not approved.

Project 2

The approval process for Project 2 is presented in Figure 0-6. The SPM reviews the documents and if he has comments he sends it back to the contractor through his document control and PMT document control and the process starts again. If the documents are concerned with cost or quantities it is sent to the relevant QS for review. The QS reviews he returns it to the SPM with his comments. The SPM may agree with the changes, and may go through the prechange process, which may subsequently lead to a change. If the SPM does not approve any time or cost implications, the SPM returns the documents to the contractor through his document control to PMT document control. Again, the whole process starts again. If the documents are found to be complete according to construction documents, and do not have time or cost impacts visible, the SPM, through his and PMT's document control, forwards them to the consultant for review and approval.

The consultant document control receives the submittals from PMT document control and forwards that to the Senior Resident Engineer (SRE). He in turn provides the distribution required for the submittals. Sometimes the submittal review concerns several disciplines and in this case the document is sent to several people. The submittal may also concern a subconsultant, where the submittal is distributed through the main consultant document control to subconsultant document control. The subconsultant Resident Engineer (RE) reviews the submittal and may forward it to his staff who answers. The submittal, is reviewed by the subconsultant RE, and if all is okay, sends it back through their document control to consultant document control. The responses on the submittals are reviewed by the main consultant SRE and if response is agreeable it is sent through consultant document control to PMT document control and further through to SPM document control. The submittal is then sent to SPM for review. The SPM then forwards the submittals to his Project Manager or MEP Coordinator for review. They then provide the SPM with their comments or accept the submittal and the comments on them. Once the SPM receives his staff reviews he may have some comments and either he would go to talk with the consultant SRE or he will make comments which would override that of the consultant. If there is any possibility of time or cost impact, the response on the submittal is sent to the QS for input, again through all the relevant document controls. The submittal is then sent to the contractor through SPM, PMT and contractor document controls. If the submittal is not approved at any point, the submittal goes through the whole process again from where it was not approved.

Figure 0-5 Approvals process for Project 1



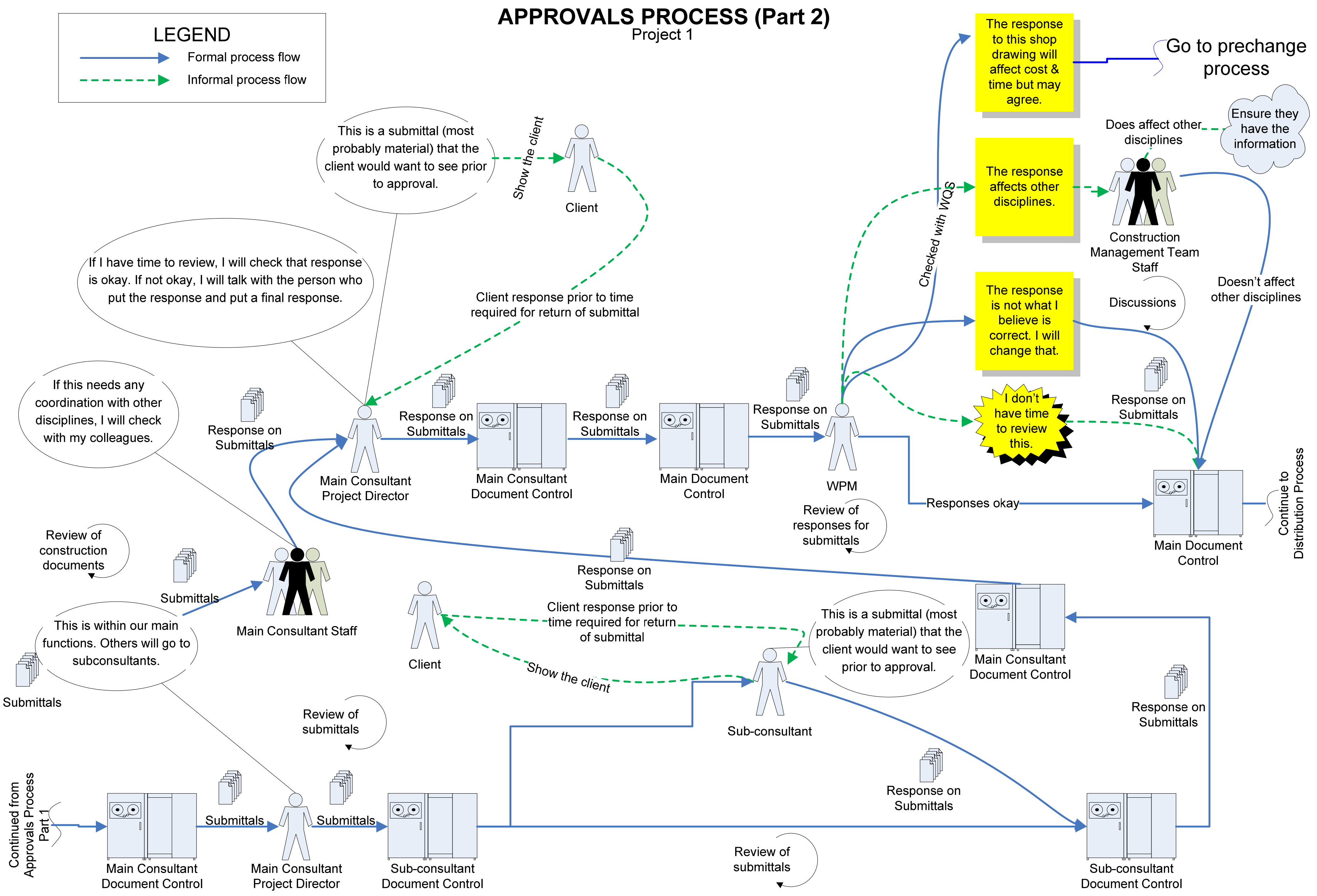
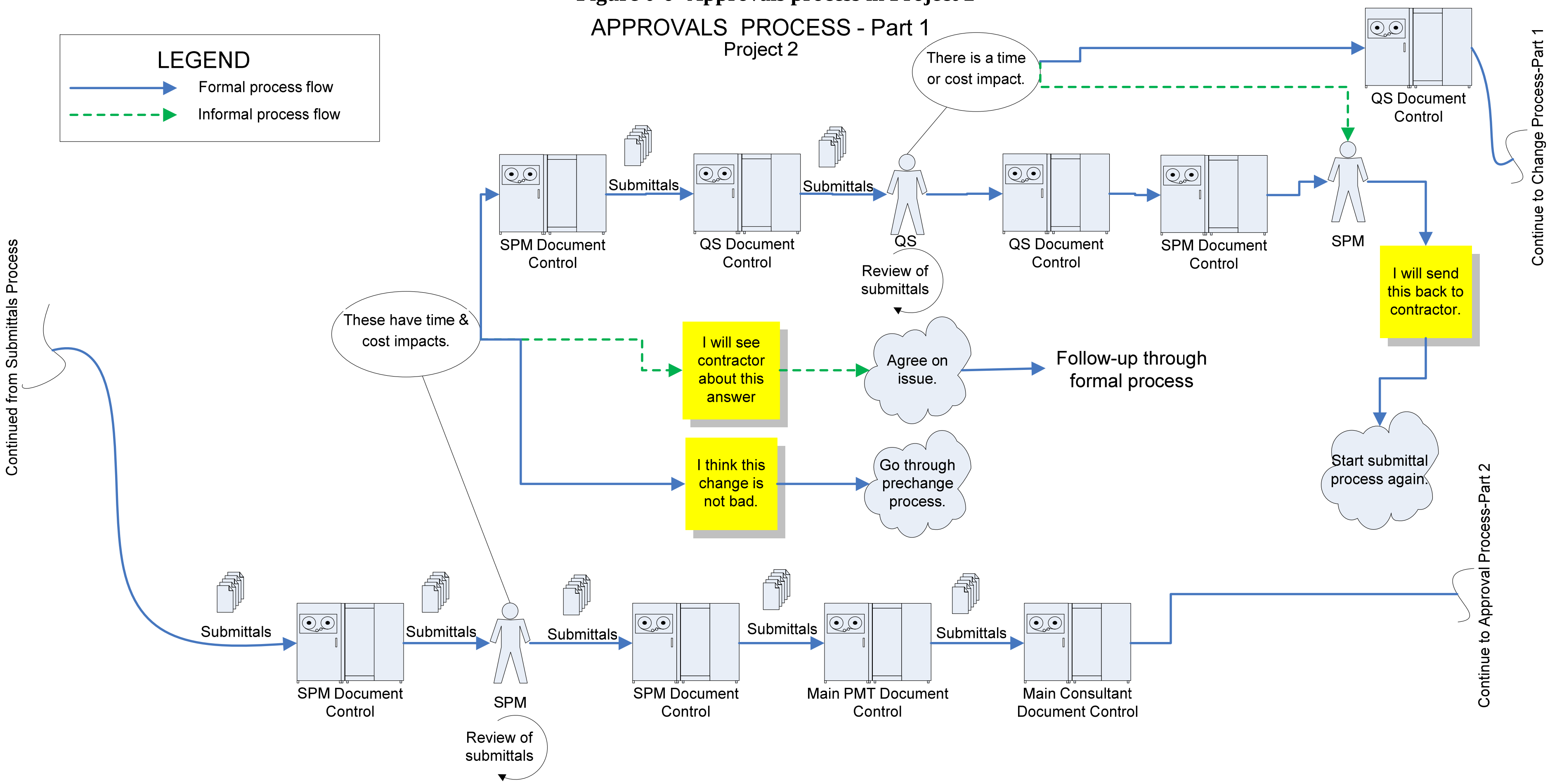
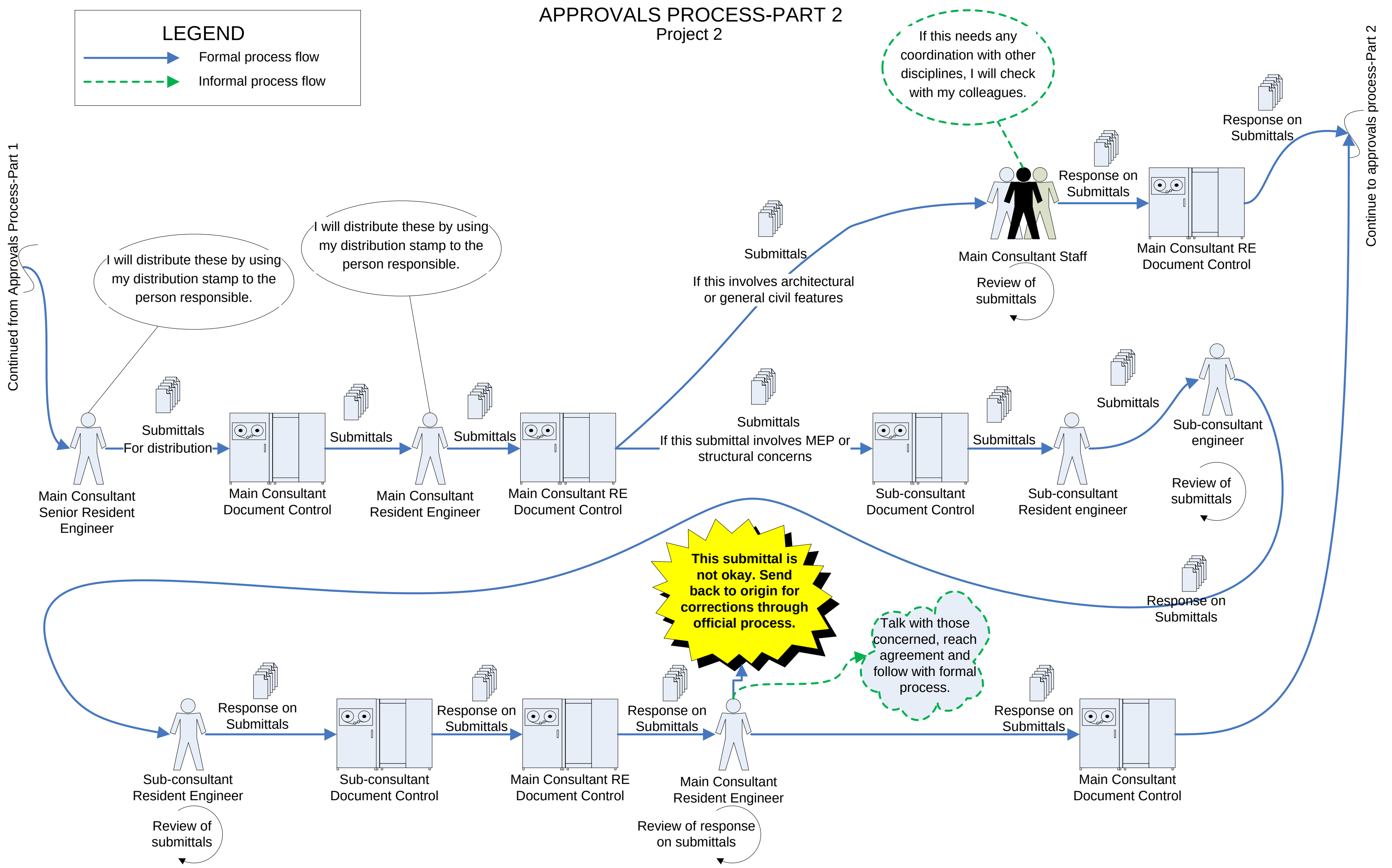
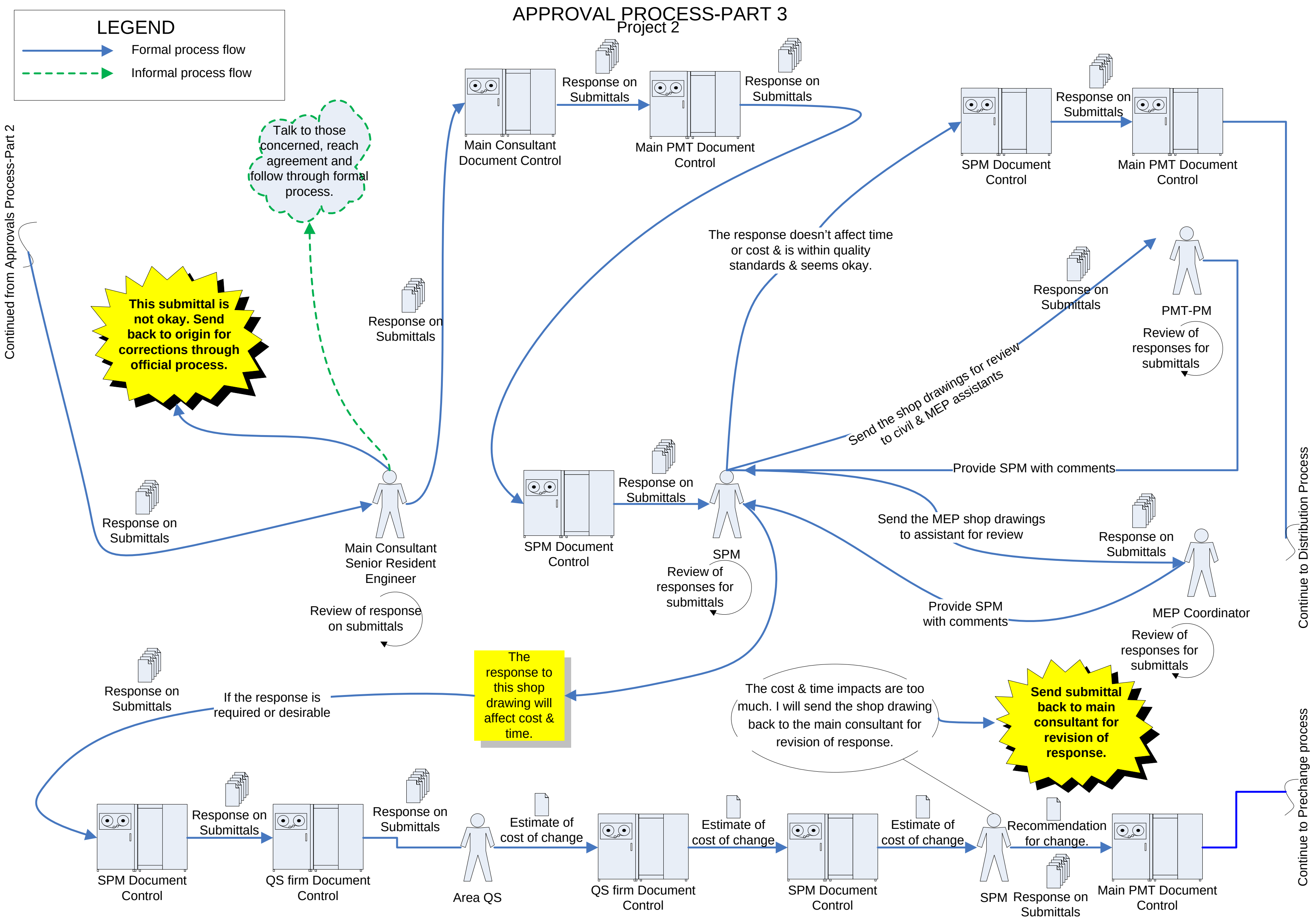

APPROVALS PROCESS (Part 2)
Project 1
LEGEND
Formal process flow
Informal process flow
This is a submittal (most probably material) that the client would want to see prior to approval.
Show the client
Client
If I have time to review, I will check that response is okay. If not okay, I will talk with the person who put the response and put a final response.
Client response prior to time required for return of submittal
If this needs any coordination with other disciplines, I will check with my colleagues.
Response on Submittals
Main Consultant Project Director
Response on Submittals
Main Consultant Document Control
Response on Submittals
Main Document Control
Response on Submittals
WPM
Review of responses for submittals
The response to this shop drawing will affect cost & time but may agree.
Go to prechange process
Checked with WQS
The response affects other disciplines.
Does affect other disciplines
Ensure they have the information
Construction Management Team Staff
Discussions
Doesn't affect other disciplines
The response is not what I believe is correct. I will change that.
I don't have time to review this.
Response on Submittals
Responses okay
Main Document Control
Continue to Distribution Process
Review of construction documents
Submittals
Main Consultant Staff
This is within our main functions. Others will go to subconsultants.
Submittals
Response on Submittals
Client
Client response prior to time required for return of submittal
Show the client
This is a submittal (most probably material) that the client would want to see prior to approval.
Main Consultant Document Control
Sub-consultant
Response on Submittals
Review of submittals
Continued from Approvals Process Part 1
Main Consultant Document Control
Submittals
Main Consultant Project Director
Submittals
Sub-consultant Document Control
Response on Submittals
Review of submittals
Sub-consultant Document Control

Figure 0-6 Approvals process in Project 2




APPROVALS PROCESS-PART 2
Project 2
LEGEND
Formal process flow
Informal process flow
Continued from Approvals Process-Part 1
Continue to approvals process-Part 2
I will distribute these by using my distribution stamp to the person responsible.
I will distribute these by using my distribution stamp to the person responsible.
If this needs any coordination with other disciplines, I will check with my colleagues.
Main Consultant Senior Resident Engineer
Submittals For distribution
Main Consultant Document Control
Submittals
Main Consultant Resident Engineer
Submittals
Main Consultant RE Document Control
Submittals
If this involves architectural or general civil features
Main Consultant Staff
Review of submittals
Response on Submittals
Main Consultant RE Document Control
Response on Submittals
Submittals
If this submittal involves MEP or structural concerns
Sub-consultant Document Control
Submittals
Sub-consultant Resident engineer
Submittals
Sub-consultant engineer
Review of submittals
Response on Submittals
This submittal is not okay. Send back to origin for corrections through official process.
Talk with those concerned, reach agreement and follow with formal process.
Sub-consultant Resident Engineer
Review of submittals
Response on Submittals
Sub-consultant Document Control
Response on Submittals
Main Consultant RE Document Control
Response on Submittals
Main Consultant Resident Engineer
Review of response on submittals
Response on Submittals
Main Consultant Document Control


APPROVAL PROCESS-PART 3
Project 2
LEGEND
Formal process flow
Informal process flow
Continued from Approvals Process-Part 2
Talk to those concerned, reach agreement and follow through formal process.
This submittal is not okay. Send back to origin for corrections through official process.
Response on Submittals
Main Consultant Document Control
Main PMT Document Control
SPM Document Control
The response doesn't affect time or cost & is within quality standards & seems okay.
PMT-PM
Review of responses for submittals
Send the shop drawings for review to civil & MEP assistants
Provide SPM with comments
Main Consultant Senior Resident Engineer
Review of response on submittals
SPM
Send the MEP shop drawings to assistant for review
Provide SPM with comments
MEP Coordinator
Continue to Distribution Process
The response to this shop drawing will affect cost & time.
If the response is required or desirable
The cost & time impacts are too much. I will send the shop drawing back to the main consultant for revision of response.
Send submittal back to main consultant for revision of response.
QS firm Document Control
Area QS
Estimate of cost of change
Recommendation for change.
Continue to Prechange process

A-3-4 Distribution process

Introduction

Once there is approval on the submittal it is sent for distribution. The distribution may be made from a preset guide or according to a distribution list provided from the person responsible. It can be both also.

Project 1

Once there is approval on the submittal it is sent for distribution according to a preset matrix of distribution as well as the distribution that the WPM provides prior to sending the submittal to CMT document control for distribution. The distribution process seems rather simple. The CMT document control would receive documents and then check a premade matrix as to where this typical document would be distributed. Additionally, the documents would come with a distribution list as to whom the document should be provided to from the WPM, or in the case of contractual documents from the Project Leader. The distribution process is presented in Figure 0-7. However, there were several problems faced in distribution. The problems are in the legal receipt of documents and lack of use of the electronic management system in the project. The legal problem consisted of having the relevant parties sign the receipt for the submittals. At times the document control would call the parties and advise them that there are documents to be received. Some would not come for some time and then advise that they did not receive it. However, it would be posted on the electronic document management system and they did not view it because they do not use the system. It was finally decided that each would be emailed, despite the fact that the email was not considered as contractually binding.

Project 2

The distribution process seems rather simple. The PMT document control would receive documents with a distribution stamp on it from the SPM providing to whom it should be distributed. In the case of contractual documents, the distribution list may be from the SPM or from the project management team Project Director (PD). The distribution process is presented in Figure 0-8. The distribution was made through document receipts by each party’s document control. This was the only legal form of document transfer.

Figure 0-7 Distribution Process in Project 1

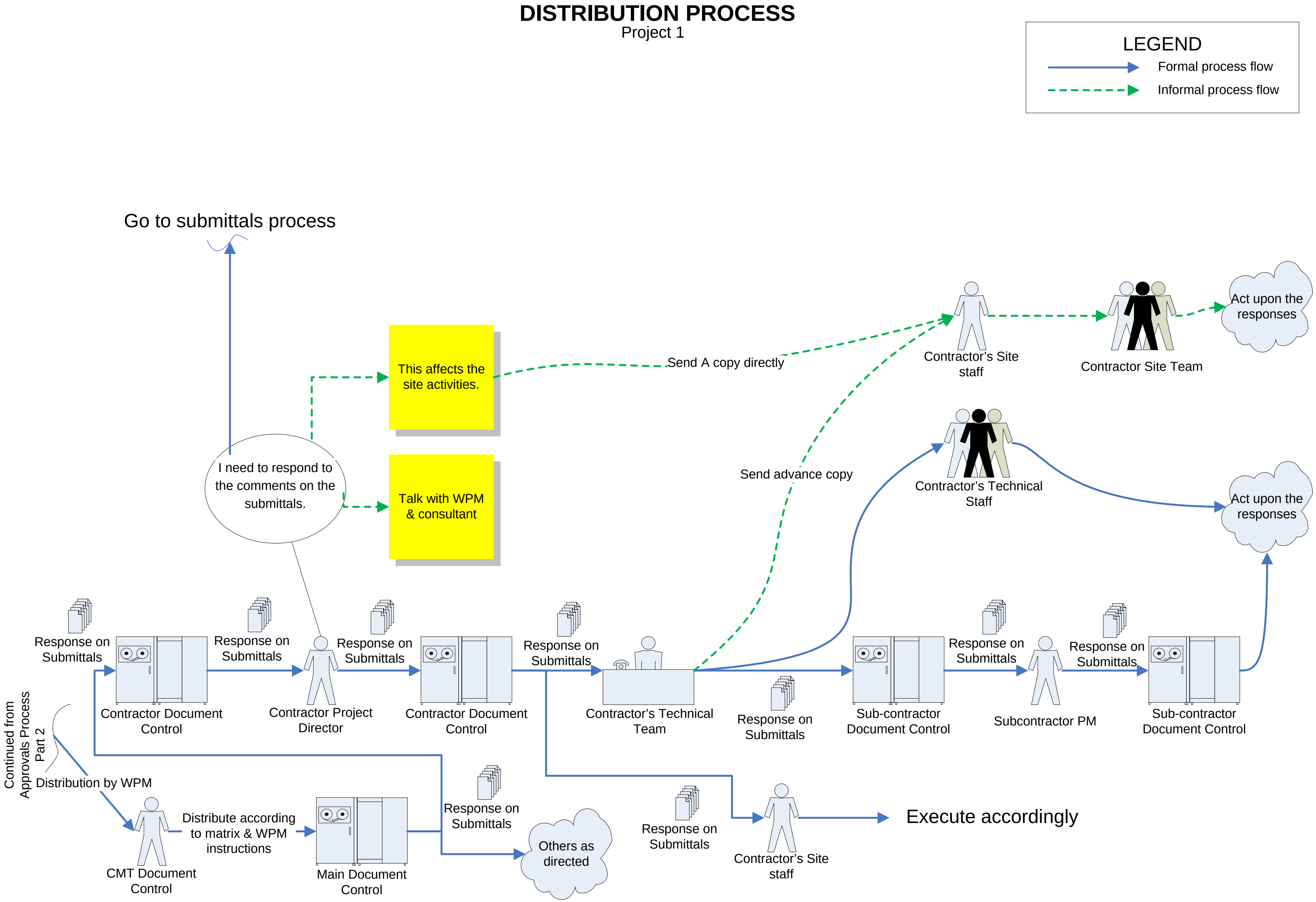
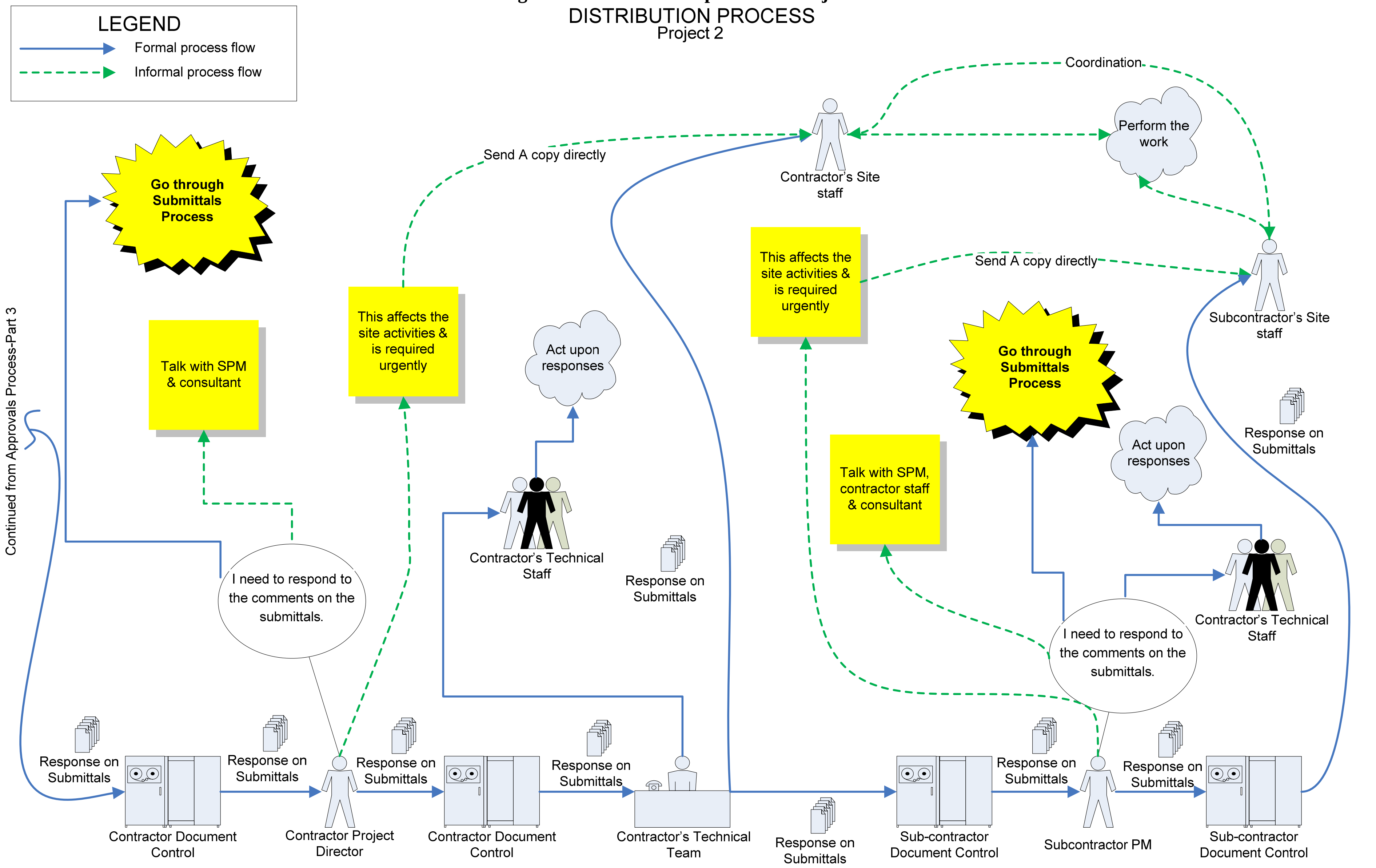


Figure 0-8 Distribution process in Project 2



A-3-5 Inspection process

Introduction

Once the work is executed through the execution process, it is to be inspected. The inspection process results in rejection, modifications or acceptance. Once the task is approved it is considered completed. The rate of inspection process affects the task completion and the tasks that follow it that are reliant on its progress.

Project 1

The inspection process is presented in Figure 0-9. The inspection process is largely left between the contractor and consultant. This is the only process where the client or construction management team are not directly involved. The contractor submits an inspection request through his document control to the consultant document control. The inspection request is reviewed and sent to the person responsible for inspecting that particular work. The inspection is distributed accordingly. If the main consultant staff is inspecting, then that person provides a time for inspection. If the person responsible is a subconsultant staff, then consultant document control send the inspection sheet to the person through subconsultant document control. A time for inspection is provided to the contractor.

Sometimes the inspection sheet requires that an inspector from the Authorities be present at time of inspections. In that case the Authorities are requested to provide a time for inspection. The Authorities provide a time as well as their requirements for original approved documents to be present at the time of inspection. The time of inspection is then forwarded to the contractor to ensure his staff is present at the time of inspection.

During inspection, the result may be approval of the work, and the task is considered completed. There may also be requirements for modifications or rejection of the works, which is rare. In the case there are modifications required the contractor would usually correct the comments made during the inspection and start the process again by submitting another inspection request. However, at times the rework may have negative impacts for the project. In this case the WPM may find it more feasible to change the design for subsequent tasks and here the prechange process is initiated.

Project 2

The inspection process (shown in Figure 0-10) is left between the contractor and consultant due to the large numbers of inspections, which the project management team was not interested in being involved with. The only interest of the project management team was to know what the outcomes of inspections were. Therefore, the project management team would be informed of the outcome through a copy of the inspection.

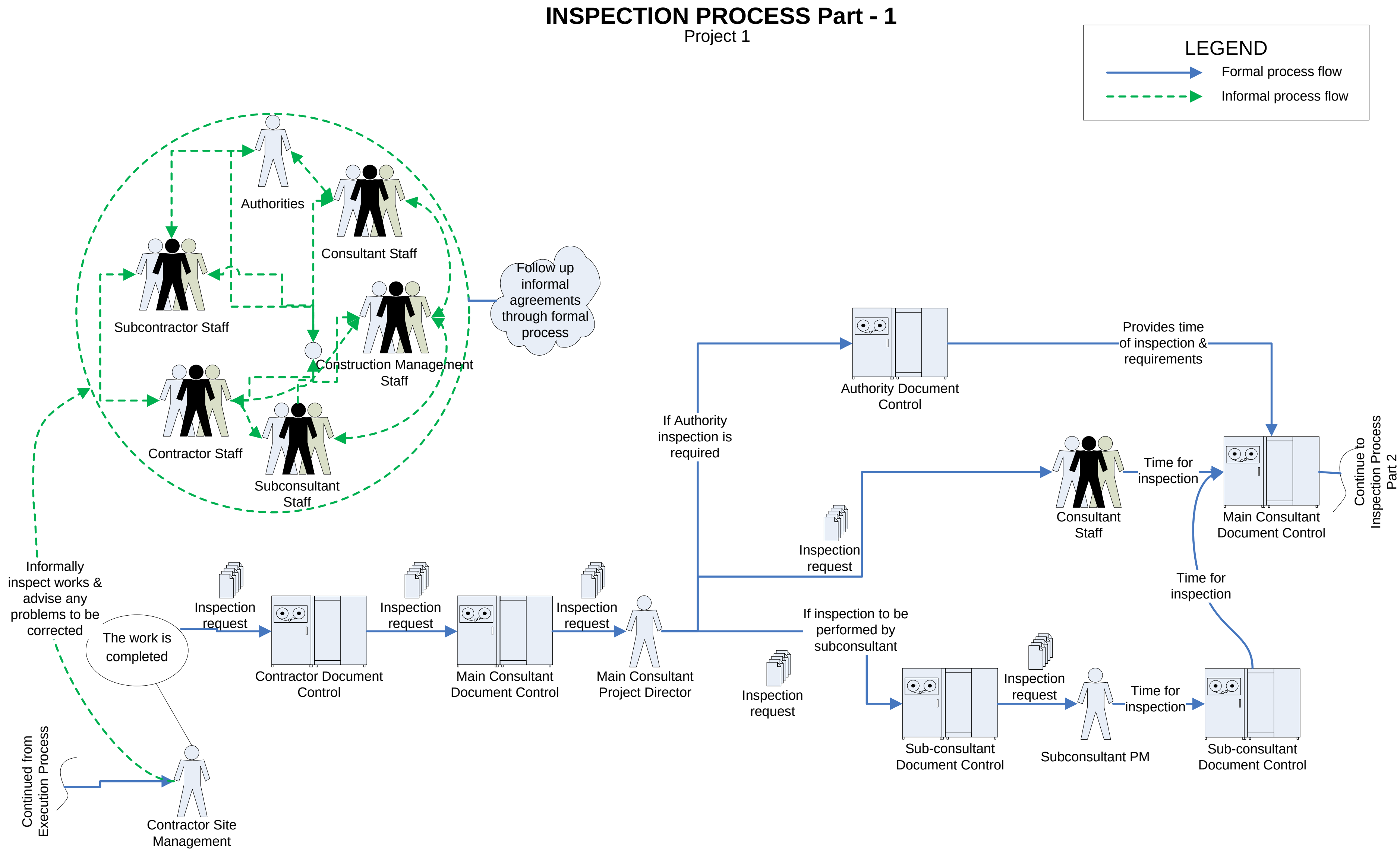
The inspection is performed once the task is completed. The inspection is performed formally through the inspection process. The outcome of the inspection process results in rejection, modifications or acceptance. Once the task inspected is approved it is considered completed. The rate of inspection process affects the task completion and the tasks that follow it that are reliant on its progress.

The contractor submits an inspection request through his document control to the consultant document control. The inspection request is reviewed by the SRE and sent to the person responsible for inspecting that particular work through his document control to the document control of the person if he is not a subconsultant staff. If the person responsible is a subconsultant staff, then consultant document control send the inspection sheet to the person through subconsultant document control. A time for inspection is provided to the consultant who forwards the time of inspection to the contractor.

Sometimes the inspection sheet requires that an inspector from the Authorities be present at time of inspections. In that case the Authorities are requested to provide a time for inspection. The Authorities provide a time as well as their requirements for original approved documents to be present at the time of inspection. The time of inspection is then forwarded to the contractor to ensure his staff is present at the time of inspection.

During inspection, the result may be approval of the work, and the task is considered completed. There may also be requirements for modifications or rejection of the works, which is rare. In the case there are modifications required the contractor would usually correct the comments made during the inspection and start the process again by submitting another inspection request. However, at times performing the rework may have negative impacts for the project. In this case the SPM may find it more feasible to change the design for subsequent tasks and here the prechange process is initiated.

Figure 0-9 Inspection process in Project 1



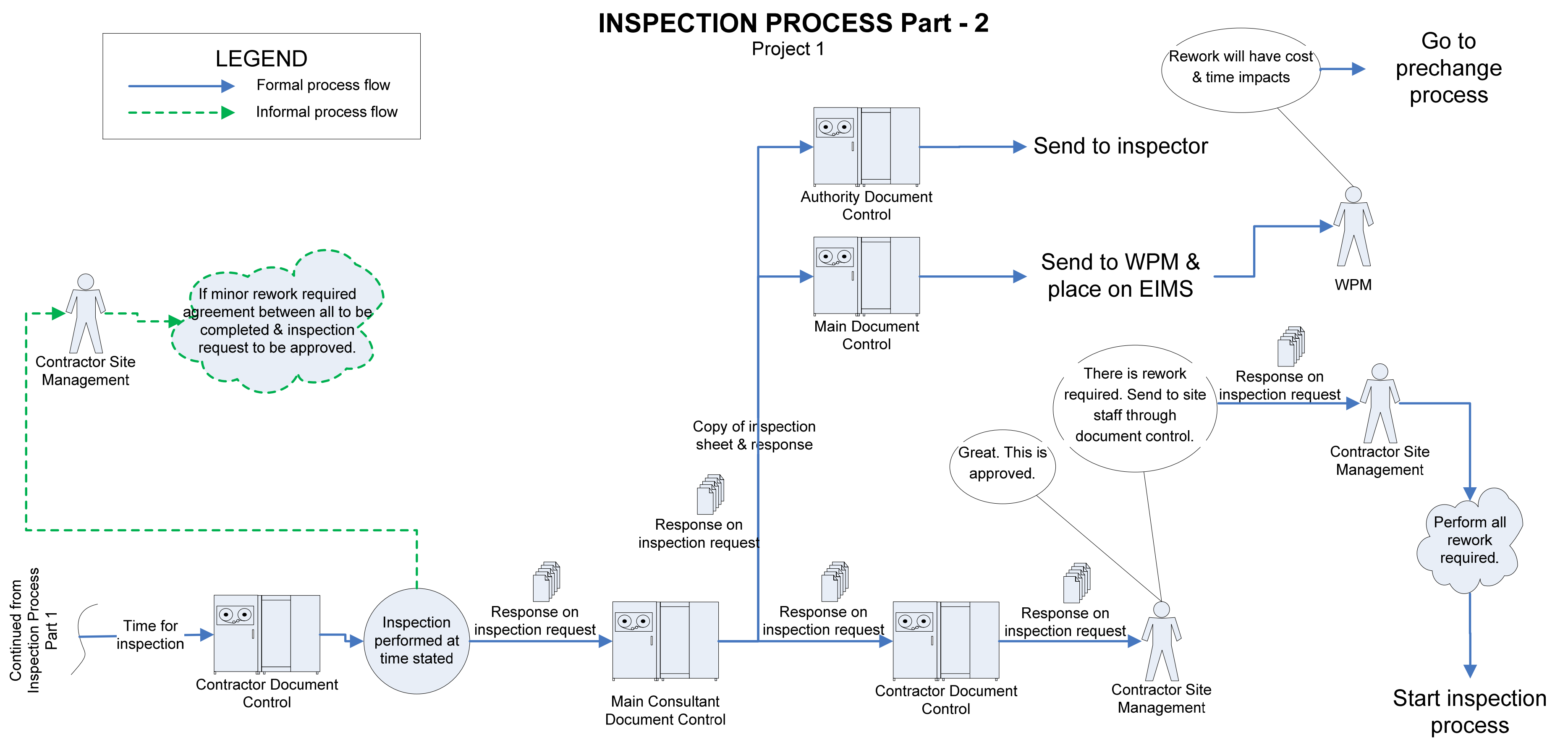
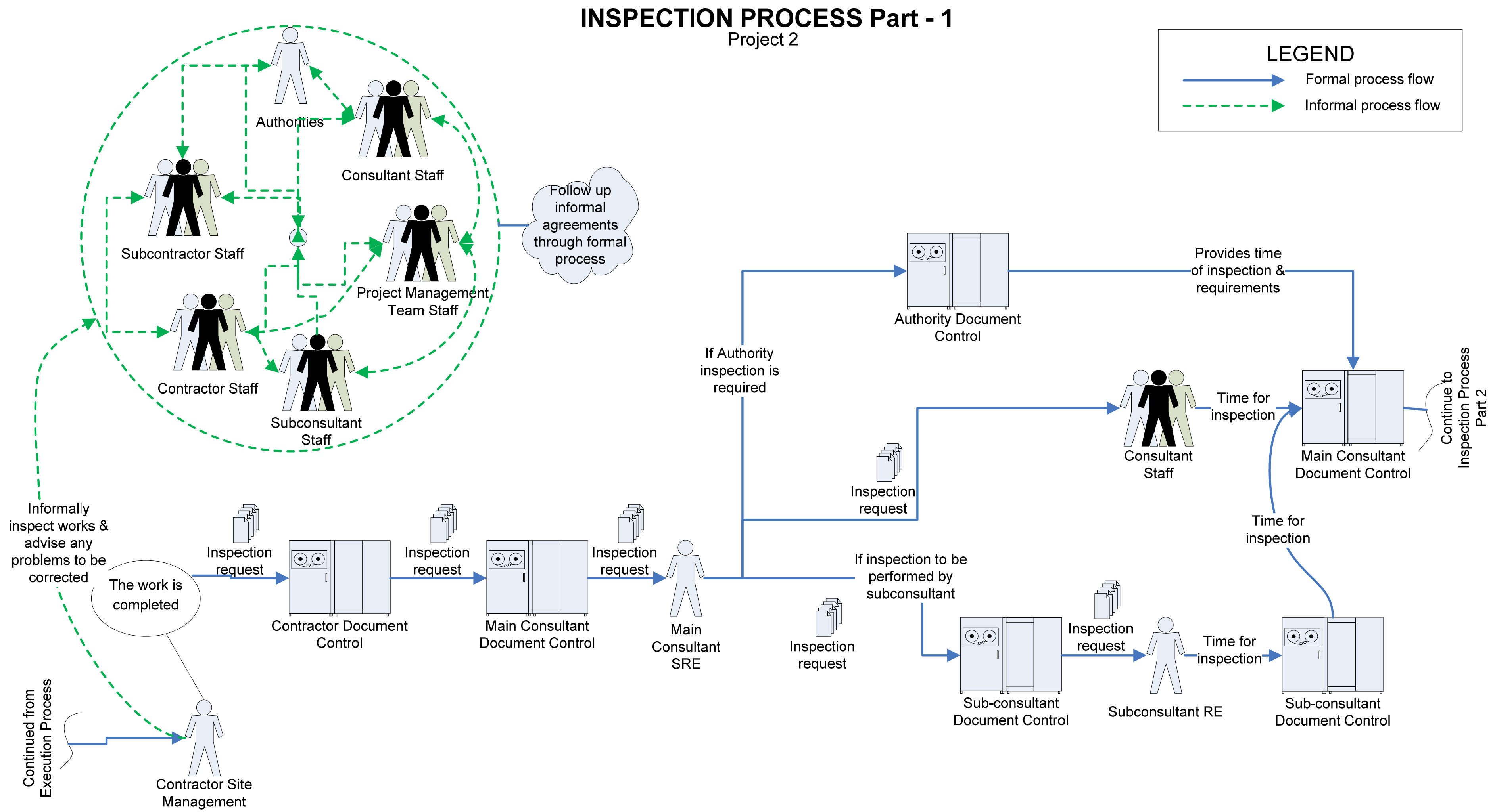
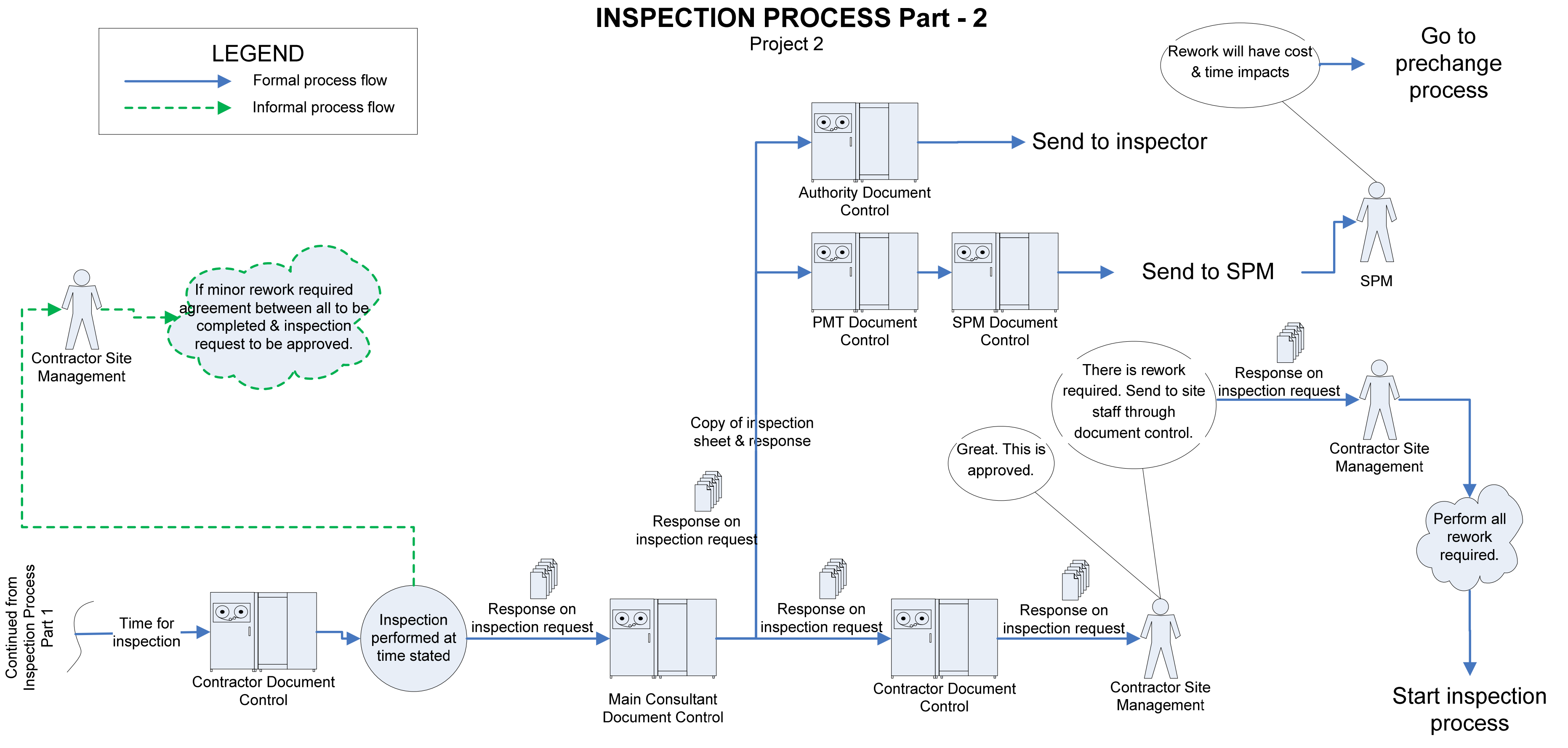

INSPECTION PROCESS Part - 2
Project 1
LEGEND
Formal process flow
Informal process flow
Rework will have cost & time impacts
Go to prechange process
Send to inspector
Authority Document Control
Send to WPM & place on EIMS
Main Document Control
WPM
Contractor Site Management
If minor rework required agreement between all to be completed & inspection request to be approved.
There is rework required. Send to site staff through document control.
Response on inspection request
Contractor Site Management
Copy of inspection sheet & response
Great. This is approved.
Perform all rework required.
Response on inspection request
Continued from Inspection Process Part 1
Time for inspection
Contractor Document Control
Inspection performed at time stated
Response on inspection request
Main Consultant Document Control
Response on inspection request
Contractor Document Control
Response on inspection request
Contractor Site Management
Start inspection process

Figure 0-10 Inspection process in Project 2




INSPECTION PROCESS Part - 2
Project 2
LEGEND
Formal process flow
Informal process flow
Rework will have cost & time impacts
Go to prechange process
Send to inspector
Authority Document Control
PMT Document Control
SPM Document Control
Send to SPM
SPM
Contractor Site Management
If minor rework required agreement between all to be completed & inspection request to be approved.
Copy of inspection sheet & response
There is rework required. Send to site staff through document control.
Response on inspection request
Contractor Site Management
Great. This is approved.
Perform all rework required.
Response on inspection request
Continued from Inspection Process Part 1
Time for inspection
Contractor Document Control
Inspection performed at time stated
Response on inspection request
Main Consultant Document Control
Response on inspection request
Contractor Document Control
Response on inspection request
Contractor Site Management
Start inspection process

A-3-6 Prechange process

Introduction

The prechange process is largely informal, except once a decision is made to pursue any change further by the client. This is actually not in any of the formal processes devised by the clients of the case projects but it was the only way that the ideas could be forthcoming from any source. The idea of a change would gather "steam" as staff discussed the possibilities and potential of the idea.

Project 1

The prechange process for Project 1 is seen in Figure 0-11 Anyone could discuss anything with anyone. If the idea has some merit, it would usually end up being discussed with a decision maker such as the Project Leader or client staff. The preliminary go ahead to pursue an idea may be provided. This would entail that the source of the idea provide preliminary costs and potential impacts and risks. This then is further studied by the decision maker (usually Project Leader) who may then discuss it with the client. The client may not agree with the assessments and decide not to pursue the change further. But if the client agrees to the preliminary proposal the process starts to be formalized where the WPM, in conjunction with the WQS, provide a Change Proposal, which is the initial formal process for initiation of a change. During this time the consultant may not be involved and may not even know that a change is forthcoming during these discussions. Only when the process starts to be formalized would he surely know. An example of this incidence has been provided by both consultant and a member of the construction management team.

Project 2

The prechange process in Project 2 is shown in Figure 0-12. This idea may be further developed through a preliminary approval process to identify risks, costs and time impacts. The final approval may be provided to make the change. The change requires preparation of submittals such as shop drawings and would go through the submittal process, the approval process and the distribution process. The rate of change affects the task that is in consideration and those that follow it and are reliant on it.

The change may be initiated by site. In this case the process is largely the same except that in some cases changes that do not affect cost, time or quality may be performed without going through the whole formal change process. The rate of this type of change affects the tasks that follow it.

The prechange process as seen in Figure 0-12 is largely informal, except once a decision is made to pursue any change further by the client. This is actually not in any of the formal processes devised by the client but it was the only way that the ideas could be forthcoming from any source. The idea of a change would gather “steam” as staff discussed the possibilities and potential of the idea. Anyone could discuss anything with anyone. If the idea has some merit, it would usually end up being discussed with a decision maker such as the SPM or Project Director or client staff.

The preliminary go ahead to pursue an idea may be provided. This would entail that the source of the idea provide preliminary costs and potential impacts and risks. This then is further studied by the decision maker (usually SPM or Project Director) who may then discuss it with the client. The client may not agree with the assessments and decide not to pursue the change further. But if the client agrees to the preliminary proposal the process starts to be formalized where the SPM, in conjunction with the QS, provide a Change Proposal, which is the initial formal process for initiation of a change.

Figure 0-11 Prechange process in Project 1

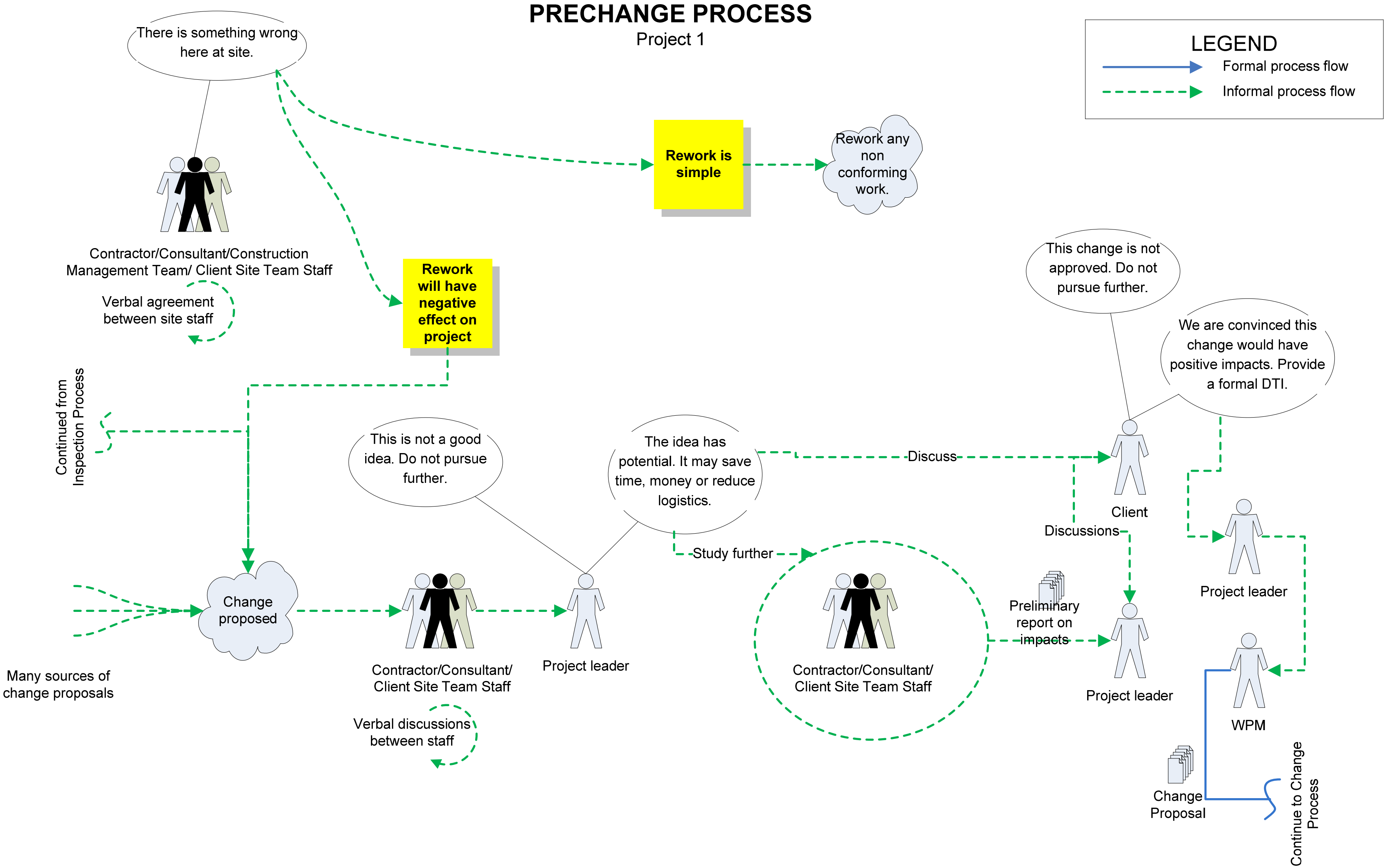
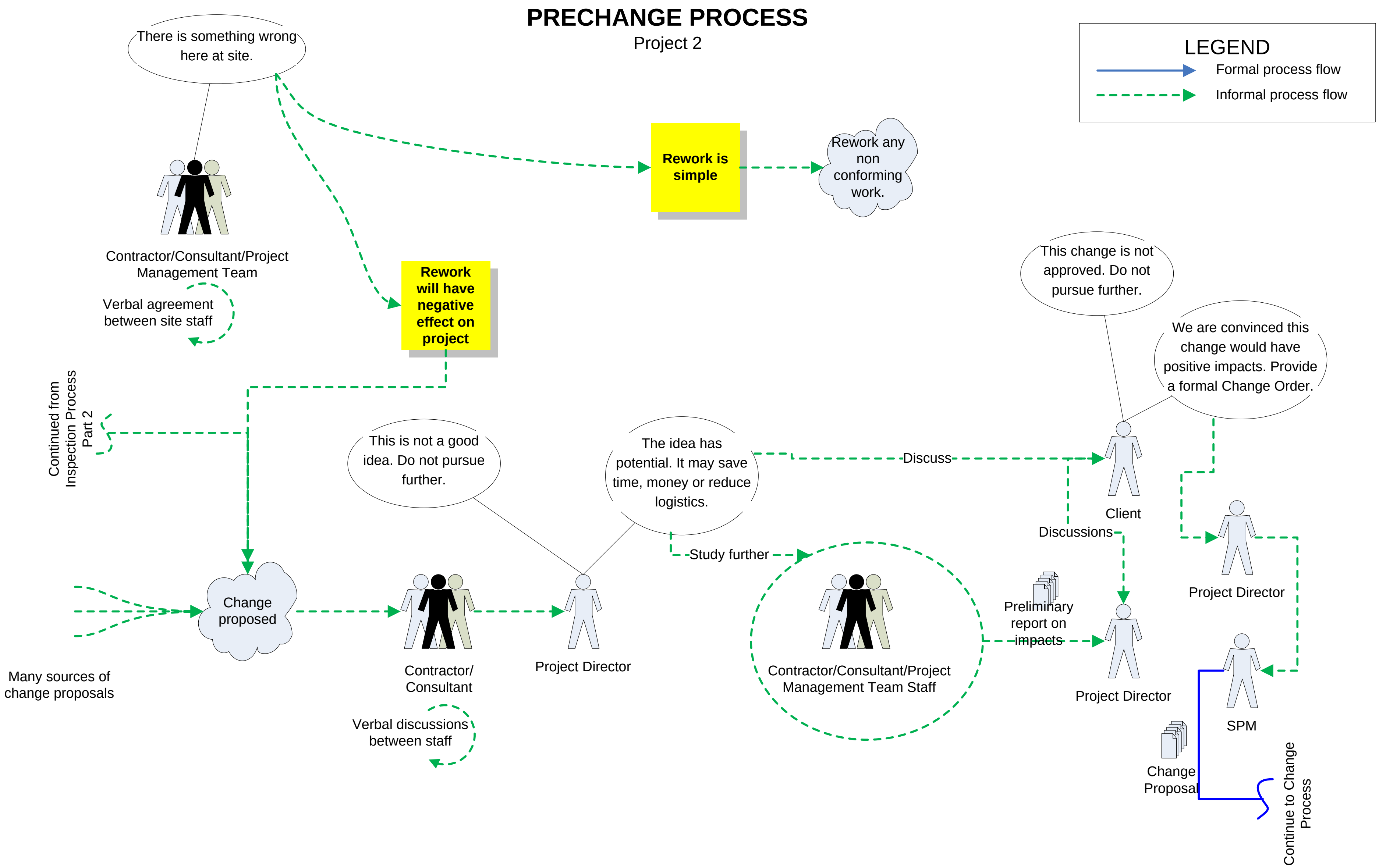


Figure 0-12 Prechange process in Project 2



A-3-7 Change process

Introduction

The actual "formal" change process would start once a "formal" proposal is submitted. This process includes for urgencies, but even that is slow through formal channels. The change process shall be described in the following subsections.

Project 1

The formal change process (shown in Figure 0-13) starts when the Change Proposal is submitted from the WPM to the WPQS for "firming up" of prices, who then sends it on to the Commercial Manager for preparation of a budget, as well as the Project Engineer for coordination purposes and checking of impacts. This is then forwarded to the Project Leader who reviews the Change Proposal and the impacts, whether time, cost or even risk. The Project Leader's decision at this junction will either get the Change Proposal to the client or the change will not be pursued. If the Project Leader approves the change proposed it will be forwarded to the client, where there are several people it goes through including client staff from the development and operations arms of the client. This process in itself is long since it goes through several people, each reviewing and approving it. If the change is not approved by the client, the change is stopped. If the client approves there is still a long process.

A Change Proposal will become into a DTI (Development Team Instruction) once approved by the client. The process itself is quite long but the essence of it is that the DTI will be issued in two ways. The first will be in an urgent situation where the change must be made. In that case, the DTI (called a DTIp) is issued to the contractor to proceed with the works and submit a price. When there is no urgency the Change Proposal becomes a DTIe and is issued to the contractor through CMT and contractor document controls. In a DTIe, the contractor shall submit a price and following client approval shall proceed with the changes.

Once the contractor estimates the cost of the change and submits a price, the WPM accepts the price if it is within ten percent of estimated costs. If contractor price is beyond that, the WPQS and WPM negotiate the price with the contractor staff. If agreement is reached, the DTIe becomes a Change Order. If no agreement is reached, the change may be stopped. However, negotiations may continue.

The DTIp is an instruction for the contractor to proceed with the changes and invoice the client. The invoice may be within a ten percentage of estimated budget and accepted. If the invoice is beyond the estimated budget and the ten percent contingency, the WPM and WPQS negotiate with their respective counterparts in the contractor organization. If the negotiations fail, the invoice may become a claim. However, the client was keen to reach to reasonable agreements and not leave anything behind once the project is completed. In the rare case that there still is disagreement, the DTIp ultimately becomes a claim.

The informal process was a much shorter route but was dependant on the level of trust between the various parties. If trust was established through good relations, changes were performed by verbal agreement and then followed by formal procedures. This required that there is mutual faith that what each individual stated was followed through and that each was actually authorized to make such decisions. The informal route in general was much shorter, could be performed in very short notice and was very suitable in urgent situations or where there was a high degree of uncertainty in order to provide the required information in a timely manner. Additionally, in the informal process advanced information was provided to avoid any rework. An example was when the window sizes were changed, the contractor was provided with advance information, which he acted upon and avoided unnecessary rework.

Project 2

The formal change process shown in Figure 0-14 starts when the Change Proposal is submitted from the SPM to the QS for providing a budget for the change. The QS then provides the budget for the change proposal to the SPM through QS, PMT and SPM document controls. Through this process the Project Director of the project management team has the opportunity to see the documents going to and from the SPM. The budget is then reviewed by the SPM regards, costs, time and other things such as risk. Once the SPM approves the change it is forwarded to the consultant for signing off on the change proposal. The consultant signs it off, sends it back to SPM where he signs it off and sends it to the client for signing off. If the proposal is rejected by the SPM following his review the change stops and is no longer pursued. This process in itself is long since it goes through several people, each reviewing and approving it. If the change is not approved by the client, the change is stopped. If the client approves there is still a long process.

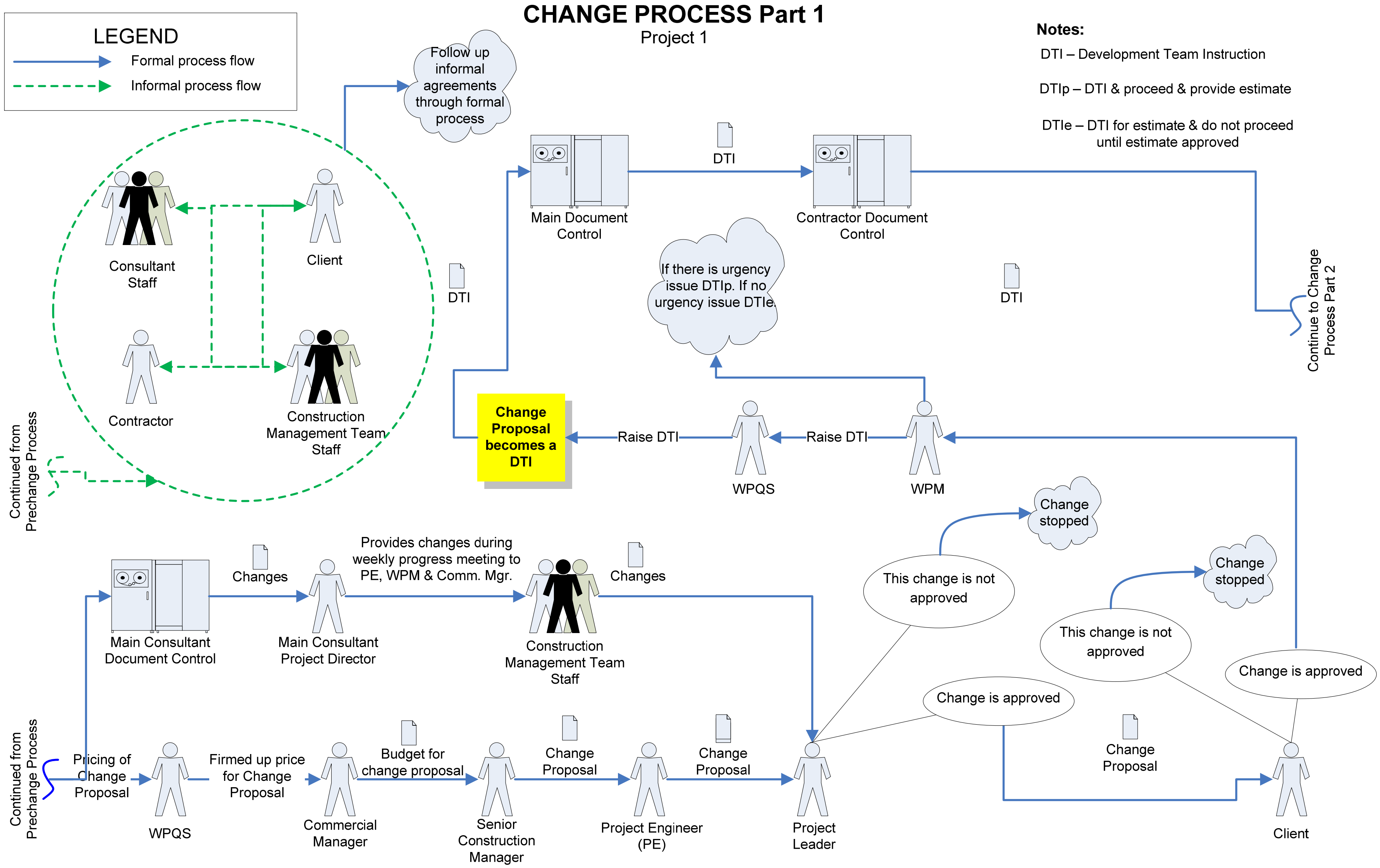
A Change Proposal will become into a PVO (Potential Variation Order) once approved by the client. The process itself is quite long but the essence of it is that the PVO will be issued in two ways. The first will be in an urgent situation where the change must be made. In that case, the PVO (called a PVOp) is issued for the contractor to proceed with the works and submit a price. When there is no urgency the Change Proposal becomes a PVOe and is issued to the contractor through SPM, PMT and contractor document controls. In a PVOe, the contractor shall submit a price and only following client approval shall proceed with the changes.

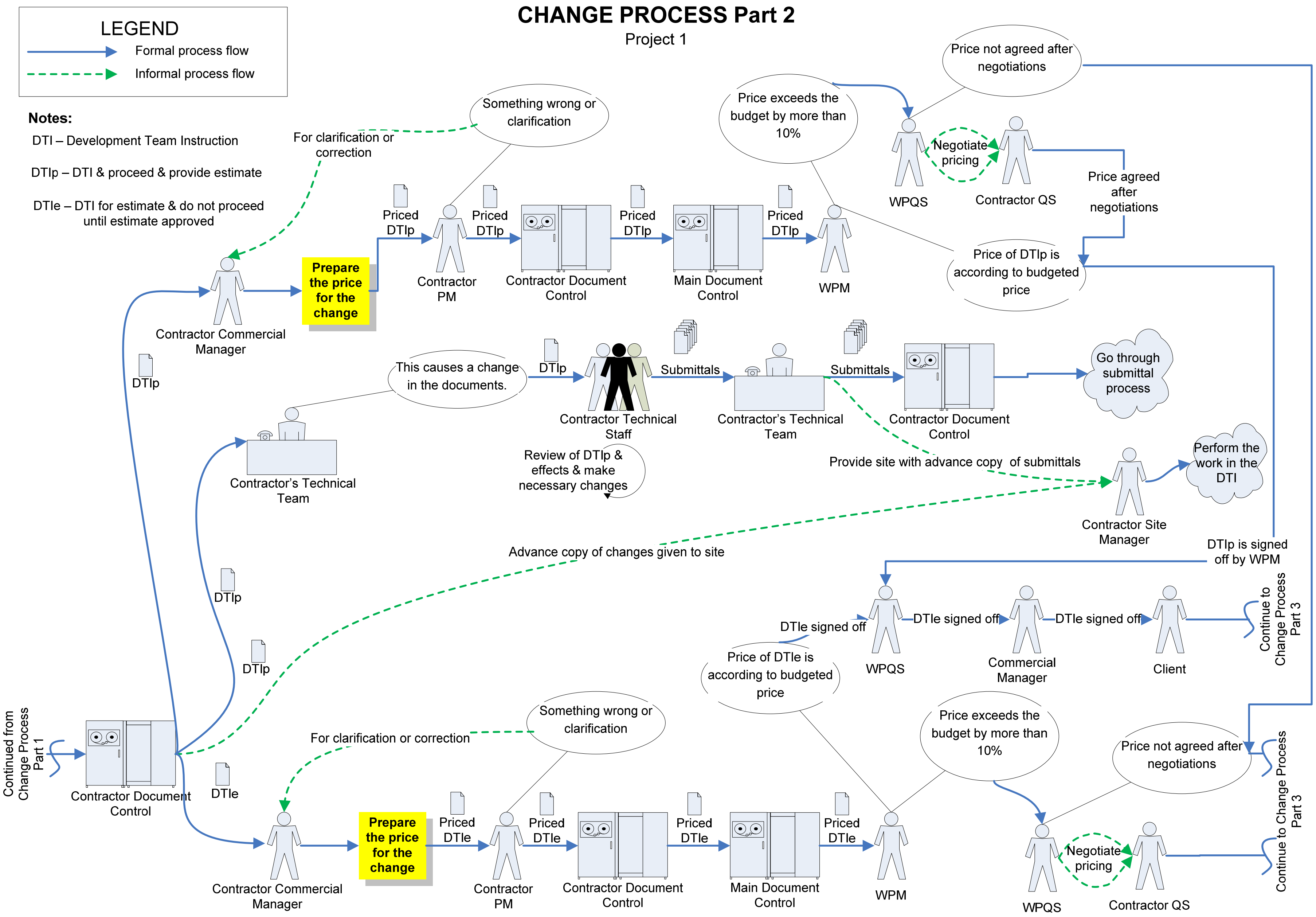
Once the contractor estimates the cost of the change and submits a price, the SPM accepts the price if it is within estimated and budgeted costs. If contractor price is beyond that, the QS and SPM negotiate the price with the contractor staff. If agreement is reached, the PVOe becomes a Variation Order. If no agreement is reached, the change may be stopped. However, negotiations may continue.

The PVOp is used in urgent situations and is an instruction for the contractor to proceed with the changes and invoice the client. The invoice may be within that of estimated budget and accepted. If the invoice is beyond the estimated budget, the SPM and QS negotiate with their respective counterparts in the contractor organization. If the negotiations fail, the invoice may become a claim. However, the client was keen to reach to reasonable agreements and not let things remaining once the project is completed. In the rare case that there still is disagreement, the PVOp ultimately becomes a claim.

The informal process was a much shorter route but was dependent on the level of trust between the various parties. If trust was established through good relations, changes were performed by verbal agreement and then followed by formal procedures. This required that there is a mutual faith that what each individual stated was followed through and that each was actually authorized to make such decisions. The informal route being shorter was very suitable in urgent situations or where there was a high degree of uncertainty where information is required in a timely manner. Additionally, in the informal process advanced information was provided to avoid any rework.

Figure 0-13 Change process in Project 1





CHANGE PROCESS Part 2
Project 1
LEGEND
Formal process flow
Informal process flow
Notes:
DTI – Development Team Instruction
DTIp – DTI & proceed & provide estimate
DTIe – DTI for estimate & do not proceed until estimate approved
Something wrong or clarification
For clarification or correction
Price exceeds the budget by more than 10%
Price not agreed after negotiations
Negotiate pricing
WPQS
Contractor QS
Price agreed after negotiations
Price of DTIp is according to budgeted price
Priced DTIp
Prepare the price for the change
Contractor Commercial Manager
Contractor PM
Contractor Document Control
Main Document Control
WPM
DTIp
This causes a change in the documents.
Contractor Technical Staff
Submittals
Contractor's Technical Team
Go through submittal process
Review of DTIp & effects & make necessary changes
Provide site with advance copy of submittals
Perform the work in the DTI
Contractor Site Manager
Advance copy of changes given to site
DTIp is signed off by WPM
DTIe signed off
Commercial Manager
Client
Continue to Change Process Part 3
Price of DTIe is according to budgeted price
Continued from Change Process Part 1
DTIe
Priced DTIe

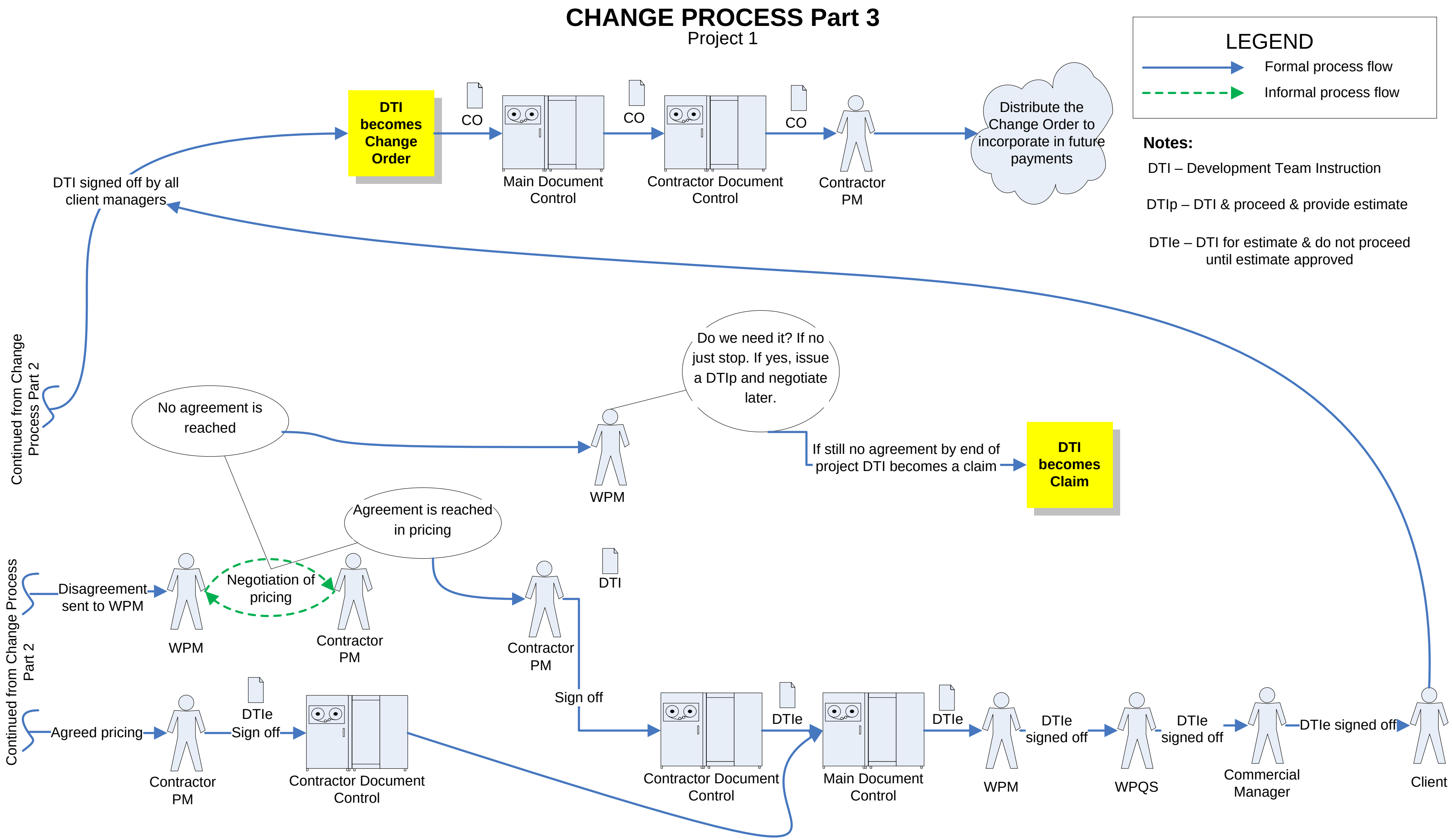
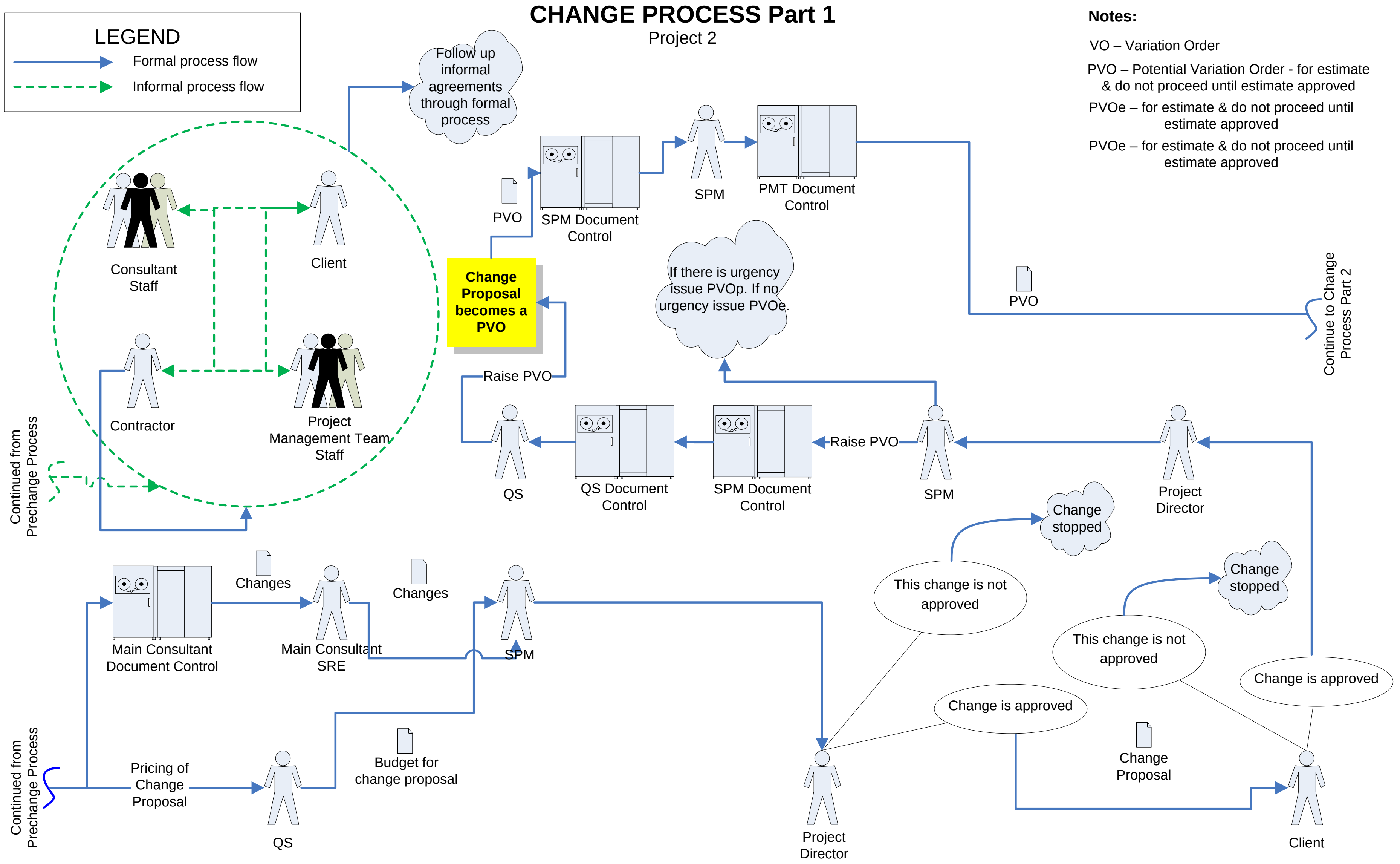
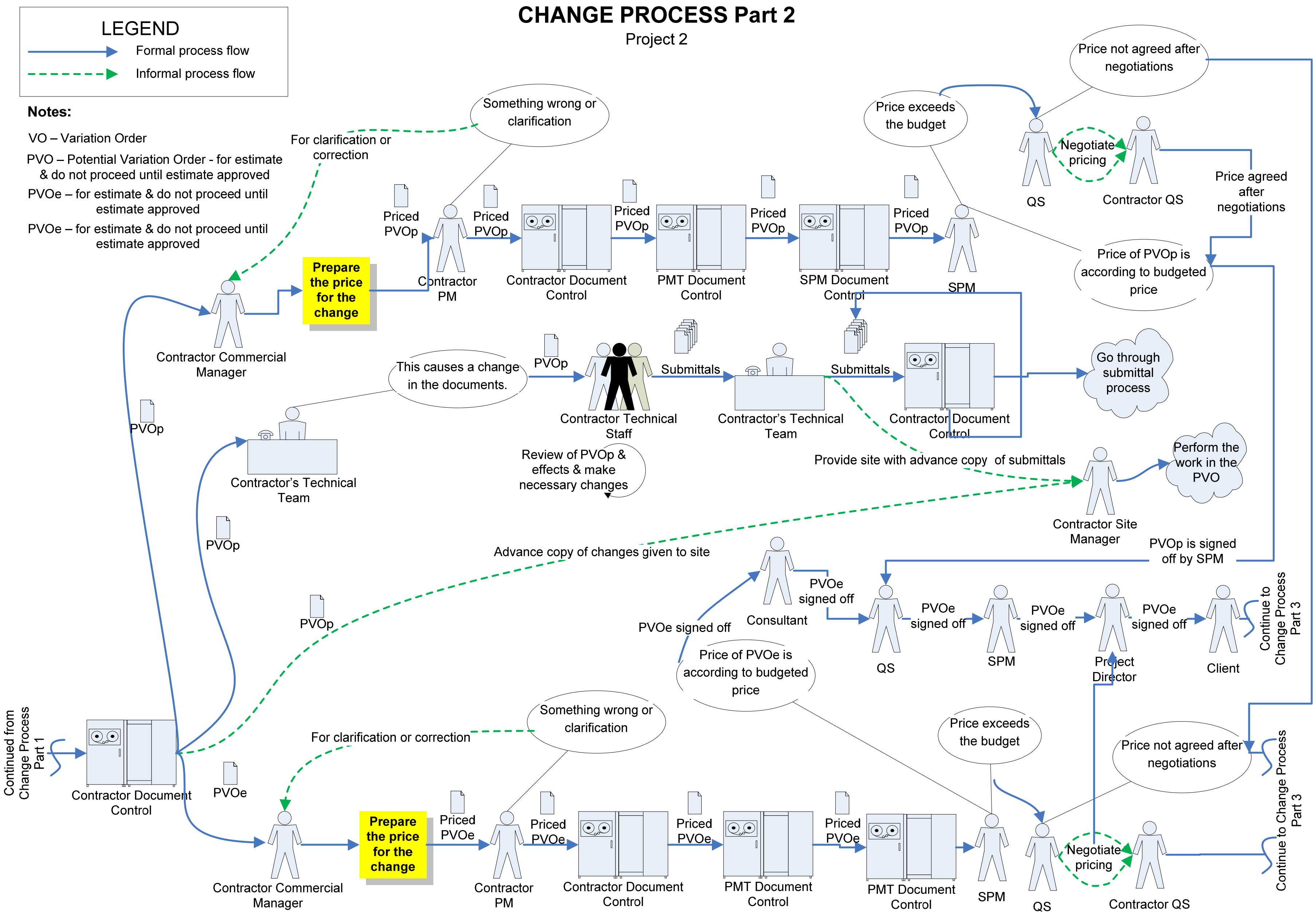

CHANGE PROCESS Part 3
Project 1
LEGEND
Formal process flow
Informal process flow
Notes:
DTI – Development Team Instruction
DTIp – DTI & proceed & provide estimate
DTIe – DTI for estimate & do not proceed until estimate approved
DTI signed off by all client managers
DTI becomes Change Order
CO
Main Document Control
CO
Contractor Document Control
CO
Contractor PM
Distribute the Change Order to incorporate in future payments
Continued from Change Process Part 2
No agreement is reached
Do we need it? If no just stop. If yes, issue a DTIp and negotiate later.
WPM
If still no agreement by end of project DTI becomes a claim
DTI becomes Claim
Agreement is reached in pricing
Continued from Change Process Part 2
Disagreement sent to WPM
WPM
Negotiation of pricing
Contractor PM
Contractor PM
DTI
Sign off
Agreed pricing
Contractor PM
DTIe
Sign off
Contractor Document Control
Contractor Document Control
DTIe
Main Document Control
DTIe
WPM
DTIe signed off
WPQS
DTIe signed off
Commercial Manager
DTIe signed off
Client

Figure 0-14 Change process in Project 2

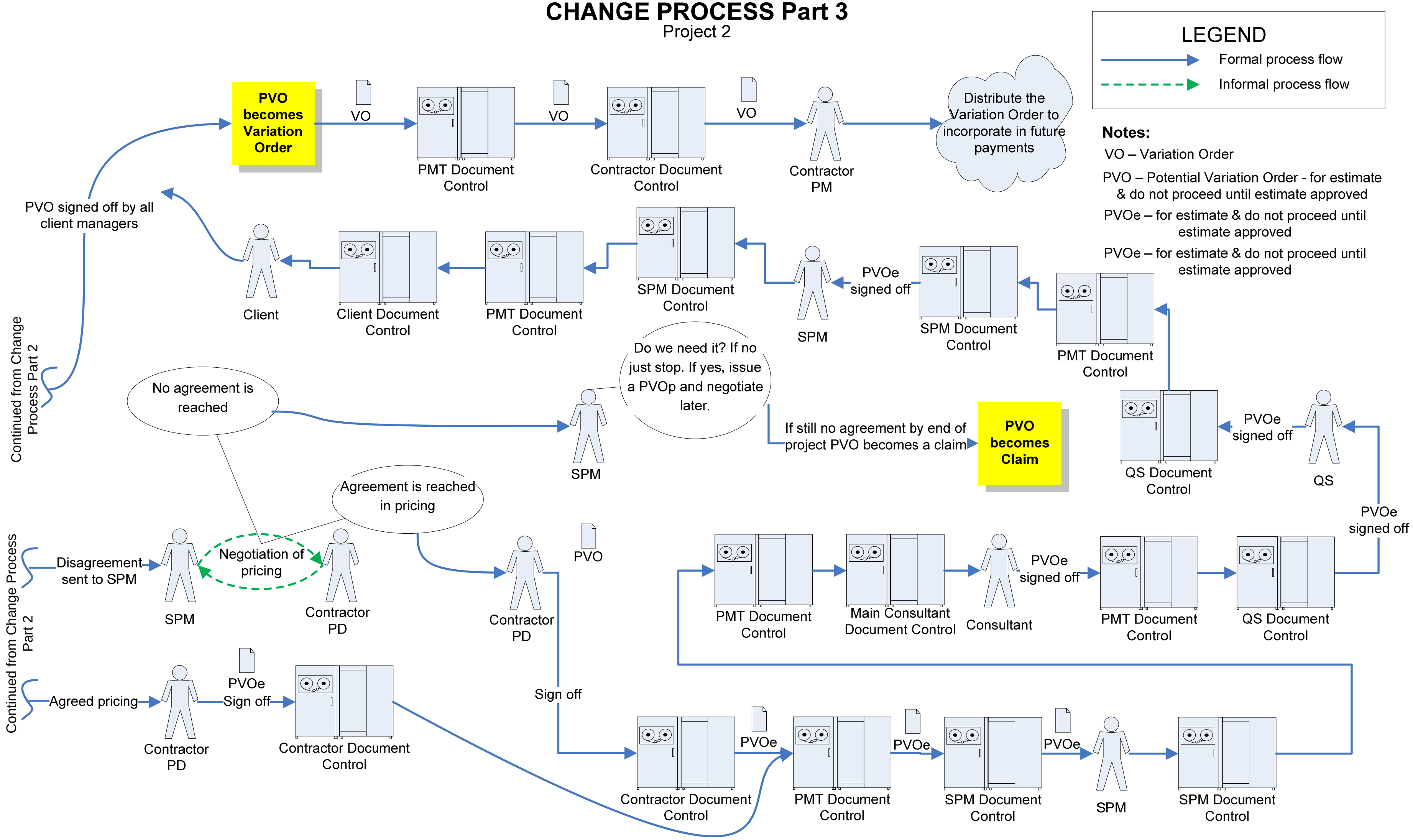




CHANGE PROCESS Part 2
Project 2
LEGEND
Formal process flow
Informal process flow
Notes:
VO – Variation Order
PVO – Potential Variation Order - for estimate & do not proceed until estimate approved
PVOe – for estimate & do not proceed until estimate approved
PVOe – for estimate & do not proceed until estimate approved
Something wrong or clarification
For clarification or correction
Priced PVOp
Priced PVOp
Priced PVOp
Priced PVOp
Priced PVOp
Prepare the price for the change
Contractor PM
Contractor Document Control
PMT Document Control
SPM Document Control
SPM
Price exceeds the budget
Price not agreed after negotiations
QS
Negotiate pricing
Contractor QS
Price agreed after negotiations
Price of PVOp is according to budgeted price
Contractor Commercial Manager
This causes a change in the documents.
PVOp
Submittals
Submittals
Contractor Technical Staff
Contractor's Technical Team
Contractor Document Control
Go through submittal process
Review of PVOp & effects & make necessary changes
Provide site with advance copy of submittals
Perform the work in the PVO
Contractor Site Manager
PVOp
Contractor's Technical Team
PVOp
Advance copy of changes given to site
PVOp is signed off by SPM
PVOp
PVOe signed off
Consultant
PVOe signed off
QS
PVOe signed off
SPM
PVOe signed off
Project Director
PVOe signed off
Client
Continue to Change Process Part 3
Price of PVOe is according to budgeted price
Continued from Change Process Part 1
Contractor Document Control
PVOe
Something wrong or clarification
For clarification or correction
Price exceeds the budget
Price not agreed after negotiations
Contractor Commercial Manager
Prepare the price for the change
Priced PVOe
Contractor PM
Priced PVOe
Contractor Document Control
Priced PVOe
PMT Document Control
Priced PVOe
PMT Document Control
SPM
QS
Negotiate pricing
Contractor QS
Continue to Change Process Part 3

CHANGE PROCESS Part 3

Project 2



A-4 Background of staff of the case study projects

A-4-1 Project 1

The response regarding the technical and managerial qualifications and abilities of the staff was overwhelmingly positive. The staff of all parties in the project was technically and managerially qualified and able to perform the requirements entailed to them as described by the respondents. However, there were complaints of lack of human resources. The lack of human resources was largely due to the construction boom in Dubai. It was further aggravated by new regulations put in place earlier in 2007 for protection of labour rights.

The problems that were voiced were in regards to skilled and unskilled labour and junior staff, including engineers, foremen, etc. There was a noticeable shortage of labour. There were three reasons provided for this:

- The construction boom in Dubai and the high demand for labour resources.
- The regulations put in place and the amnesty provided to illegal workers in Dubai which reduced the supply by 200,000 labour.
- The illegalization of labour supply firms by the authorities due to abuse of labour by these firms.

The above reasons resulted in having lower numbers of labour supply for an increased number of ongoing projects. In addition to the decreased numbers of labour, it also resulted in lower quality of labour because the higher quality labour was scarce. This ultimately resulted in increased wages for labour, especially skilled labour.

The above was valid also for junior staff, in particular engineers, where the construction boom increased demand for junior staff. This increased their wages considerably, and this is also evident in the high turnover in staff during project execution due to what may be termed “job hopping”. This was less evident in senior staff which was more careers oriented.

This has led to a reaction by contractors in particular. The first is to get their own labour supply from overseas by sending representatives to countries like India and Bangladesh with abundant labour supply. This was also in conformance to the new regulations issued in Dubai. The labour brought in was for the company and could not transfer elsewhere without their prior approval. In that regard, they were “stabilizing” this issue. However, getting visas was not very easy, so this was a limitation to contractors.

An additional reaction by contractors was to redesign for reduction of labour. This was evident where precast was favoured over cast in situ concrete and block work. Major redesign efforts were performed and accepted (even encouraged), by the client. The client was aware of this problem and it was in his interest to assist in its resolution.

In regards to the junior staff and engineers’ problem, the client and contractors imported them from overseas. They preferred Westerners despite being more expensive to local hires. It seems that they perceived that they were more capable and stable than local hires. However, there were local hires, but they were not “indispensable”.

A-4-2 Project 2

Project 2 responses completely confirmed the same result. However, unlike Project 1 the client did not have the liberty to hire Westerners, and in the project management firm, there was a high turnover of staff. Due to the small number of staff in the firm this was very obvious and it was a problem for them. In fact, when I first approached the client in regards to the project, the Client Project Director stated that he had a problem there with staff leaving. The main reason most staff left was because they received better offers.

The contractors didn’t have the aforementioned issue. They were at liberty to bring Westerners. And they did. This was particular to the project management firm. Everything else was just confirmation of what was stated in Project 1.

Appendix 6 Letter requesting participation in the research

Position
Company
Dubai, U.A.E.

Date: August 27, 2007

Subject: Request to perform research on project.

Dear Sir:

I am a PhD student at Loughborough University in the United Kingdom. My research topic is information management in construction projects. Dubai was chosen for performing the research due to the high ongoing construction activity and the lack of research in the area.

The research requires interviews with staff of the Client, Consultant and Contractor and will be performed on three case study projects. Enclosed are a copy of the letter from the University and a brief summary of the research along with the main questions to be asked. The project and interviewed staff will remain confidential and the interviews will be used for research purposes only.

With this introduction, I request your permission to perform interviews with various staff of the Client, Consultant and Contractor. The interviews are between one and one and half hours in length based on the pilot study performed. These interviews would be based on a preset schedule and may be performed in parts in order not to disrupt the activities of the staff.

Thank you for your cooperation in this matter.

Should you have any questions or concerns, please do not hesitate to contact me. My contact number whilst in Dubai is 050-4517391.

Best Regards,

Tarek A. Barakat

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Loughborough University Leicestershire LE11 3TU UK
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Loughborough University

Direct Line: +44 (0)1509 228742
Fax: +44 (0)1509 223981
E-mail: A.R.J.Dainty@lboro.ac.uk
http://www.lboro.ac.uk

2nd July 2007

To Whom It May Concern:

This is to certify that Mr. Tarek A. Barakat is a post graduate research student at the university. He is currently performing research on several construction projects in the UAE as part of a programme to achieve a PhD qualification.

Any assistance you may be able to provide him to complete his research will be helpful, and greatly appreciated. His research topic focuses upon information management and how this can be improved for the benefit of the construction industry and its clients. A brief overview of the research is enclosed, along with the general questions that may be asked during taped interviews.

Thank you and should you have any questions please do not hesitate to contact the undersigned at the numbers shown in the letterhead.

Yours sincerely,

ARJ Dainty

Professor A R J Dainty
Research Director

June 05, 2007
Research summary
Rev. 0
Rev.1 (18-06-2007)

1/3

THE QUEEN'S ANNIVERSARY PRIZES
2002 & 2005

Summary of Research

The Research Problem:

The construction boom in UAE has placed a huge strain on the construction industry to complete projects in time and in the required quality. Ironically, the same construction boom has caused a substantial increase in wages for staff, particularly those with a technical background, which are also not readily available. This has caused the construction companies to attempt to reduce the costs by reducing the required staff. This has resulted in loss of efficiency, productivity, and performance due to the fact that each staff is overloaded and the already inefficient information systems used are becoming useless. The lack of coordination and information flow is evident in the projects as per conversations with staff working in the field in both Dubai and Abu Dhabi, where the largest construction activities are ongoing. Projects are unproductive, and ultimately delayed.

Research Aim:

To develop a framework for an information management system that suits the needs and requirements of construction projects in the UAE in order to increase efficiency, effectiveness and performance.

Required participation for research:

The participants in this research should be the following:

- Client, consultant, contractor, main sub-contractors & some of their sub-contractors of the project should be willing to participate in the research
- All staff of all the aforementioned parties should be accessible and willing to participate in the research project.
- All participants should be willing to undergo some semi-structured interviews that will ask questions relevant to the research. (General questions that would be asked are included).

Ethics of the research:

There are some points that are to be addressed for the research by the researcher, which are ethical in nature. These are:

- Confidentiality of the parties: The case study project would be confidential if required by any of the parties to the project. That is the name of the project and the parties would not be disclosed if required by any of the parties.
- Confidentiality of the project: The case study project would be confidential if required by any of the parties to the project. That is, the name of the project and information regarding the project would not be disclosed used other than for research purposes.

- Confidentiality of the persons: No information provided during the interviews will be used for any other purpose other than the research.

Questions for semi-structured interviews:

- Could you provide a brief history of yourself, your experience & your work in the project?
- Could you state what the project objectives are?
- Could you provide a brief history of the project, including what in your opinion is done well or not done well in the project?
- Could you describe the technical & managerial abilities & qualifications of the staff in the project, whether in your organization or outside of it?
- Could you provide an overview of the relations between staff within & outside of your organization?
- Could you provide an overview of the quality of work in the project & any occurrences of rework, as well as examples?
- Could you provide a brief history regarding change orders, variations, claims, & time extensions in the project?
- Could you describe the organization of the project & how effective it is & why?
- Could you describe the communication in the project, including methods, between yourself & the various parties & staff & how effective it is & why?
- Could you describe the current process of information circulation, production & distribution of the work in the project, in particular as relates to your work?
- What are the IT programs used in relation to communication & information transfer within & outside of your organization, in particular those that are used by you to perform your work?
- What do you think you should be done to make the project work better in terms of communication & information, organization, process of work, human resources & IT?

Appendix 7 Letter requesting interviews during execution of the rsearch

Date: July 31, 2007

Subject: Request for participation in research project and interview schedule.

Dear Sir(s):

A PhD research project is embarking regarding information management systems. The research will be performed on three case study projects in the UAE. The project you are in has been chosen as one of the three case study projects. A brief description of the research follows.

The research aim is:

To develop a framework for an information management system(s) that suits the needs and requirements of construction projects in the UAE that would increase their efficiency, effectiveness and performance.

The research objectives are:

- To establish the problem(s) and the objectives to be achieved by the information management systems as perceived by the stakeholders of the various parties in the case studies
- To evaluate the effectiveness of the current information systems in relation to overcoming the challenge inherent in project information. Also, compare with the "problem" expressed
- Develop an information management framework that addresses the problem(s) and achieves the objectives of key stakeholders
- To verify and validate the designed information management system across the projects

To achieve the research aims and objectives, your cooperation is essential, and would be highly appreciated. This cooperation would be in the form of a taped interview lasting between one and one and half hours. Rich picture diagrams would be sketched during the interviews. The interview and respondent will remain confidential and interviews will be used for research purposes only. There is no required preparation for the interview on your part.

I am requesting your participation and permission to perform an interview with you at your work place. A proposed preliminary interview schedule is enclosed. If the time of the interview is not convenient for you, please advise the convenient date and time slot for you to my email at T.A.H.Barakat@lboro.ac.uk or my mobile 050-4517391.

Thank you for your cooperation.

Sincerely,

Tarek Barakat

Appendix 8 Preliminary and final schedule in Project 1

ORIGINAL SCHEDULE

Date/Time	9 am - 11 am	11 am - 1 pm	1 pm - 3 pm
July 26		A-1-Part 1	
July 27			
July 28			
July 29		A-1-Part 2	
July 30			
July 31			
August 1			
August 2			
August 3			
August 4			
August 5	A-2	A-3	A-4
August 6	A-5	A-6	A-7
August 7	A-8	A-9	A-10
August 8	A-11	A-12	A-13
August 9	A-14	A-15	A-16
August 10			
August 11			
August 12	A-17	A-18	A-19
August 13	A-20	A-21	A-22
August 14	A-23	A-24	A-25
August 15	A-26	A-27	A-28
August 16	A-29	A-30	A-31
August 17			
August 18			
August 19	A-32	A-33	A-34
August 20	A-35	A-36	A-37
August 21	A-38	A-39	A-40
August 22			
August 23			

ACTUAL SCHEDULE

Date/Time	9 am-10 am	10 am-11 am	11 am-12 pm	12 pm-1 pm	1 pm-2 pm	2 pm-3 pm	3 pm-4 pm	4 pm-5 pm	5 pm-6 pm
July 26			A-1-Part 1	A-1-Part 1					
July 27/28									
July 29			A-1-Part 2						
July 30									
July 31									
August 1									
August 2									
August 3/4									
August 5	A-2	A-2	A-4 (Part 1&2)		A-4 (Part 3)		A-25	A-25	
August 6	A-3	A-41 (Part 1)	A-6	A-6	A-7	A-7	A-42	A-42	
August 7	A-41(Part 2)	A-8							
August 8					A-13	A-13	A-9	A-9	
August 9	A-17	A-17	A-15	A-15					
August 10/11									
August 12			A-18	A-18	A-19	A-19			
August 13	A-14	A-14	A-21	A-21	A-22	A-22	A-43		
August 14	A-23	A-23	A-16	A-16	A-44	A-44			
August 15	A-26	A-26		A-27	A-27				
August 16		A-29	A-29				A-20	A-20	
August 17/18									
August 19	A-32	A-32	A-45	A-45	A-34	A-34			
August 20	A-46 (Part 1)	A-46 (Part 1)	A-5	A-5	A-47	A-38	A-38	A-28	A-28
August 21	A-24	A-24	A-48	A-48	A-49		A-46 (Part 2)	A-46 (Part 2)	
August 22	A-50	A-50	A-51	A-51			A-52		
August 23	A-12	A-12	A-53	A-53	A-54	A-54	A-55	A-55	
August 24/25									
August 26									
August 27	A-56	A-56							

Note:
1- Total 47 interviews
2- Some interviews were not completed
3- Some interviews were made after original schedule

Appendix 9 Preliminary and final schedules –Project 2

ORIGINAL SCHEDULE

Date/Time	9 am - 11 am	11 am - 1 pm	1 pm - 3 pm
September 6			
September 7			
September 8			
September 9	B-1	B-2	B-3
September 10	B-4	B-5	B-6
September 11	B-7	B-8	B-9
September 12	B-10	B-11	B-12
September 13	B-13	B-14	B-15
September 14			
September 15	B-16	B-17	B-18
September 16	B-19	B-20	B-21
September 17		B-22	B-23
September 18	B-24	B-25	
September 19			
September 20			

ACTUAL SCHEDULE

Date/Time	9 am-10:30 am	10:30 am-12 pm	12 pm-1:30 pm	1:30 pm-3 pm	3 pm-4:30 pm
September 6					
September 7					
September 8					
September 9	B-3	B-2	B-1	B-26	
September 10	B-4	B-5	B-6	B-27	B-28 (Part 1)
September 11	B-9	B-8			B-28 (Part 2)
September 12	B-10	B-11	B-12	B-29	
September 13	B-30	B-14	B-15		
September 14					
September 15	B-31	B-17	B-18	B-32	
September 16	B-7	B-20	B-21	B-33	
September 17	B-13	B-22	B-23	B-34	
September 18	B-24	B-39	B-25	B-40	B-35
September 19	B-36				
September 20	B-37 (Part 1)	B38	B-37 (Part 2)		
September 21					

Note:
1- Total 38 interviews
2- Some interviews were not completed
3- Some interviews were made after original schedule

Appendix 10 Log for Project 1

Nos	Date of Interview	Person Name	Person Position	Person Original Party	Person Current Party	Package of Work	Contract Package Size	Transcript	Organization Chart Sketch	Work Process Sketch	Field & Observ. Notes	Other Documents
1	July 26	A-1		CLIENT	CMT	Line Staff		Done	Done	Done	Done	Part QA/QC
2	August 5	A-2		MAIN CONS	MAIN CONS	Consultant		Done	Done	Done	Done	
3	August 5	A-4		CONT	CMT	Park		Done	Done	Done	Done	
4	August 5	A-25		CLIENT	CMT	Retail Area	Major	Done	Done	Done	Done	
5	August 6	A-3		MAIN CONS	MAIN CONS	Consultant		Done	Done	Done	Done	
6	August 6	A-41		CONT	CONT	Concrete Frame	Major	Done	Done	Done	Done	
7	August 6	A-6		CONT	CMT	Tower & Park	Major	Done	Done	Done	Done	
8	August 6	A-7		SUB CONS	MAIN CONS	Interior designers	Major	Done	Done	Done	Done	
9	August 6	A-42		CONT	CONT	Concrete Frame	Major	Done	Done	Done	Done	
10	August 7	A-8		CONT	CONT	Concrete Frame	Major	Done	Done	Done	Done	
11	August 8	A-13		CONT	CONT	Façade Package	Major	Done	Done	Done	Done	
12	August 8	A-9		CONT	CONT	Precast Pods	Major	Done	Done	Done	Done	
13	August 9	A-17		SUB CONS	MAIN CONS	Landscape		Done	Done	Done	Done	
14	August 9	A-15		CLIENT	CMT	Logistics		Done	Done	Done	Done	
15	August 12	A-18		SUB CONS	MAIN CONS	Consultant		Done	Done	Done	Done	
16	August 12	A-19		CLIENT	CMT	QA/QC		Done	Done	Done	Done	
17	August 13	A-14		CLIENT	CMT	Park	Major	Done	Done	Done	Done	
18	August 13	A-21		CLIENT	CMT	Tower & Park	Major	Done	Done	Done	Done	
19	August 13	A-22		CLIENT	CMT	Line staff		Done	Done	Done	Done	Organ. Chart
20	August 13	A-43		CONT	CMT	Line Staff		Done	Done	Done	Done	
21	August 14	A-23		CONT	CMT	Precast Pods	Major	Done	Done	Done	Done	
22	August 14	A-16		None	CMT	Tower & Park	Major	Done	Done	Done	Done	
23	August 14	A-44		CONT	CONT	Tower & Park	Major	Done	Done	Done	Done	
24	August 15	A-26		CLIENT	CMT	Client Staff		Done	Done	Done	Done	
25	August 15	A-27		CLIENT	CMT	Tower & Park	Major	Done	Done	Done	Done	
26	August 16	A-29		QS Firm	CMT	Park	Major	Done	Done	Done	Done	

Nos	Date of Interview	Person Name	Person Position	Person Original Party	Person Current Party	Package of Work	Contract Package Size	Transcript	Organization Chart Sketch	Work Process Sketch	Field & Observ. Notes	Other Documents
27	August 16	A-20		CLIENT	CMT	Towers & Retail	Major	Done	Done	Done	Done	
28	August 19	A-32		None	CMT	Fitout public areas		Done	Done	Done	Done	
29	August 19	A-45		CONT	CONT	Fitout public areas	Major	Done	Done	Done	Done	
30	August 19	A-34		CLIENT	CMT	Acrylic Panels	Major	Done	Done	Done	Done	
31	August 20	A-46		CLIENT	CMT	Park Area	Major	Done	Done	Done	Done	
32	August 20	A-5		QS Firm	CMT	Line Staff		Done	Done	Done	Done	
33	August 20	A-47		CONT	CONT	Fitout public areas	Major	Done	Done	Done	Done	
34	August 20	A-38		CONT	CMT	Structural Steel		Done	Done	Done	Done	
35	August 20	A-28		CONS	CMT	Façade Package	Major	Done	Done	Done	Done	
36	August 21	A-24		None	CMT	Tower	Major	Done	Done	Done	Done	
37	August 21	A-48		CONS	MAIN CONS	Consultant		Done	Done	Done	Done	
38	August 21	A-49		None	CMT	Line Staff		Done	Done	Done	Done	
39	August 22	A-50		CONT	CONT	Tower & Park	Major	Done	Done	Done	Done	
40	August 22	A-51		SUB CONT	CONT	Fitout public areas	Major	Done	Done	Done	Done	
41	August 22	A-52		None	CMT	MEP Package	Major	Done	Done	Done	Done	
42	August 23	A-12		CLIENT	CMT	Line Staff		Done	Done	Done	Done	
43	August 23	A-53		CONT	CONT	Restaurant Fitout	Major	Done	Done	Done	Done	
44	August 23	A-54		MAIN CONS	MAIN CONS	Consultant		Done	Done	Done	Done	
45	August 23	A-55		None	CMT	Tower & Park	Major	Done	Done	Done	Done	
46	August 27	A-56		CONT	CONT	Interior Design	Major	Done	Done	Done	Done	

Appendix 11 Log for Project 2

Nos	Date of Interview	Person Name	Person Position	Person Party	Package of Work	Contract Package Size	Transcript	Organization Chart Sketch	Work Process Sketch	Field & Observ. Notes	Other Documents
1	September 9	B-3		PMT	Area 1	Major	Done	Done	Done	Done	
2	September 9	B-2		PMT	Area 2	Major	Done	Done	Done	Done	
3	September 9	B-1		PMT	Line Staff		Done	Done	Done	Done	Organiz. Chart
4	September 9	B-29		PMT	Towers	Major	Done	Done	Done	Done	
5	September 10	B-4		CONS	Area 2	Major	Done	Done	Done	Done	
6	September 10	B-5		CONS	Area 2	Major	Done	Done	Done	Done	
7	September 10	B-6		PMT	Area 2	Major	Done	Done	Done	Done	
8	September 10	B-27		CONS	Consultant	Major	Done	Done	Done	Done	
9	September 10	B-28		PMT	Line Staff		Done	Done	Done	Done	QA/QC
10	September 11	B-9		PMT	Area 1	Major	Done	Done	Done	Done	
11	September 11	B-8		CONS	Area 1	Major	Done	Done	Done	Done	
12	September 12	B-10		CONS	Mall	Major	Done	Done	Done	Done	
13	September 12	B-11		CONS	Mall	Major	Done	Done	Done	Done	
14	September 12	B-12		CONS	Mall	Major	Done	Done	Done	Done	
15	September 12	B-29		PMT	Line Staff		Done	Done	Done	Done	
16	September 13	B-30		CONT	Area 2	Major	Done	Done	Done	Done	
17	September 13	B-14		CONT	Area 2	Major	Done	Done	Done	Done	
18	September 13	B-15		CONT	Area 2	Major	Done	Done	Done	Done	
19	September 15	B-31		CONS	Area 1	Major	Done	Done	Done	Done	
20	September 15	B-17		CONT	Area 1	Major	Done	Done	Done	Done	Organiz. Chart
21	September 15	B-18		CONT	Area 1	Major	Done	Done	Done	Done	
22	September 15	B-32		CONT	Area 1	Major	Done	Done	Done	Done	
23	September 16	B-7		CONT	Area 2	Major	Done	Done	Done	Done	
24	September 16	B-20		CONT	Area 2	Major	Done	Done	Done	Done	QA/QC
25	September 16	B-21		CONT	Area 2	Major	Done	Done	Done	Done	
26	September 16	B-33		CONT	Towers	Major	Done	Done	Done	Done	
27	September 17	B-13		CONT	Area 2	Major	Done	Done	Done	Done	
28	September 17	B-22		CONT	Area 2	Major	Done	Done	Done	Done	
29	September 17	B-23		CONT	Area 2	Major	Done	Done	Done	Done	

Nos	Date of Interview	Person Name	Person Position	Person Party	Package of Work	Contract Package Size	Transcript	Organization Chart Sketch	Work Process Sketch	Field & Observ. Notes	Other Documents
30	September 17	B-34		CONT	Towers	Major	Done	Done	Done	Done	
31	September 18	B-24		CONT	Towers	Major	Done	Done	Done	Done	
32	September 18	B-39		PMT	Area 2	Major	Done	Done	Done	Done	
33	September 18	B-25		PMT	Area 2	Major	Done	Done	Done	Done	
34	September 18	B-40		PMT	Towers	Major	Done	Done	Done	Done	
35	September 18	B-35		PMT	Towers	Major	Done	Done	Done	Done	
36	September 19	B-36		CONS	Towers	Major	Done	Done	Done	Done	
37	September 20	B-37		CONS	Towers	Major	Done	Done	Done	Done	
38	September 20	B-38		CONS	Towers	Major	Done	Done	Done	Done	

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