DEVELOPING A STRATEGY-LED APPROACH AS A SUITABLE METHODOLOGY FOR CONSTRUCTION PROJECT PLANNING AND IMPLEMENTATION

Chamila Dilhan Dushantha Ramanayaka

A thesis submitted to

Auckland University of Technology

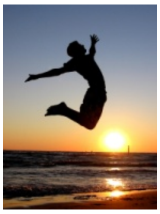
in fulfilment of the requirements for the degree of

Doctor of Philosophy (PhD)

2013

Construction Management Programme
School of Engineering
Faculty of Design and Creative Technologies

Dedication



"For the homeless boy who taught the best lesson to my life"

Table of Content

List of Figures

List of Tables

List of publications

Ramanayaka, C., & Rotimi, J. (2011, 5-7 September). Strategy: Towards its applicability for successful project delivery. In C. Egbu & E. C. W. Lou, Symposium conducted at the meeting of the Association of Researchers in Construction Management (ARCOM) 27th Annual Conference, University of the West of England, Bristol.

Ramanayaka, C., & Rotimi, J. (2012, 4- 6 July). Strategy-led Construction: Success Through a Human-Centred Approach. In I. Kamardeen, S. Newton, B. Lim, & M. Loosemore, Symposium conducted at the meeting of the 37th Annual Conference of Australasian University Building Educators Association (AUBEA), University of New South Wales.

Ramanayaka, C., & Rotimi, J. (2012, 10-13 September). Reflective Practice: Scoping its applicability for successful construction project delivery. In D. Kashiwagi & K. Sullivan, Symposium conducted at the meeting of the RICS COBRA 2012, Construction, Building and Real Estate Annual Conference, Las Vegas, Nevada.

Ramanayaka, C., & Rotimi, J. (2013). Scoping the applicability of Reflective Practice and Technical Rationality for successful construction project delivery, Paper submitted for reviewing to the *Journal of Civil Engineering and Environmental Systems.*

Attestation of Authorship

"I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning."

Signature: ………………………….   Date: 02/10/2013

(Chamila Ramanayaka)

Acknowledgement

My wholehearted thanks belong to three mums and three dads who are my gods and goddesses in this life. The love and care given by six of you makes it difficult for me to separate godparents from biological parents. Only a very few can talk about parents in plural as ‘mums’ and ‘dads’, and I am lucky to be among those few. Thanks for the four sisters from three mums; you are the best girls I can ever have in my life.

Without my supervisor, Dr James Rotimi, I certainly could not have done this job. You have done an unimaginable job to make my future successful while letting me to think freely. The pain that James is given and the support I am given are both beyond measures. I cannot pay back James for trusting me without knowing my strengths and weaknesses at the beginning, which ultimately led me to accept his supervision when I was facing issues to find a primary supervisor. My sincere thanks are extended to my secondary supervisor, Dr John Tookey, for miscellaneous support given.

I would like forward my sincere thanks for Fletcher Construction for awarding a scholarship for three years to progress with this study. I cannot skip one person here, Associate Professor Abeysekara, for helping me a lot to get that award. My thanks go to the School of Engineering and AUT post graduate centre, especially to Kath, Lesley, Armida, David Parker, Ken Hyde and Annette for their miscellaneous support.

During the field investigation, New Zealand Institute of Building (NZIOB) and AGM publishing, NZ were enormous supportive to find out the contact information of the NZIOB award recipients. The assistance given by construction companies in NZ to distribute the questionnaire and the participants’ dedication to provide information should be accredited. Arrow International, Fletcher Construction, Aspec Construction, Dominion Construction, Hawkins Construction, Kalmar Projects, Mainzeal Property & Construction, Multiplex Construction and Brookfield Multiplex NZ are some of the construction companies made their contribution towards this research study

There is always someone beside me and who is called a friend. Unless there are two universally accepted definitions for friends and brothers, you are not my friends ever. Describing how important you are is the worst job I can do in this life, but this quote is the best attempt to explain my thoughts to you.

“Lots of people want to ride with you in the limo, but what you want is someone who will take the bus with you when the limo breaks down” - Oprah Winfrey

If I put all your names here, the list would have been longer than this thesis of 300+ pages. But, there are a few names which my heart does not allow to skip here who are Adil, Nisha, Chanaka, Gimhana, Sathsara, Churanaga, Sanne, Kasim, Posa, Kanishka, Jiku, Ricky, Michael, Hemal, Vidhu, Sami, Paul, Steve and so many others left from A-Y. Because of you guys, I cannot find a brotherly friend only from one letter, ‘Z’.

Next, I would thank my two Grade 5 teachers at Hidellana Junior School, Palitha and Chandralatha, from the bottom of my heart, for their ceaseless focus to get me through the Grade 5 scholarship with top marks, which ultimately helped me to continue my secondary and high school life in Sivali Central College; nowhere can be a better place than my high school. When I write about my high school, trust me, my heart beats unceasingly faster. Special thanks to my high school class teacher, Swarana, for her limitless tolerance towards teenage rebellious behaviours.

Next, I pay my gratitude to my college lectures at the University of Moratuwa that comprehend my Engineering knowledge and enhance interest of being a researcher in the field of Engineering. I would like to forward my special thanks to Professor Chintha and Professor Jayasinghe for endless support during my undergraduate time and Professor Dias as well as Samith Jayakodi for supportive and constructive opinions to shape up my initial thoughts towards this doctoral program.

Further thanks extended to the colleagues of the School of Engineering, AUT, for kicking away obstacles and walking through this journey together. Support given by Andy for proofreading my thesis is remarkable. I could finish on time with the very tight schedules I had because of your support. I would pay my gratitude for Asiri and Thilina for recommending Andy as the proof-reader. Special thanks go to Sampath, Asiri, Ralph, Thanuja, Nimesha and Rajeev for numerous help throughout the programme.

Finally, I would like to pay my gratitude for all successful celebrates who were not scared to reveal their true stories to the world. When I was writing my thesis at the hardest time of my life, your life stories convinced me that there are similar stories everywhere behind success.

‘We see stars most clearly when there is no moon at all’

Abstract

Successful project delivery is somewhat elusive because project failures in terms of cost overruns, time delays and quality failures have become common far and wide contributing to low productivity statistics. The evolvement of management philosophies has shown that real world situations are complicated involving qualitative and quantitative features, and hence mathematics and science cannot provide adequate solutions effectively by their own. To enhance decision making through heuristic procedures, several efforts are described in literature including the development of advanced database software packages and computer aided design such as the use of artificial intelligence. However, these solutions are inadequate to mitigate construction failures due to their inadequate capacities and hefty investment amounts. Under these circumstances, some scholars suggest that the development of a strategy-led approach is the only viable solution for construction project planning.

Therefore, throughout this doctoral study, the aim is to investigate what strategic approach could be suggested for planning and implementation to successfully deliver construction projects that ensure achievement of the desired outcomes. To investigate the suitability of the strategy-led approach, this research study employs 'critical multiplism', in which different research methods are used and the results of each method are finally triangulated. These research methods include the review of literature, an archival analysis of the Construction Manager Year Award (CMYA) statements provided by the Chartered Institute of Building (CIOB), UK, a questionnaire survey to recipients of New Zealand Institute of Building (NZIOB) achiever awards, and interviews with recognized subject matter experts.

The results of the data analysis showed that the strategy-led approach to planning and implementation can effectively cope with complexity, dynamism, uncertainty and uniqueness of construction projects. Further, significant relationships were found between the influence of strategies towards critical success factors and project success in terms cost, time, quality and overall success. The research study found that the strategy-led approach would involve a combination of technical rationality and reflective practice, which construction project managers should apply in planning and implementing projects.

The research gives useful recommendations which could facilitate successful delivery of construction projects. The strategy-led approach suggested by this research study is a combination of construction project strategies and traditional planning tools where generative versus rational, spontaneous versus deliberate and transformational versus revolutionary

typologies are used as a combination in an appropriate way. It is hoped that these recommendations could improve the reliability of construction project planning approaches so that failures due to increasing complexities and uncertainties can be avoided successfully.

Chapter 1. Introduction

1.1 Background

Construction project failures have recently become widespread due to increasing complexities and uncertainties associated with project implementation (Wong & Ng, 2010). Although in earlier studies, time extension, cost overruns as well as inability to satisfy predetermined performance criteria were considered as indications of project failures, in recent years cost and time overruns are commonly reported at the completion of construction projects. Thus, the criteria considered in past to indicate project success are no more valid to measure performance on construction project failures (Ganaway, 2006; Sambasivan & Soon, 2007). Complexity, dynamism, uncertainty and uniqueness are a few characteristics of construction projects and pose challenges to a successful project delivery.

The construction industry is recognized as one of the most vulnerable sectors that requires innovative solutions to minimize high frequency of project uncertainties (Sriprasert & Dawood, 2002). The context of construction projects are dynamic (Hegazy & Menesi, 2010) and hence the supply chain characteristics are different from many other industries. The production manager usually handles a stable workforce in a repetitive work environment (Fryer, 2004). In construction, every new project poses unique challenges and involves a high degree of uncertainty around construction project planning and implementation (Long & Ohsato, 2007). Decision making and problem solving are therefore difficult. Consequently, reliable planning approaches are required to gather and analyse information carefully and accurately (Fryer, 2004). This research study reflects on the following question:

> ***'Have previous studies explored adequate solutions which construction project managers could employ to achieve successful construction project deliveries?'***

Review of literature provides evidence of studies that focus on the avoidance of project failures by emphasizing on the definition of success as well as methods to ensure it (Hegazy & Menesi, 2010; Pinto & Covin, 1989; Sambasivan & Soon, 2007). Sometimes, resolutions are suggested through the development of sophisticated micro-computer solutions such as nD modelling and artificial intelligence (Kumar, 2002). Notwithstanding these attempts, construction project failures, to varying extents, are predominant (Wong & Ng, 2010). Under these circumstances, an important factor for achieving construction project success is suggested, which is to develop early stage strategies and philosophies (Price & Newson, 2003).

Although strategies have been suggested for the industry at the project implementation level, strategic model developments are still relatively new for the industry (Betts & Ofori, 1992; Kassab, Hegazy, & Hipel, 2010). Some strategic concepts (such as Porter's (1985) competitive advantage) are introduced to the construction industry at the corporate level, yet those suggestions have not been implemented (Betts & Ofori, 1992). Because construction projects are unique in nature (Long & Ohsato, 2007), the current study assumes that project level strategies are more appropriate to the construction industry than corporate level strategies.

Similarly, the applicability of project level strategies is emphasized by past scholars (Abeysekera, 2007; Wong & Ng, 2010). Another reason of the suitability of project level strategies is the risk associated with strategies. Thomson, Strickland & Gamble (2007) emphasize that strategies are not exact rules and, consequently, can go wrong. The current study postulates that project level strategies could be tested at the activity level thus revealing success/ failure sooner than corporate level strategies, and hence more easily and effectively adjusted or replaced.

Therefore, this research study focuses to develop a strategy-led approach as a more suitable planning tool for construction project delivery. The strategy-led approach that is investigated by this study will complement conservative planning algorithms which are currently used to plan and implement construction projects. The complementary planning approach intends to minimize the inadequacies associated with traditional planning approaches. Some of the inadequacies are:

- Traditional planning tools are not capable of providing adequate solutions under complexities (Kassab et al., 2010), i.e. situations that cannot be captured by theoretical formulations (Dias & Blockley, 1995; Winch, 2010). Dias (2002) emphasizes that the most important constraints such as social and political issues related to construction project implementation are difficult to be modelled and solved through engineering science, which is the base of current planning methodologies. Therefore, the complementary planning approach intends to provide direction to plan and implement construction projects under complex and uncertain conditions where problem clarification and solution derivation are not straightforward.

- Lu and Lam (2008) articulate that traditional planning tools are based on reductionist approaches. Reductionism makes it difficult to satisfy multiple requirements in construction project implementation. However, successful construction project delivery needs to achieve more than one objective such as completion on time, within budget and meeting quality requirements (Chan, Scott & Lam, 2002). Thus, the need of the complementary planning approach is to clarify construction project implementation issues in a holistic manner.
- Tacit knowledge comes from practitioners' experience and artistry and unlike the explicit knowledge that can be captured by engineering theories and science (Kinsella, 2007; Schon, 2001). Both tacit and explicit knowledge should be used effectively to provide adequate solutions to construction project implementation issues (Bourne & Walker, 2005; Walker, 2007). The complementary planning approach is to enable the construction project managers to include their tacit knowledge, effectively.
- Nomothetic theories hinder the ability to consider specific characteristics of a construction project, and consequently, plans and schedules become unrealistic (Rand, 2000). Planning without considering the context may lead to the implement of ineffective actions (Schon, 1992). Thus, this complementary planning method is supposed to integrate project context into construction project planning.

Considering these requirements, strategies should be able to bring the characteristics of reflective practice (RP), such as holism, reflective interaction, context-dependency and practitioner-dependency, into construction project planning(Schon, 1992) to become a viable planning approach to plan and implement construction projects. Thus, the limitations of reductionism, selective inattention, context-independency and practitioner-independency, which are the characteristics of technical rationality (TR), underpinning traditional planning tools can be overcome (Dias & Blockley, 1995).

This background in the domain of construction project planning and implementation, the strategy-led approach will be developed out of successful practices of past projects. Construction projects which are delivered with successful outcomes in terms of time, cost, quality and client satisfaction, in addition to overall success, will be the objects of this research study. Construction projects that are considered in the analysis of this study have already been evaluated and recognized by professionals within the construction industry to be successful enough to merit industry recognition. Throughout the current study one question is consistently addressed:

> ***'What strategic approach could be suggested for planning and implementation to successfully deliver construction projects that satisfy the desired outcomes?'***

1.2 Statement of the Problem

Regardless of the particular economic, social, political and cultural environments in which construction projects are executed, project failures and corresponding company failures in the construction industry are widespread all over the world. Related to the company level, Ganaway (2006) has found that newly started construction companies in the US struggle for their survival, and eventually 57% of them declare bankruptcy within the first four years of operations. Literature review generally indicates that project level failures are prevailing. In Saudi Arabia, construction projects suffer time overruns of up to 30% (Assaf & Al-Hejji, 2006). Similar observations are reported in Jordan (Al-Momani, 2000). Chan and Kumaraswamy (1997) investigated 83 factors that cause construction project failures in Hong-Kong. There are many other studies investigating construction project failures. Similarly, time and cost overruns of high-rise building projects in Indonesia indicate productivity issues in the construction industry (Kaming, Olomolaiye, Holt & Harris, 1997). Sambasivan and Soon (2007) emphasize the cause and effect relationships of construction project failures in Malaysia. In the context of NZ construction industry, Zheng (2007) has found construction project delays, and additionally, Cunningham (2010) found that the productivity curves of NZ construction industry tend to be flat or declining indicating need for improvements.

As a cause for project failures and low productivity, the ineffectiveness of traditional construction planning methodologies to support today's project characteristics of the industry have been recognized (Sriprasert & Dawood, 2002). Authors usually describe construction projects as complex (Fryer, 2004), dynamic (Wong & Ng, 2010), uncertain (Winch, 2010) and unique (Fallah, Ashtiani, & Aryanezhad, 2010). These four key project characteristics influence the primary objectives of construction projects: cost, time and quality parameters (Smith, Merna, & Jobling, 1999). Further, these key project characteristics are recognized as the reason to demand innovative strategies for construction project planning in addition to the use of traditional planning tools (Fryer, 2004). Fryer (2004) supports innovative planning approaches articulating that there is no single way to carry out processes in an uncertain construction project context. Innovative planning approaches should be able to consider project context in terms of size, task, technology, achievements, prevailing conditions and organizational characteristics (Fryer, 2004). To handle complexities and uncertainties, practitioners should identify opportunities and risks associated with a construction project context in advance (Abeysekera, 2007). Wong and Ng (2010) and Kumar (2002), both emphasize that strategy application is the most promising way to handle dynamic situation within the context of construction project planning and implementation. Abeysekera (2007) suggests that a strategy-led approach should be developed to plan and implement construction projects.

Strategies could be defined in several ways according to their particular purpose (De Wit & Meyer, 2004). In the context of construction project implementation, strategic developments are relatively low and hence authors emphasize the importance of developing strategic concerns to plan construction projects (Abeysekera, 2007; De Wit & Meyer, 2004). Ofori (1990) opines that the relative simplicity of the construction industry compared to other industries has hindered strategic development in construction management discourses, but what Ofori (1990) means by simplicity seems to be controversial when other scholars' views are considered. From the 1950s' on, the construction industry is recognized as complex in the evolvement of construction project management (Fryer, 2004). De Wit and Mayer (2004) encourage researchers to evaluate strategies through the three dimensions of strategy process, content and context. The current study believes that investigations around these three dimensions can help to define what a strategy-led approach is in the domain of construction project planning and implementation.

Traditional planning techniques are criticized for their limited scope focussing on schedule performance only. In industry practice, schedules in construction project implementation should have more holistic considerations (Belassi & Tukel, 1996). Kumar (2002) suggests that strategies can have several considerations in addition to the development of schedules, thus improving construction project planning and implementation as a whole. Price and Newson (2003) further exhibit how the entire scope of construction project planning and implementation could be represented by using critical success factors.

Critical success factors represent the nature of construction projects as well as the interests of project stakeholders (Belassi & Tukel, 1996). There are some critical success factors which relate resource availability and external factors to construction project planning and implementation (Price & Newson, 2003). Further, past research studies have focused on creating interrelationships among critical success factors to explain how they combine to determine project success or failure (Kumaraswamy & Chan, 1998). In addition to these developments, approaches to improve critical success factors need to be evaluated. Therefore, this research study assesses the suitability of construction project implementation strategies to improve critical success factors, and to avoid the risk of project failures. A number of studies on developing scheduling techniques have recognized these employed planning methods as sub-optimal (Belassi & Tukel, 1996; Mensi, 2010), but there are no studies that considered the scope of construction project strategies (Abeysekera, 2007).

Kumar (2002) suggests using strategies to plan and improve critical concerns in the domain of construction project planning and implementation. This investigation is needed to determine the requirements elevating strategies over other planning approaches to become a suitable planning method.

Many of the critical concerns Kumar (2002) mentions cannot be described through theoretical formulations. For example, many of the socio-economic concerns related to construction projects cannot be diagnosed through engineering or science (Dias & Blockley, 1995). Inability to solve real world issues that cannot be described through theoretical formulation is known as 'selective inattention' and is one of the characteristics of technical rationality (TR).

Many planning algorithms that are widely used in construction planning are based on TR. For example, Lu and Lam (2008) articulate that critical path method (CPM) does not have the ability to jointly consider resource constraints and timely achievements. Consequently, CPM is based on reductionism where problems are solved by dividing the whole into parts without considering interrelationships between those parts. Dias (2002) articulates that parts can never represent the whole unless interrelationships are considered. Further, many traditional planning algorithms like PERT and CCPM use mathematical techniques (such as probability) to cope with uncertainties without considering the project context and practitioners' subjective interpretations based on their tacit knowledge (Long & Ohsato, 2007). Because of the association of traditional planning approaches with TR characteristics, these methodologies are not effective to plan and implement construction projects under complex and uncertain situations. Schon (1992) was one of the early proponents of RP, defending the position that RP can clarify problems through reflective interaction by bringing contextual background into planning in a holistic manner (Dias & Blockley, 1995).

Several heuristic procedures are suggested in literature to support decision making through reflective interaction such as decision support system developed by Kassab et al (2010), the innovative critical chain method (Zhao, You, & Zuo, 2010) and artificial intelligence (Dias, 2002). Yet, these costly solutions have generally been unsuccessful in curbing failures in the construction industry (Abeysekara, 2007; Kumar, 2002). High cost associated with these micro-computer applications is recognized as a reason to make them impracticable (Kumar, 2002), but more importantly, these micro-computer solutions cannot replace human intervention (Boussabaine, 1996; Rand, 2000). Underhill (1999) emphasizes that computer-based heuristic procedures are greedy algorithms. Therefore, for the construction industry, decision making and problem solving and thus successful outcomes depend on humans actions in projects, not on micro computer solutions (Fryer, 2004; Kumar, 2002; Rand, 2000). However, philosophical changes are required to turn humans into effective practitioners to find more reliable solutions (Dias, 2002; Schon, 1992; Winch, 2010). Therefore, in addition to investigating the influence of strategies toward construction project implementation, this research study evaluates whether the strategy-led approach can integrate characteristics of RP nature into construction project planning and implementation.

Through the aim, objectives and research questions of this study, a complementary strategy-led planning tool is expected to be developed providing reliable solutions to complex and uncertain situations by eliminating TR deficiencies associated with traditional planning tools.

1.3 Statement of Research Aim, Objectives and Research Questions

The research aims at developing a strategy-led approach as a tool for construction project managers to successfully plan and execute construction projects. The study will investigate strategy-led approaches as a suitable practice to minimize drawbacks in traditional project planning practices within the ambit of construction project implementation.

The objectives pursued throughout the study are as follows:

1. To identify what constitutes success and failure of construction projects. This objective helps to identify the most appropriate measures of success which the current study should focus on. Further, under this objective, the current study is set its goal to identify areas of interests that a suitable planning approach should focus on in order to achieve success in terms of identified measures. These areas are needed to be identified before the field investigation commences. This objective is achieved by means of a literature survey and preliminary investigations.

2. To recognize the contributory role of the construction project manager in achieving project success or avoid project failures, with particular emphasizes paid to strategy crafting and implementation. This objective supports identification of the most suitable stakeholder to provide information on construction project implementation strategies and to select the participants for the field investigation. The second objective is reached through literature review and preliminary investigation.

3. To investigate the drawbacks of traditional planning practices related to construction project planning and implementation. Since the current inquiry focuses on finding a complementary strategic approach to planning algorithms, the strategy-led approach should be able to provide solutions to drawbacks of current approaches. Drawbacks are identified by reviewing past literature; the suitability of strategies to resolve them is evaluated in the preliminary and primary investigations.

4. To develop the theoretical framework of the study representing conceptual relationships between the characteristics of construction projects, nature of issues in project implementation, construction project strategies, nature of those strategies and success measures. Based on the problem identification through literature reviews and preliminary investigation, the theoretical framework is employed in the primary investigation.

5. To propose a strategy-led approach for adoption by project managers in the form of a suitable practice to deliver construction projects with

successful outcomes. With this objective, the research study defines what strategy-led approach is by investigating the influence of strategies on construction project implementation and determining dimensions of strategies within the context of construction projects. The objective is achieved through literature review, and preliminary and primary investigations.

These five objectives have led this study to develop the following research questions.

1. What is the scope of construction project planning in order to achieve a successful project delivery (Objective 1)?
2. What are project managers' roles in construction project planning and delivery under a strategy-led approach (Objective 2)?
3. Which approaches of reflective practice (RP) and technical rationality (TR) could ensure success on construction projects and what is the efficiency of traditional planning algorithms to support each paradigm (RP and TR) (Objective 3)?
4. Could a strategy-led approach be developed for successful project planning and execution (Objective 5)?
5. What are successful project delivery strategies that project managers could use to deliver construction projects successfully in terms of strategy process, content and context (Objective 5)?
6. What are the reasons to use the strategy and where is it applicable (Objective 5)?

1.4 Scope

This research study belongs to the domain of construction project planning. The focus of this study is to evaluate the use of construction project strategies to improve problem solving during project implementation. In this research study, four project characteristics, which are complexity, dynamism, uncertainty and uniqueness, were selected as challenges to successfully implement construction projects over other factors such as responsiveness or susceptibility of projects to environemental dynamics. To improve problem solving vis-à-vis these four characteristics that make traditional project planning algorithms ineffeicient or inappropreate is the reason to develop the strategy-led approach in the ambit of construction project planning and implemnatation.

The ultimate aim of the strategy-led approach is to improve project success in terms of cost, time, quality, client satisfaction.

The study viewed project success from the perspectives of the construction project manager. Construction project strategies, extent of project characteristics as well as stakeholder contributions were evaluated mainly using the construction project manager's points of view. In addition, other industrial evaluations were considered to select successful projects. As the third-party involvement, the Chartered Institute of Building (CIOB), UK and New Zealand Institute of Building (NZIOB) were considered to select successful projects and expert construction project managers. It was assumed that construction project managers are the most appropriate stakeholder to provide information about construction project implementation strategies.

This study considered construction project planning and implementation from the conceptual stage until the projects are handed over to the owner. The conceptual stage is considered with respect to the contractor's involvement. The pace of project progress before contactor's involvement was not considered under the scope of this study.

This research investigation was mainly carried out by participation of the NZIOB award winners who are construction project managers recognized as experts based on the performance in an individual project completed within NZ. For the preliminary investigation, this study employed the Construction Manager of the Year Award (CMYA) recipients who are recognized by the CIOB, UK, based on their performance in a construction project completed in the UK.

1.5 Research Methods

This research study employs 'critical multiplism', in which different research methods are used and the results of each method are finally triangulated to corroborate findings (Guba & Lincoln, 2005). The research therefore includes both quantitative and qualitative research methods at the data collection and analysis levels.

The study uses archival information provided by the CIOB in the UK on the award winners for the preliminary investigation. These sources of qualitative information are analysed by using both quantitative and qualitative methods such as frequency counts and content analysis, respectively. For the primary investigation stage of this study, a questionnaire survey is used.

In the questionnaire survey, the award winners of NZIOB are requested to provide their responses both for open-ended questions and predetermined closed-ended questions. These open-ended questions are analysed by using content analysis, while the closed-ended responses are analysed through the use of extensive statistical methods including both descriptive and inferential statistical analyses. To test the conceptual relationships made under the third objective of this study, 95% confidence level is used for the inferential statistical analyses.

The findings of the archival analysis and the questionnaire survey are finally validated through semi-structured interviews with subject matter experts (SMEs) who are requested to provide their opinions on construction project strategies and procedures to use those strategies to improve construction project planning and implementation.

1.6 Organization of Thesis

As shown in Figure 1.1, there are four major parts constituting this research study. The first stage is the problem identification consisting of statements of the problem (chapter 1.), literature review (chapter 2.) and archival analysis (chapter 5.). The next stage of this research study is to collect and analyse data, which is done in the theoretical framework (chapter 3), research methodology (chapter 4), result and presentation of the findings (chapter 5), and the SME validation interviews (chapter 6). Chapter 7 is related to the third stage of the research study, which is research synthesizing. The last part of this research study is the conclusion where descriptions are given in chapter 8.

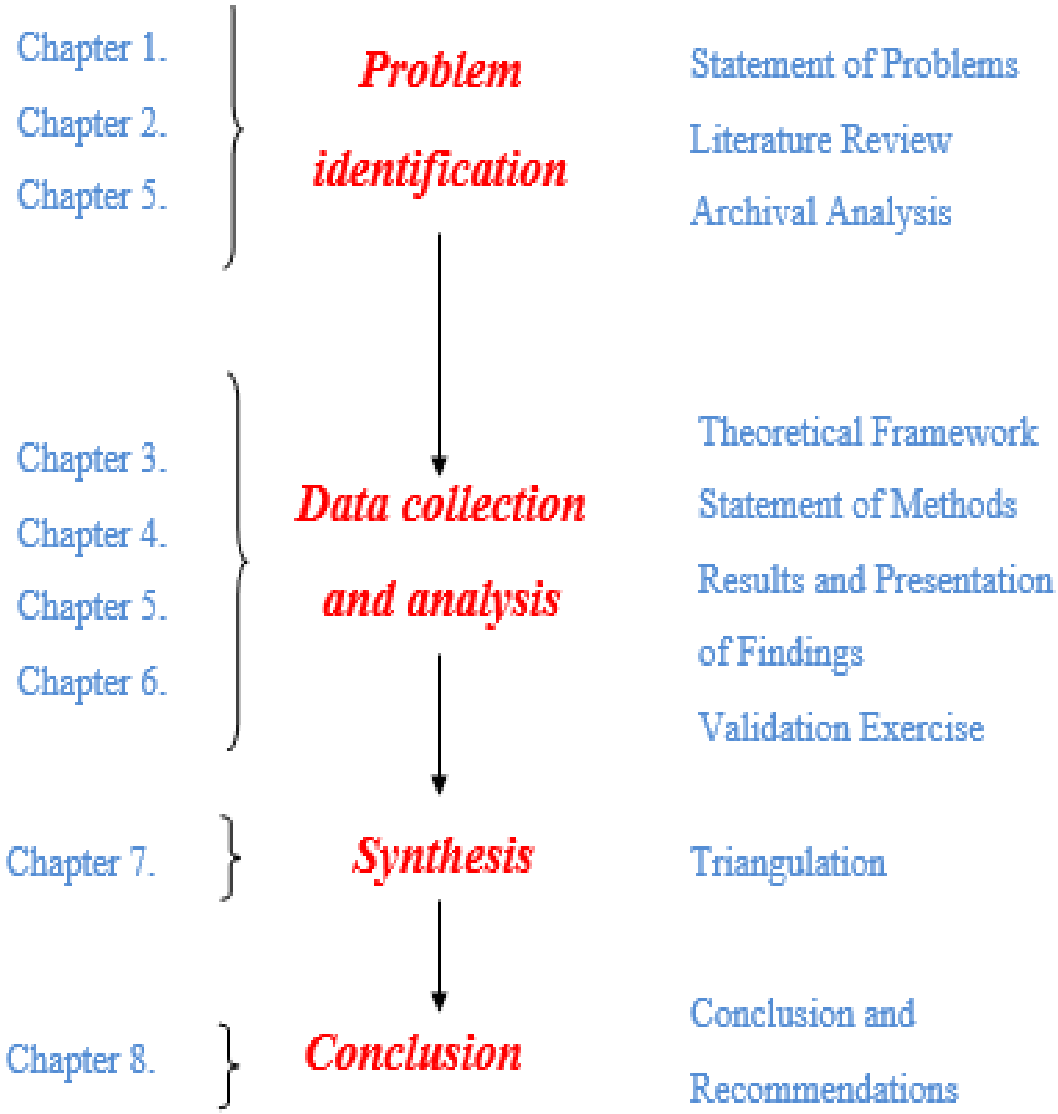


Figure 1.1: Outline of the thesis

Chapter 1 provides an introduction to this research study. In this chapter, background information related to construction project planning and implementation is discussed to articulate the significance of the research problem. The chapter justifies the requirement to carry out this research study based on the results of previous studies in the ambit of construction project management. The focus of this research study is described by using aim, objectives and research questions. Further, the chapter provides the scope and limitations of this research study.

Chapter 2 is an extensive review of past literature to identify the research problem for this research. Past literature associated with project success, construction project characteristics, strategies and traditional planning tools are reviewed to recognize research gap related to construction project implementation strategies.

Chapter 3 describes the theoretical framework of this study. This chapter provides a coherent perception about the relationships among the variables that this research study investigates. This chapter describes the conceptual relationship between strategy, project characteristics and project success. Further, it discusses hypothetical constructs, which can be used to explain strategy-led approach in terms of the three dimensions process, content and context.

Chapter 4 describes the research methodology. This chapter positions this research study in relation to research paradigms. Further, it describes the use of a mixed method approach in the current study to employ both, quantitative and qualitative, methods to comprehend the research findings. The chapter provides direction toward data analysis techniques. Finally, this chapter justifies that this research study is carried out in accordance with Auckland University of Technology Ethics Committee.

Chapter 5 presents the findings and results of both preliminary and primary investigation. The findings of the preliminary investigation support the comprehension of the problem identification together with the literature review to be synthesised with the findings of the primary investigation. In the primary investigation, the responses of the NZIOB awardees to the survey questionnaire are analysed and presented in detail. The chapter includes sophisticated statistical analyses. Interpretations are described in line with the conceptual relations made in Chapter 3. In addition to the quantitative analyses, content analyses related to the open-ended questions of the questionnaire survey are described in detail. Both preliminary and primary investigations are explained with respect to the aim and objectives of the current study.

Chapter 6 is the validation exercise. Based on the research questions of this research study, qualitative information provided by the SMEs is extracted and themes are presented. Three SME interviews are described and analysed in this chapter.

Chapter 7 describes how the research findings of the preliminary and primary investigations are synthesized with the literature review and the findings of SMEs interviews to answer the research questions of this research study. The synthesis exercise of this study helps to determine agreements as well as disagreements between the findings that are investigated under several stages of this research investigation. This triangulation work allows a more meaningful conclusion.

Chapter 8 is the conclusion of this research study. This chapter represents the findings of this research study in the form of recommendations. A list of recommendations is given for construction project managers to plan and implement construction projects strategically along with traditional planning algorithms. To fill the gaps that the current study could not investigate, future studies are recommended.

Chapter 2. Literature Review

2.1 Introduction to Literature Review

Past literature was reviewed in this research study for purposes that include problem identification, determination of the research methodology, selection of a suitable analysis methods, and synthesis of the study findings. This literature review describes only some aspects related to the 'problem identification' of the current study. The chapter broadly includes others' contributions toward construction project planning as well as controversies built around innovations related to planning methods.

The literature review covers strategies in the construction context, role of construction project planning and project success. The chapter is initiated with identifying current conditions of the construction industry related to success/failure and productivity. Having recognized that new planning approaches are required to minimize project failures and ultimately increase productivity, the chapter identifies that strategies are suggested at the conceptual level as a potential and suitable planning approach. The study hence progresses to identify strategies in-detail.

The study then focuses on why strategies are suitable to plan and implement construction projects. Current planning tools are evaluated to find out deficiencies so that the purpose of strategies can be understood. Two decision making philosophies, which are technical rationality and reflective practice, are discussed with limitations of each philosophy. The issues covered in this chapter are with the ultimate aim of finding a reliable planning approach that could help to achieve successful project outcomes.

The problem identification stage of the current research was carried out as an iteration process that is described in the chapter Methodology under section 4.6.1.

2.2 The Need for a New Construction Planning Approach

There are two major reasons that are identified in literature as critical considerations in the development of alternative planning methods: existing project and company level failures, low productivity. Traditional construction planning and control systems have been criticized because of insufficiencies that emerge from their underlining theories and ineffectiveness (Sriprasert & Dawood, 2002). Sriprasert & Dawood (2002) mention that construction project planning is among the top potential areas demanding improvements. Existing project and firm level failures in the industry provide credence to support these statements. These needs related to both global and NZ contexts are presented in the following sections.

2.2.1 Need in Global Context

Construction project failures in one form or the other is commonplace, with construction companies being vulnerable to bankruptcy (Wong & Ng, 2010). Ganaway (2006) found that only about 43% of construction firms, which started in 1998 in the US, could survive after four years of operation. Assaf and Al-Hejji (2005) find that construction projects in Saudi Arabia suffer 10%-30% time overruns. Further, 70% of projects have suffered delays during their execution stage in Nigeria (Odeyinka & Yusuf, as cited in Sambasivan & Soon, 2006). Similarly, construction project delays are prevalent in Jordan (Al-Momani, 2000), Thailand (Noulmanee, 1999) and Indonesia (Kaming, 1997). Chan and Kumaraswamy (1997) identified 83 factors that could cause project time overruns and which could indicate that construction projects are under crises. Therefore, the current study focuses on reasons for widespread failures.

One of the key reasons for existing failures is lack of experience toward construction project management (Ganaway, 2006) and hence, one can expect that failures are preventable if careful consideration is given to performance management. Therefore, the current study's aim is to develop a suitable planning approach to increase reliability related to performance management. In addition to the global condition mentioned above, conditions of NZ construction industry are reviewed.

2.2.2 Need in New Zealand Context

Zheng (2007) says that there is no past study that focuses on construction project failures related to New Zealand context. The reason may be that there is less emphasis on research and development particularly in the construction sector. In the same way, Davis (2007) mentions that there are no official measures available for construction productivity despite the review statistics of NZ (Tran & Tookey, 2012). However, a few studies have found that NZ construction industry suffers similar issues related to global context (White, 2008; Zheng, 2007).

Table 2.1: Project delays in Auckland commercial construction projects (source: Zheng, 2007)

The Participant	Construction Delay (% from the original duration)
1	75%
2	90%
3	50%
4	100%
5	5%
6	20%
7	25%
8	95%
Mean	57.5%

Based on a study of Auckland commercial contractors, Zheng (2007) found the extent of project delays as summarized in Table 2.1. Zheng (2007) concludes that New Zealand construction industry experiences about 57.5% of average delay on projects. However, since this study used only eight commercial contractors, statistical significance of the result is questionable. Using mean as the central tendency seems to be unsuitable in this case because the data is widely spread with a standard deviation of about 35. Despite these facts, the data shows that time overruns are a common problem of commercial construction projects in Auckland. Everyone except the fifth participant on the table indicates that they suffer considerable delays in excess of 20% in project deliveries. In addition, the data shows that four out of eight participants (50%) experienced delays in more than or equal to75% construction projects.

Similarly, by focusing on a construction company in Auckland, White (2008) found that the company faces an average delay of 81% in its office and warehouse construction projects. Both findings suggest that the NZ construction industry suffers construction project failures. In addition to failure statistics, data on low productivity gives credence to the assumption that construction projects in NZ are under risk (Cunningham, 2010).

Productivity improvement is recognized as an important factor to the well-being of the construction industry (Sriprasert & Dawood, 2002). Cunningham (2010) states that "productivity in the Building & Construction (B&C) industry is believed to be declining or at best to be flat, in New Zealand" (p. 1). Further, Tran and Tookey (2012) reviewed NZ productivity statistics, having the aims to deconstruct construction productivity indicators and explain the industry's poor performance.

Table 2.2: Average multifactor productivity growth for different industries, (Source, Tran & Tookey, 2012)

March year	Primary	Mining & quarrying	Construction	Manufacturing	Electricity gas & water	Transport & communication	Business & property services	Personal & community services	Retail & wholesale trade
1988-1993	-0.52%	-1.91%	-4.59%	0.29%	1.11%	6.75%	-2.54%	0.82%	-0.38%
1993-2002	2.45%	0.72%	0.25%	-0.16%	-0.93%	5.52%	0.74%	1.48%	1.40%
1988-2002	1.38%	-0.23%	-1.51%	0.00%	-0.21%	5.95%	-0.44%	1.24%	0.75%

Table 2.2 shows average periodical multifactor productivity growth for different industries from 1988-2002 extracted from the study by Black, Guy and McLellan (2003). During the period 1988-2002, the construction industry shows the lowest productivity growth in NZ with 1.5% of declining multifactor productivity despite the average of 0.88% multifactor productivity growth in the whole economy (Tran & Tookey, 2012). In addition to multifactor productivity, NZ construction industry shows poor performance indicators related to labour productivity as described below.

Introducing NZ treasury aims for long term productivity performance, Janssen and McLoughlin (2008) found that NZ construction industry has the lowest labour productivity growth (-3.1% pa) compared to 13 industrial sectors which count for an average growth of 0.3% p.a. for the period of 2000 to 2007 (Tran & Tookey, 2012). In a report prepared for the Department of Building and Housing, Davis (2007) found that construction labour productivity has dropped by 10% compared to the aggregate labour productivity growth in NZ during 1997-2006. Tran and Tookey (2012) hypothesized that construction productivity indicators may be much worse than Davis's (2007) calculations if increasing land prices and inflation would have been considered. Tran and Tookey's (2012) focus is to obtain real performance indicators of labour productivity by considering inflation and related prices including land. However, using Statistics NZ, information from the Reserve Bank of NZ and Rawlinson's (1986-2008) supplemented analysis, Tran and Tookey (2012) finally articulate that the conclusion made by Davis (2007) are still consistent.

As a concluding remark, one can see that the construction industry faces critical issues regarding project success according to facts given in both NZ and global contexts. As a remedy toward project failures, management practices have evolved over time.

2.2.3 Evolution of Management Practices

Figure 2.1shows key concerns of construction project planning and that have evolved over time (Fryer, 2004).

Scientific or classical management is considered as the beginning of the evolution of management theories by Fryer (2004). This management approach focuses only on 'productivity' and hence no concern is paid toward employees 'well-being'. After about a quarter century, Brown and Jaques (1965) identified that project managers should perform social roles (such as workers involvement in decision making) in addition to technical tasks that managers essentially need to focus on, as cited in Fryer, 2004. This becomes the beginning of the social science approach which includes the consideration of informal structures and participative culture into management.

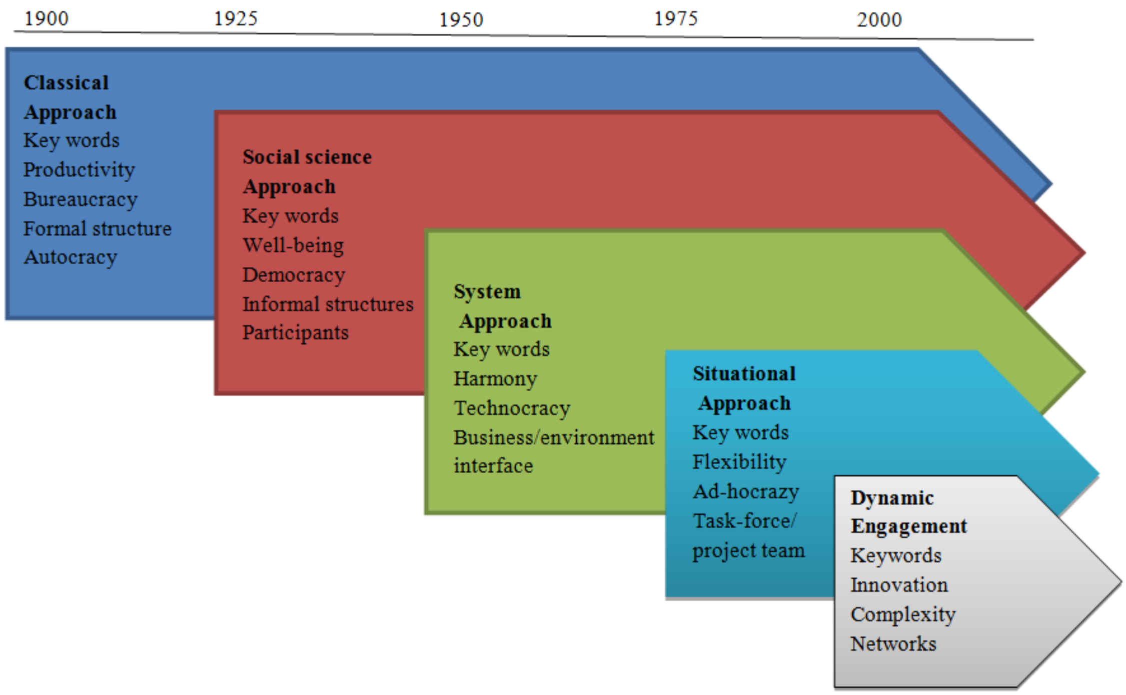


Figure 2.1: Development of management thinking approaches (Fryer, 2004)

However, Fryer (2004) describes that the social science approach has deficiencies: it has little concern about relationships between humans, machines and business environment. These inadequacies open the door to another management culture called the systems approach. The systems approach considers inter-relationships between sub-systems (Fryer, 2004) similar to reflective practice which perceives problems both as a whole and in parts (Dias, 2002). For example, Fryer (2004) describes that changes to construction methods can affect the attitudes and morale of the workforce. However, the systems approach considers that sub-systems have certain properties (Fryer, 2004) which is a principle of hard systems approach, as described later on.

In the mid-1970s, scholars identified that project systems cannot be treated as systems with fixed properties anymore. Furthermore, there is no single best procedure to carry out any process (Fryer, 2004). The contingency (situational) management approach came into practice to address these issues. Management approaches become more generative from fully-rational (Fryer, 2004). In addition, the new approach stresses that project managers should handle situations by considering contextual backgrounds such as size, task, technology, achievements, prevailing conditions and organizational characteristics (Fryer, 2004). Considering systems as complicated and uncertain, the contingency management approach seems to bring into line with the doctrines of reflective practice (Dias, 2002) which is described later in section2.3.3.3.

To think about potential occurrence of situations in advance is a must in order to survive in fast changing environments, but contingency management focuses on current conditions only (Fryer, 2004). Management principles consequently evolve into dynamic engagement which is the most recent debate of management practice (Fryer, 2004). Fryer (2004) states that dynamic engagement encourages practitioners to foresee constraints as well as opportunities, and consequently to develop solutions through a participative culture. Similarly, Abeysekera (2007) introduces ‘living through a project in advance’ in order to cope with complexities by using suitable construction project strategies. Both dynamic engagement and the study by Abeysekera (2007) indicate that innovation can help to cope with complex and dynamic situations.

In addition to the study by Abeysekera (2007), there are a few scholars who recommend to apply strategic consideration to mitigate contingencies: Wong and Ng (2010) articulate that the construction industry needs regular performance evaluations and strategic applications to cope with dramatic changes. Similarly, Betts and Ofori (1992) recommend planning strategically, saying that tactical considerations must be replaced or at least embedded within the context of strategic concerns to cope with the increasingly dynamic situations that the construction industry operates in. Considering increasing contingencies as well as other scholars’ suggestions on using suitable strategies to make construction projects less complex and hence easily predictable, the current study aims to provide a broad view about strategies and their relevance to the construction industry.

2.3 Strategy

Literature is reviewed under different themes ranging from definitions to the three dimensions of strategies: process, content and context. Strategy formation routine is discussed in terms of ‘how’, ‘who’, ‘when’ and ‘where’. Further, different strategy-making typologies are discussed in the context of construction. It is described how the same strategy could result in different outcomes according to ways a strategy is treated. Further, the strategist at the project implementation stage is recognized. In addition, the importance of strategists’ education, experience and qualities is described. The reviews go further to relate strategies to the construction industry by describing the contemporary strategic context while identifying its drawbacks. Finally, current planning techniques are reviewed with respect to philosophical underpinnings to understand their deficiencies where strategies can be used as alternatives to make construction project planning reliable.

Regarding strategies, the study reviews literature from other industries because, in contrast to the construction industry, other disciplines like military, manufacturing, business management and marketing are well established with strategic concerns (Abeysekera, 2007). However, since the construction industry is unique (Wong & Ng, 2010) the relevance of strategic discourses from other industries can become questionable to construction projects.

Thus, the study uses knowledge of strategies from other industries as the best available knowledge to explore strategies related to the construction industry. This is a recommended way in past literature when incomplete knowledge is investigated (Denzin & Lincoln, 2005). This does not encourage the researcher to accept or reject what construction practitioners say about strategies based on knowledge gained from other fields. Rather, if strategic concepts are different in construction with respect to other fields the researcher can investigate ‘why this is different’ by asking additional questions. This is referred to as pragmatic criticism of anti-foundationalism (Denzin & Lincoln, 2005).

The next section discusses different interpretation of strategy given in literature in the context of the current research.

2.3.1 Definition of 'Strategy'

An early and precise definition of 'strategy' is essential to avoid conflicting interpretations, but, at the same time, such definitions may become misleading (De Wit & Meyer, 2004). Mintzberg et al. (1998) articulate that there is no universally accepted definition of 'strategy'. Further, Norton and Irving (1999) comprehend that there are several definitions, but they tend to confuse rather than clarify: "…virtually everyone writing on strategy agrees that no consensus on definition exists" (Chaffee, 1985, p. 89).

Chandler (1962, p. 13) defines strategy as "the determination of the basic, long-term goals and objectives of an enterprise, and the adoption of course of action and the allocation of resources necessary for those goals". Further, Thompson, Strickland and Gamble (2007) define strategy as ".... the management action plan for running the business and conducting operations" (p. 3). The two definitions include contrasting views of the timeframes for which strategies are developed. While Chandler (1962) sees strategies in the long-term, Thompson et al. (2007) mention that strategies can be long-term or short-term. Clegg (1992) identifies this tendency as 'indexicality' and Popper (2002) calls it 'historicism' which describes that personal understanding, interpretations and behaviours about strategies depend on their background, socialization, education and training. Thus contexts that Chandler (1962) defines his strategy is different from that of Thomas et al. (2007).

Chandler (1962) focuses on business administration and his target is limited to four goals: decision to expand the volume of activities, set up plants and offices, move into new economic functions and become diversified along many lines of business. All these goals refer to long term achievements. However, Thompson, Strickland and Gamble (2007) focus on four management levels: corporate, business, functional and operational levels. Not surprisingly, the definition contains both long-term and short-term concerns. This implies that the purpose and contextual background which the strategy is defined must be understood at the beginning. The observation corroborates Chaffee (1985) who stresses that strategy must be situational and should vary according to the industry.

For the current study, the term 'strategy' is defined in the context of construction project planning and implementation. A strategy-led approach is supposed to overcome construction challenges such as complexities, dynamism, uncertainties and uniqueness as described later in section 2.3.3.3. The aim of using strategies is to achieve successful outcomes by supporting decision making and problem solving. By considering these criteria, the current study defines the term strategy as follows:

> "Strategy is that which will assist the construction planners in decision making and problem solving within the complexities, dynamisms, uncertainties and uniqueness of the construction process."

This definition shows some similarities to the definition given by Abeysekera (2007) who sees strategies as techniques that project managers could use to make construction projects more understandable, less complex and surprising, and imaginable. The suitability of the current study's definition was reviewed through three conference articles (ARCOM, 2011; AUBEA, 2012; COBRA, 2012). De Wit and Mayer's (2004) widely acclaimed seminal work encourages decision makers to understand overall strategy making procedure by using the three dimensions of strategies.

2.3.2 Three Dimensions of Strategy

De Wit and Mayer (2004) stress that every strategic problem has three useful dimensions:

> Strategy process –strategy formation routing in terms of '*how*', '*who*' and '*when*',
> Strategy content –refers to the *what* of strategy, and
> Strategy context –refers to *where* the strategy process and content are rooted.

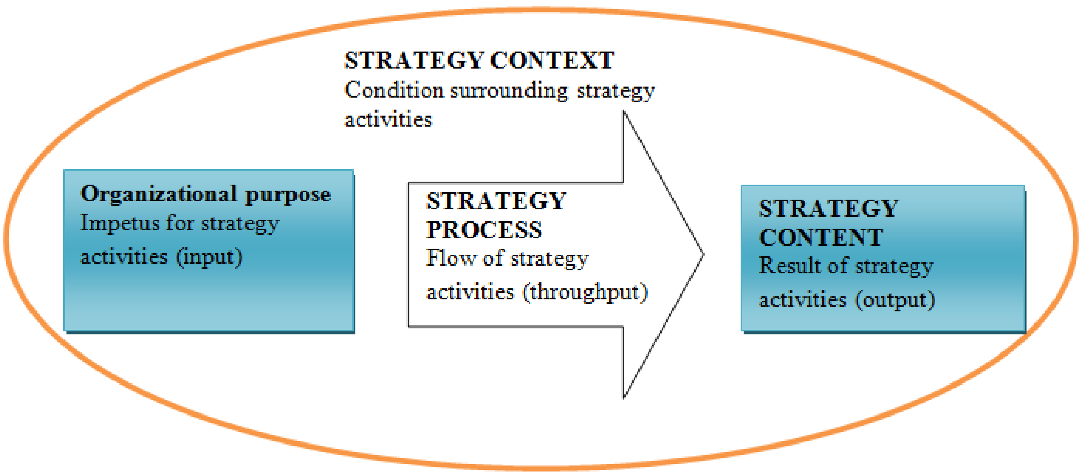


Figure 2.2: Three dimensions of strategy together with organizational purpose (De Wit & Mayer, 2004)

More importantly, the three dimensions should be considered together, but not as three parts of a strategy (Ketchen, Thomas, & McDaniel, 1996; Pettigrew, 1992). De Wit and Mayor (2004) describe the nature of interrelations between the dimensions, saying that the manner in which strategy process is organized has a considerable influence toward the resulting strategy content and that strategy content can help to rethink the strategy making process in future. Considering strategies in terms of their dimensions is advantageous for the current inquiry in two ways. Firstly, investigation can be conducted to explain what a strategy-led approach is. Secondly, the dimensions emphasis ensures that during exploration of one dimension, the respective other two dimensions are considered as well (De Wit & Meyer, 2004).

The interrelationship between the three dimensions is shown in Figure 2.2. Here, De Wit and Mayer (2004) have added a fourth section called 'organizational purpose' to the three dimensions and pointed out that this fourth section is not about strategies and hence not a dimension. While the three dimensions of strategy answer the questions of how, who, when, what and where, the fourth section answers 'why the strategy exists' (De Wit & Meyer, 2004). The conversation continues by describing the three dimensions and purpose in detail.

2.3.2.1 The First Dimension: Strategy Process (how, who and when)

As mentioned earlier, 'strategy process' helps to understand strategy making sequences in terms of 'how', 'who' and 'when' (De Wit & Meyer, 2004).

How to Make Strategies

De Wit and Meyer (2004) recognize that strategy process, consists of three interconnected main courses: strategic thinking, strategy formation and strategic change.

Strategic thinking, which is the first in the strategy process proposed by De Wit and Meyer (2004), describes reasoning process of a strategist and the way he/she organizes his/her reasoning (De Wit & Meyer, 2004). According to De Wit and Meyer (2004), strategic reasoning may contain very complex tasks that can be classified mainly under 'defining' and 'solving' stages of a problem (Figure 2.3).

As shown in Figure 2.3, the first two stages of strategy reasoning are identifying and diagnosing. These two stages are to define problems strategically. In this stage, strategists should understand the most critical issues among dozens of problems that can exist (De Wit & Meyer, 2004). Both explicit knowledge and reflective interaction are key requirements to succeed at this stage (De Wit & Meyer, 2004). These two requirements are consistent with the reflective practice: science and mathematics alone cannot solve many engineering problems (Dias, 2002). Having recognized the most critical issues, the strategist comes to the next stage of the strategic reasoning loop, 'diagnosing', to gather detailed data regarding any identified problems. In construction project planning, gathering required data is an enormous challenge because of ambiguity and unavailability of the data (Cottrell, 1999; Long & Ohsato, 2007). Having identified and diagnosed problems with the best available knowledge, then the strategists move toward solving problems as graphically shown Figure 2.3.

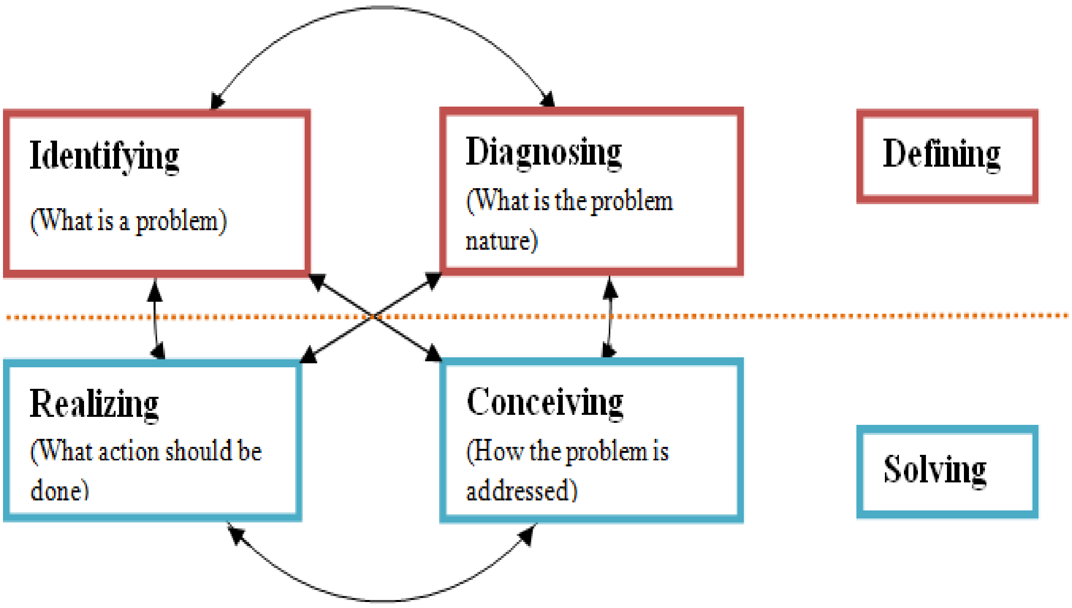


Figure 2.3: Elements of the strategic reasoning process (De Wit & Meyer, 2004)

At the conceiving stage of strategic reasoning, the strategist thinks of several options that would solve the problem. It is important to note that strategic options are not chosen from a list, but they usually become generative according to a particular situation (De Wit & Meyer, 2004; Kumar, 2002). Further, there can be several alternative solutions and the best strategic resolution can be determined after contextual backgrounds are considered (Thompson et al., 2007). Once the best strategy is selected, De Wit and Meyer (2004) articulate that the strategist should realize actions to be taken to implement the strategy. According to these perceptions about strategic reasoning, the first stage of the strategy process given by De Wit and Meyer (2004) seems to be context and practitioner dependent similar to the reflective practice (Dias, 2002).

At the end of the first stage, which is strategy thinking or strategic reasoning, strategy process comes to the next step: 'strategy formation'. De Wit and Meyer (2004) describe that 'strategy formation' should comprehensively consider the organization process of activities that a strategy influences (De Wit & Meyer, 2004). The final step, 'strategic change', focuses on the organization to systematize any proposed change into action.

Similar to De Wit and Meyer (2004), Price and Newson (2003) recognize three stages in the strategy process: strategic analysis, strategy formation and strategy implementation. Their articulation can be used to further clarify De Wit and Mayer's (2004) strategy process loop. For example, Price and Newson (2003) mention internal audit (establishing organizational capacities), external audit (assessing the external environment) and SWOT (Strength, Weakness, Opportunities and Threats) analysis as elements within their strategic analysis stage. The procedure can be added to the realizing stage of De Wit and Mayer's(2004) strategic reasoning loop. However, since Price and Newson (2003) aim at corporate level strategies, taking all opinions may not work towards project implementation strategies. For example, opportunities and threats, which are external to an organization, may not have the same importance toward project level strategies as compared to strength and weakness which are internal to an organization.

However, creating and realizing a single solution is not the end of strategy process, but may be the beginning of an iterative cycle. It is important to realize strategies as trials (Thompson et al., 2007). As trials, strategies can have strategy-to-implementation gaps (Thompson et al., 2007) and hence need regular monitoring and adjustments (Fryer, 2004).

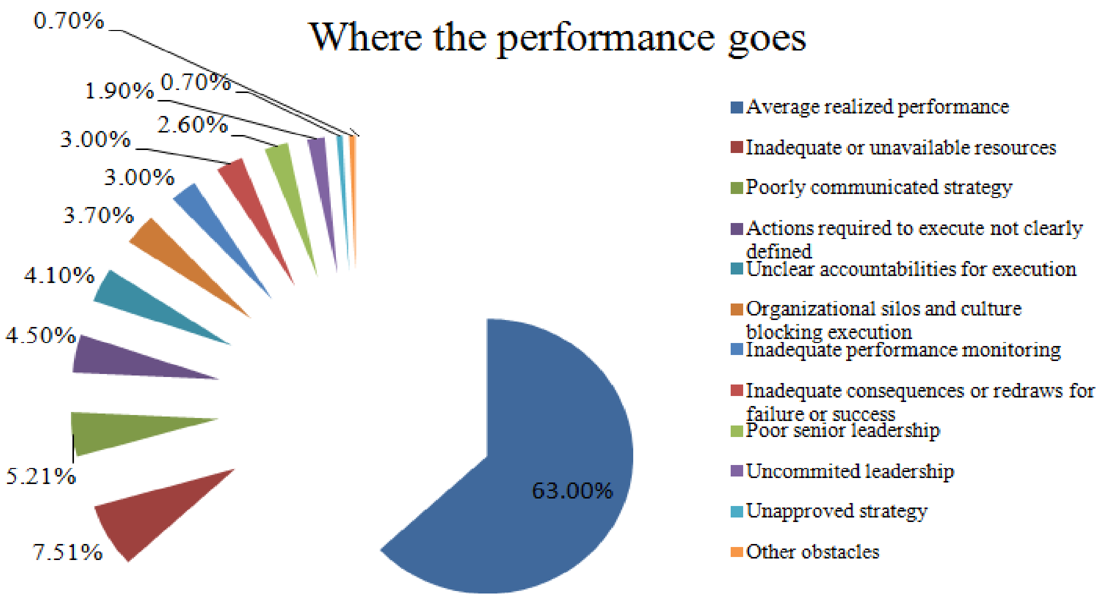


Figure 2.4: Where the performance goes (Thompson et al., 2007)

Mankins and Steele from Marakon Associates find that companies can achieve only about 60% of the potential of strategies (Thompson et al., 2007). Thompson et al. (2007) find the major factors that create strategy-to-implementation gaps. This is illustrated in Figure 2.4. The figure exhibits 12 reasons and their individual contributions toward 37% of the strategy-to-implementation gap. Although these causes are not specific to the construction industry, most of the reasons seem relevant to the construction sector. For example, the main causes of the strategy-to-implementation gap, which are the resource inadequacy and poor communication, can be major barriers to the performance of strategies in construction projects (Bourne, 2007). Reasons of strategy-to-implementation gap warn practitioner to use complementary strategies (sub-strategies) to minimize potential strategy-to-performance gaps as are outlined by Lee et al. (2006).

Lee et al.(2006) have found that concurrent design has become a strategic solution to the requirement of faster development to design and build construction projects. However, they have found that the concurrent design strategy itself creates more complexities and uncertainties compared to sequential design due to lack of available information. To overcome this, Lee et al. (2006) suggest a sub-strategy, a buffer, to be used in concurrent design projects. Therefore, the current study pays attention to integrate monitoring and adjusting as a crucial activity in reliable strategy models.

Considering the above discussion, the current study identified seven steps of strategy process: identify problems, recognizing needs to be addressed, knowing strength and weakness, crafting solution, setting scenarios, evaluate the best alternative, and implementation with monitoring and adjustment. Having recognized how strategies are made, the study continues to emphasize on the role of the strategists.

Who Makes Strategies?

After understanding the strategist of construction project implementation strategies, the study can decide the best person to be recruited as participant to gather details on construction project strategies. This section initially reviews other industries. Based on reflection from those arguments, the study moves on to review literature specific to the construction industry to find out who is best-placed to implement construction project strategies.

Not specific to an industry, scholars suggest that strategy formation is performed by managers (De Wit & Meyer, 2004; Fryer, 2004). Since there are many hierarchical levels within an organization, the types of managers must be decided according to their scope of responsibility (Thompson et al., 2007). For example, corporate level strategies are formulated by the CEO or senior level executives; business level strategies are formulated by general managers; likewise, orchestration of operational level strategies is done by functional level managers (Thompson et al., 2007). Therefore, the next question is to find out the functional level head at construction project implementation level.

There are sufficient perceptions in both academia and the industry to reflect construction project managers as the head of the project implementation level (Bourne, 2007; Walker, 2007). As example, Construction Manager of the Year Award (2011), articulate the importance of the construction project manager toward 'One New Change' project, London:

> *"If ever a project needed a safe pair of hands it was this one. It found them in Phillip Clarke, who managed out the substantial risk on a contract worth a quarter of a billion pounds" (p. 1).*

In addition to the industry perception, Sommerville et al. (2010) emphasize on construction project managers' roles and come to the conclusion that project success largely depends on project managers abilities related to planning, organizing and controlling activities. According to Lock (2007), construction managers are the stakeholder with highest responsibility throughout the whole project life cycle. Although a list of tasks for construction project managers cannot be produced due to the overlapping nature of their responsibilities (Sommerville et al., 2010), construction project managers are conscientious for the most specific interpersonal, information and decisional roles (Fryer, 2004).

Literature from a few decades back shows that project managers' performance has been given higher priority by more recent studies than past studies used to do. In the 1970's as well as 1980's, the whole project team together was considered as a success factor. Further, the whole team was considered as less important than many other success factors such as organizational philosophies (Martin, 1976), project summary and operational concepts (Clealand & King, 1983). However, with dramatically increasing complexities and uncertainties, the industry began to demand more creative solutions (Abeysekara, 2007; Fryer, 2004) recognizing construction project managers as pivotal to creativity and innovations (Jha & Iyer, 2006; Turner & Muller, 2005). Considering these facts, today, the construction project manager alone (not the whole project team as in 1970's and 1980's) is considered as one of the most important factors toward achieving project success (Bourne, 2007; Walker, 2007).

Conversely, Belassi and Tukel (1996) have found that top management support is a more important factor for project success than the project manager's competence. This single study raises suspicion for the current study about who should be the key person toward project implementation strategies: the top management or construction project manager?

However, when Belassi and Tukel's (1996) research approach is reviewed in detail, it seems that the current study can still lock in the proposition that construction project managers are the strategists of project implementation strategies. Belassi and Tukel's (1996) findings are not purely for the construction industry, but given as an overall perception for many industries including construction, defence, management information system (MIS), utilities, environment and manufacturing. Their findings show that project managers gain prominence over other stakeholders in the construction sector only when the data was separated and analysed according to industries.

In any case, construction project managers and other stakeholders cannot be separated throughout strategy crafting and implementation process (Fryer, 2004). For, example, there should be an alignment between construction project strategies and organizational strategies (Bourne & Walker, 2005; Jiang & Klein, 1999). Further, strategic decisions and their acceptance can be either individual or bottom-up depending on the situation on-hand (Fryer, 2004; Kassab, Hegazy, & Hipel, 2010). Therefore, other stakeholders' contributions would need to be considered.

Other stakeholders and their objectives toward strategy crafting and implementation are discussed later under strategy context (section 2.3.2.3). Although bottom-up strategies are frequently mentioned in construction project planning and implementation, the preliminary investigation carried out within the current study would show construction project managers as the back-bone behind bottom-up strategies (section 5.2.7). Therefore, construction project managers are considered in the current study as the best person to provide information on the three dimensions of strategies. The next section discusses timely influence toward strategy crafting and implementation.

When to Strategize

The strategy literature within marketing encourages strategists to think of timely dependent variables such as market opportunities and organizational situation as well as to perform SWOT analysis when strategies are crafted (Thompson et al., 2007). Since the construction industry is more dynamic than other industries (Ballard & Howell, 1998; Wong & Ng, 2010), it is reasonable to assume that construction project implementation strategies are also influenced by time. However, in literature, the construction industry does not discuss the effects of timing toward strategies. Despite this gap, scholars imply that construction project planning is influenced by the phase of a construction project (Pinto & Covin, 1989).

Pinto and Covin (1989) compare variations of critical success factors over the life cycle of construction projects by using step-wise regression. According to their findings tabulated in Table 2.3, 'project mission' becomes the only common success factor for all the stages: conceptual, planning, execution and termination. However, one can note that the cumulative adjusted regression factors for 'project mission' vary throughout the construction project life cycle (0.54, 0.71, 0.57, and 0.54 respectively). Therefore, if the importance of success criteria varies over time as found by Pinto and Covin (1989), strategies are potential to be affected too. Further, Thamhain & Wilcmon (1975) have found that tendency toward conflicts can be changed throughout a project and hence engagement and communication strategies can become diverse over the project life cycle. Therefore, the life cycle of a project is an important consideration toward strategies.

Table 2.3: Variation of critical success factors throughout the construction project life cycle

Stage of the project	No. projects	Success Factors	Cum. Adj. Regression
Conceptual	17	Mission	0.54
Planning	24	Mission	0.71
		Power and politics	0.82
		Technical tasks	0.84
Execution	82	Mission	0.57
		Schedule	0.66
		Client consultancy	0.69
		Client acceptance	0.70
Termination	61	Technical tasks	0.35
		Mission	0.50
		Communication	0.53
		Trouble shooting	0.54

Figure 2.5 shows eight phases of construction projects given by Fewing (2005) based on the model developed by the Charted Institute of Building (CIOB) in the UK. Passer (2011) views these eight phases as a more detailed version of the model by Adams and Brant which represents a construction project as passing through four stages: conceptualization, planning, execution and termination. The 'strategy' stage of Fewing's (2005) model is not to be confused with project strategies mentioned in the current study. Rather, the strategy stage represents activities, such as procurement route, program and quality management and methodology for construction, that are required to be carried out and controlled during a successful project (Fewings, 2005; Passer, 2011). However, since the current study focus on contractors, the stages that contractors are involved in planning and implementation are considered as relevant to the current inquiry.

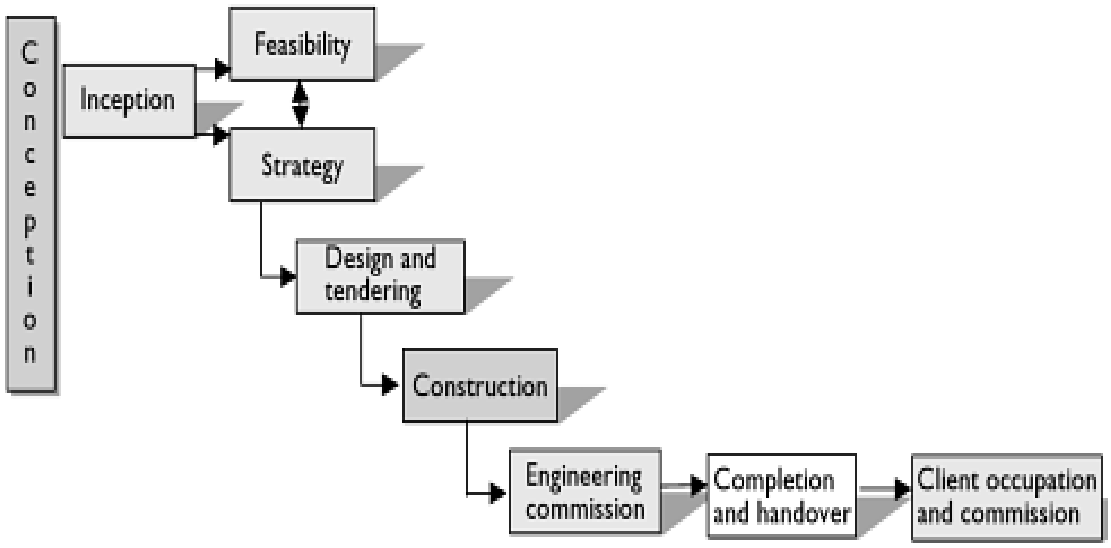


Figure 2.5: Phases of a construction project based on Fewings (2005)

Fewing (2005) says that for contractors, the complete project cycle is from tendering to completion. However, one can understand here that procurement methods can strongly influence the contractor's involvement (Fewings, 2005). For example, in Design, Build, Finance and Operate (DBFO) projects, contractors are strongly involved in the inception, feasibility and operational stages, but in a traditional procurement project this is not the case (Fewings, 2005). Considering these facts, the current study reflects on construction project managers' perceptions to find the influence of different phases toward strategy process. The responses are taken from the industrial experts though three pilot surveys and are attached to Appendix E.

Having discussed strategy process, the study next investigates De Wit and Meyer's (2004) second dimension of strategy: 'strategy content'.

2.3.2.2 The Second Dimension: Strategy Content

There are three major considerations which are used to describe strategy content in the current study: what construction project strategies can be used, what focus that strategy is associated with, and methodologies (typologies) of making construction project strategies.

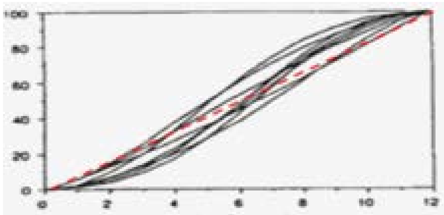
What Construction Project Strategies Can be Used?

In construction project planning literature, there are very few studies that mention construction project strategies. Abeysekera (2007) introduces some concepts that can be used to craft strategies such as rate and rhythm, slicing and packaging, and planning cells. Abeysekera (2007) believes that these concepts can be used to make construction projects more imaginable, in other words to predict potential failures earlier and to take appropriate actions against threats.

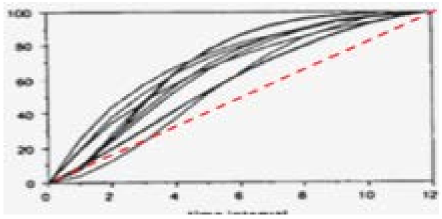
Abeysekera (2007) demonstrates rate and rhythm planning by explaining a 10 months project that is worth 20M USD. Assuming, probable variations of 5M USD for the whole project, he suggests to achieve a turnover of 2.5M USD per month to complete the project on-time. Further, Abeysekera (2007) describes that the planner can keep the rhythm for construction, such as one floor per week, constant for the total duration. Abeysekera (2007) introduces all these criteria at conceptual level consequently their applicability has not been investigated. On the other hand, the above concepts measure project success one dimensional which is on-time completion. Abeysekara (2007) does not describe how both cost and quality achievements can be integrated into rate and rhythm planning. In addition, there are many issues beyond to be considered in the first strategy that Abeysekera (2007) describes (2.5M USD turnover per month). Project cash flow depends on many factors such as field costs, client's payments and the time lag between disbursement and receipt (Kaka & Price, 1993). According to Kaka and Price (1993), cash-flow should be made according to the context of a project, but Abeysekera's (2007) conceptions have been introduced without contextual considerations.

Figure 2.6 shows cash flow variances for 150 projects from five different companies in the UK (Kaka & Price, 1993). The dashed, straight line in each graph indicates the resultant cash flow forecast according to Abesekera's (2007) rate and rhythm planning. Comparing conceptual and actual cash-flow, management contracts show contradictory observations toward the applicability of rate and rhythm planning. Design and build projects as well as traditional contracts show both agreements and disagreements toward the applicability of Abesekera's (2007) strategy. As a final conclusion, it can be said that Abeysekera's (2007) rate and rhythm planning strategy described here is occasionally found in practice consequently, one objective of this study is to find out which strategies are used.

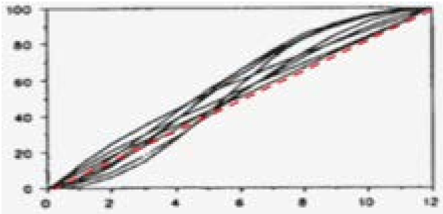
Traditional contracts of duration between (13-36)



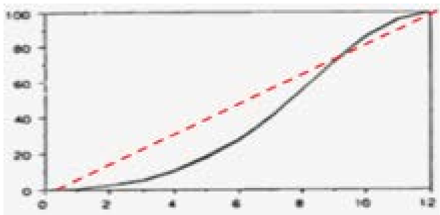
Traditional contracts duration between(0-6)



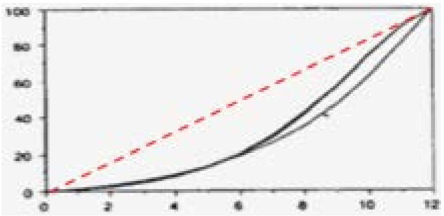
Traditional contracts duration between(7-12)



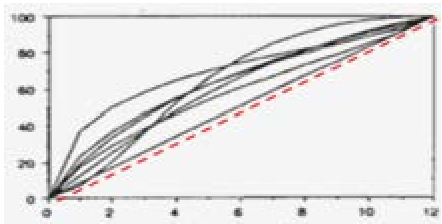
Management contracts duration between(7-12)



Management contracts duration between(13<)



Design and Build contracts duration between(7-12)



Design and Build contracts duration between (13<)

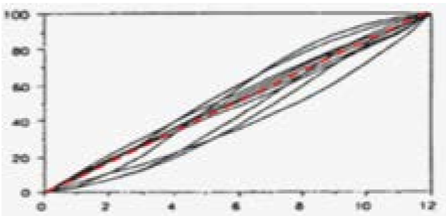


Figure 2.6: Typical cash-flow diagram (Kaka & Price, 1993) versus Abeysekera's (2007) rate and rhythm cash-flow pattern.

Kumar (2002) also describes advantages of early stage strategies related to the construction industry. Kumar (2002) describes how to develop early strategies by rigorously considering contextual background. Type of project, project organization structure, internal and external work environment as well as resource constraints are some of the basic considerations which Kumar (2002) mentions. Therefore, Kumar (2002) describes his approach as an unorthodox advance and hence considerably different from Abeysekera's (2007) suggestions which focus on a unified strategy. In Addition, Kumar (2002) articulates that strategies should be dynamic and flexible (revolutionary) to become effective. A gap of Kumar's (2002) study is that he didn't evaluate the effect of strategies toward successful outcomes. Since Kumar (2002) focuses only on a single project, it is difficult to generalize his findings. Kumar's (2002) study does not describe the three dimensions of strategies comprehensively. Having these gaps to be uncovered under the current study, attentions of construction project strategies are considered.

Strategy Focus

Strategy focus is the second consideration of strategy content. Although there are no unified strategies Kumar (2002) articulates that strategies can have common areas of attention.

Kumar (2002) describes that strategies should focus on project schedules, project organization, manning and deployment, contracting, purchasing and engineering. It could be seen that his articulation covers all of the major areas of construction project planning and implementation. Similarly, the current study posits that strategy-led approach should be able to focus on all areas relevant to construction project planning and implementation.

Generally, construction project planning strategy should answer the questions: 'what should be done (activities), 'How should activities be performed (methods)', 'who should perform each activity and with which means (resource)', and 'when should they be performed' (Laufer & Tucker, 1987). Similarly, Fryer (2004) mentions that many construction project managers tend to describe their roles as planning, organizing, directing and controlling. However, according to his perception, these four words are not enough to describe the scope of construction project planning. Therefore, scholars use critical success factors to represent the scope of construction project planning and implementation (Kumaraswamy, 1998; Pinto & Covin, 1989; Pinto & Mantel, 1990). Belassi and Tukel (1996) opine that there are many factors to be considered in addition to schedules and all those factors are referred to as critical success factors.

Further, Belassi and Tukel (1996) articulate that project successes or failures generally occur due to combinations of several critical factors. Considering this fact, Belassi and Tukel (1996) have summed critical success factors into several categories and focus on interrelationships among the groups. Further, Chan and Kumarswamy (1997) find 30 critical failure factors that cause delays in Hong Kong construction projects and categorize them under eight groups such as project related, client related, contractor related and material related. However, Belassi and Tukel (1996), or other studies related to critical success factors, have not discussed approaches that can be used to improve attention to critical success factors. Therefore, the current study finds the suitability of strategies to improve critical success factors and hence to achieve project success.

A survey of related literature finds 32 critical success factors to construction project planning which are tabulated in Table 2.4. These factors are listed under four categories: project related, organizational related, resource related and external related, in line with Belassi and Tukel's (1996), and Chan and Kumarswamy's (1997) studies.

Table 2.4: Critical success factors used in the current study (Tukel (1996); Chan & Kumarswamy (1997))

Project-related factors	**Resource-related factors**
Setting clear objectives	Minimizing material shortages
Coping with necessary variations	Coping with material changes
Improving communication	Deciding on off-site prefabrication
Speeding up decision making	Handling labour shortages
Handling unforeseen ground conditions	Coping with low skill levels
Improving project schedules and plans	Handling plant shortages
Coping with legal/statutory requirements	Coping with low efficiency of plants
Ensuring monitoring and feedback system	Coping with plant breakdowns
Better Handling of design complexities	Avoiding wrong selections of plants
Coping with estimation errors	
Organization-related factors	**External related factors**
Dealing with client's characteristics	Helping to minimize political issues
Improving project financing from client	Helping to minimize economic issues
Ensuring contractors cash flow	Helping to minimize social issues
Minimizing delays & errors in design documents	Helping to minimize weather uncertainties
Improving site management and supervision	
Getting top management support	
Developing project organizational structure	
Getting lower cadres' support	

Pinto and Selvin (1987) point out that the degree of controllability should be considered when critical success factors are used. Further, some critical factors are (more or less) under the control of the project team, but some factors such as severe weather conditions cannot be controlled at all. However, the current study does not consider these differences. The current study in a position that strategies should be able to influence any critical success factor which are decisive toward project implementation. In addition to attention of strategies, different strategy making methodologies are widely discussed in literature.

Methodologies to Plan Construction Project Strategies

Different strategy making methodologies can influence the reliability of the strategy crafted (Price & Newson, 2003). This section articulates how different methodologies underpinning the same strategy result in different consequences by using buffers for uncertainty management.

Lee et al. (2006) identify that many construction companies create buffers by adding a certain percentage of an original activity duration at the end of an activity. The approach is known in literature as contingency buffering (Lee et al., 2006). However, Lee et al. (2006) have found many inefficiencies associated with contingency buffering. Firstly, it does not consider individual characteristics of an activity and, hence, is context independent. Further, contingency buffers work as a reactive method because it takes precautions after something has already happened (Lee et al., 2006). Mathematical rigors that do not reflect on the context of activities make contingency buffers ineffective to handle uncertainties associated with construction projects, Lee et al. (2006) emphasize.

As an alternative methodology to create buffers, Lee et al. (2006) introduce a more generative approach called 'reliability and stability approach'. The reliability and stability approach emphasizes the properties and precedence of activities to estimate buffers, not only the properties of an activity itself. Lee et al. (2006) articulate how buffers should be quantified according to the rate of production: slow or fast production types. The authors use final design and shop drawings in a concurrent design project to demonstrate buffer sizing. Figure 2.7 illustrates fast and slow production types as well as relationships between production type and buffer sizes.

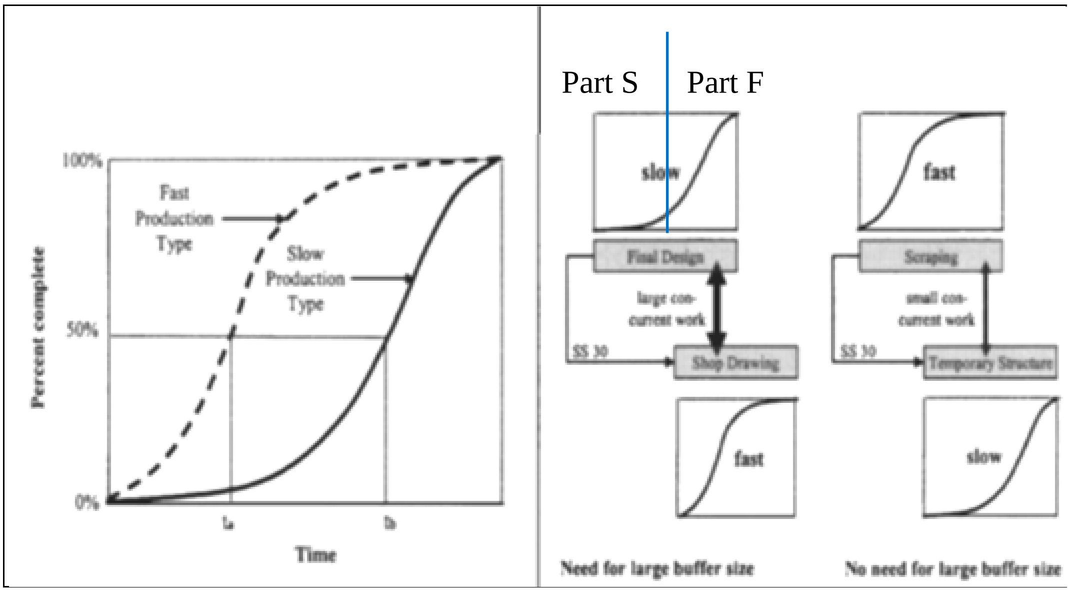


Figure 2.7: Estimation of Buffers in the Reliability and Stability Approach (Lee et al., 2006)

The final design is a slow production type and most work is done towards the end (Lee et al., 2006). Therefore, the fraction of errors found at the later stage (part F) is potentially much higher than that of at the earlier stage (part S). Since there are less opportunities to recover delays, the succeeding activity, shop drawings, may be affected considerably (Lee et al., 2006). Since shop drawing belongs to the fast construction type, most of the activity is done at the early stage Consequently, the effect of a delay at the final design is considerable (Lee et al., 2006). To cope with uncertainties a larger buffer should be added, Lee et al. (2006) recommend.

The above two approaches related to buffer sizing articulate how rational and generative methodologies make differences toward a strategy. Therefore, the current study perceives strategy making methodologies (typologies) as an important consideration.

Strategy Typologies

Literature on strategy typologies varies according to the field of study (Hambrick, 1983). According to Table 2.5, six scholars use different typologies under different backgrounds which are business administration, construction management, military operations and production. For example, in business management, Verreynne (2004) mentions adaptive, participative, intrapreneurial and simplistic as relevant typologies. However, Allison and Zelikow (1999) mention rational, organizational and bureaucratic as typologies for political policy making.

Table 2.5: Alternative strategy making typologies

Study	Background	Typologies introduced
Verreynne (2004)	Business management	Adaptive, Participative, Intrapreneurial, Simplistic
Price and Newson (2003)	Construction management	Rational, Generative, Deliberate, Emergent, Revolutionary, Transformational
Hart (1994)	Business administration	Command, Symbolic, Rational, Transactive, Generative
Ansoff (1987)	Business growth	Systematic, Ad hoc, Reactive, Organic
Chaffee (1985)	Organizational management	Linear, Adaptive, Interpretive
Allison and Zelikow (1999)	Political policy making	Rational, Organizational, Bureaucratic

Different typologies belong to different contexts due to specific bases that each background uses to define methodologies (Alison & Zelikow, 1999; Chaffee, 1985). Alison and Zelikow (1999) describe rational, organizational and bureaucracy typologies, which are made after the Cuban Missile Crisis to strategize foreign affairs in the USA. The rational methodology encourages decisions to be made by a monolithic government or as a nation. However, recently the US government has adopted the organizational methodology where policies come from an allied organization in which government leaders are represented. Therefore, the base of foreign policy making in the USA is the strategist.

As opposed to the strategist in US policy making, business management uses specific goals as the base of strategy making typologies. As an illustration, Chaffee (1985) articulates that linear typology focuses toward long term achievements such as setting up a new business plant. Considering these arguments, the current study reviews past literature to find out suitable bases to define typologies in the context of construction project implementation.

Price and Newson (2003) explain construction strategy making typologies according to schools of thoughts. For example, the planning school of thought views strategy making procedure as a formal process while the learning school treats strategy making as a cognitive process. Based on different schools of thought, Price and Newson (2003) identify eight distinct strategy making behaviours in the context of construction.

These eight methodologies are rational, generative, deliberate, emergent, revolutionary, transformational, strategic fit and strategic stretch. Since strategic fit and strategic stretch seem to fit into the corporate level, the current study considers the remaining six typologies as relevant in the context of project implementation level. Strategic-fit methodology identifies core competencies and downsizes organizational scope (Price & Newson, 2003). Conversely, the strategic-stretch typology pays attention to sell some parts of the organization to create a more focused business environment. Similarly, Abeseykera (2007) describes rational, generative and revolutionary typologies to craft construction project implementation strategies.

Rational and generative typologies describe the rigors that are underpinning strategies. Rational methodology considers science and mathematics in a logical manner to provide solutions whereas generative solutions come about as a result of personal experience and skills (Abeysekera, 2007; Dias & Blockley, 1995). Deliberate and emergent strategies specify the amount of preparedness: deliberate strategies are made in advance and ready to be implemented, but emergent strategies have to be made spontaneously and situational (Price & Newson, 2003). The last two typologies described the stability of strategies over time. Transformational strategies remain unchanged while revolutionary strategies change and are modified frequently (Price & Newson, 2003).

The operational definitions of the six typologies selected are described in-detail under the conceptual framework (section 3.7).

These typologies are usually considered as paradoxes (pairs of opposing alternatives) such as rational versus generative, deliberate versus emergent and transformational versus revolutionary (Abeysekera, 2007; Price & Newson, 2003). Further, strategy making process is seen as a combination of several rival methodologies. For example, Abeseykera (2007) mentions that construction project implementation strategies contained a combination of generative, rational, transformational and revolutionary methodologies. This is a similar opinion in other industries. For example, Hart (1994) opines that strategy making in business administration is a combination of five methodologies: command, symbolic, rational, transactive and generative. Similarly, Verreynne (2005) has found that NZ small to medium enterprises (SMEs) are apt to use some, if not all, of simplistic, adaptive, intrapreneurial and participative strategy making methodologies.

However, there is a knowledge gap related to the construction industry insofar as literature does not mention contributions from these typologies toward strategy crafting. In particular whether there is a dominant typology. This gap is considered under the current study.

The findings of the current study related to the six typologies can emphasize on how strategy making should be performed. In addition, the current study perceives that the six typologies can add meaning toward kinds of strategies which are used to implement construction projects.

Having discussed strategy content in detail, literature related to strategy context is described below.

2.3.2.3 The Third Dimension: Strategy Context

Strategy context is the last dimension of strategies as articulated by De Wit and Meyer (2004). Potential strategies must be selected by considering contextual variables that strategies are designed for. For example, Porter (1985) introduces the generic competitive advantage to create business strategies in the marketing sector by considering two contextual variables: strategic target and strategic advantage (Figure 2.8).According to Porter’s (1985) competitive advantage, a company can establish its products in global market by considering three main selections: focus on particular segments of the market, industry-wide focus with product differentiation or industry-wide focus with low cost products. Therefore, the current study reviewed the context that construction project strategies belong to.

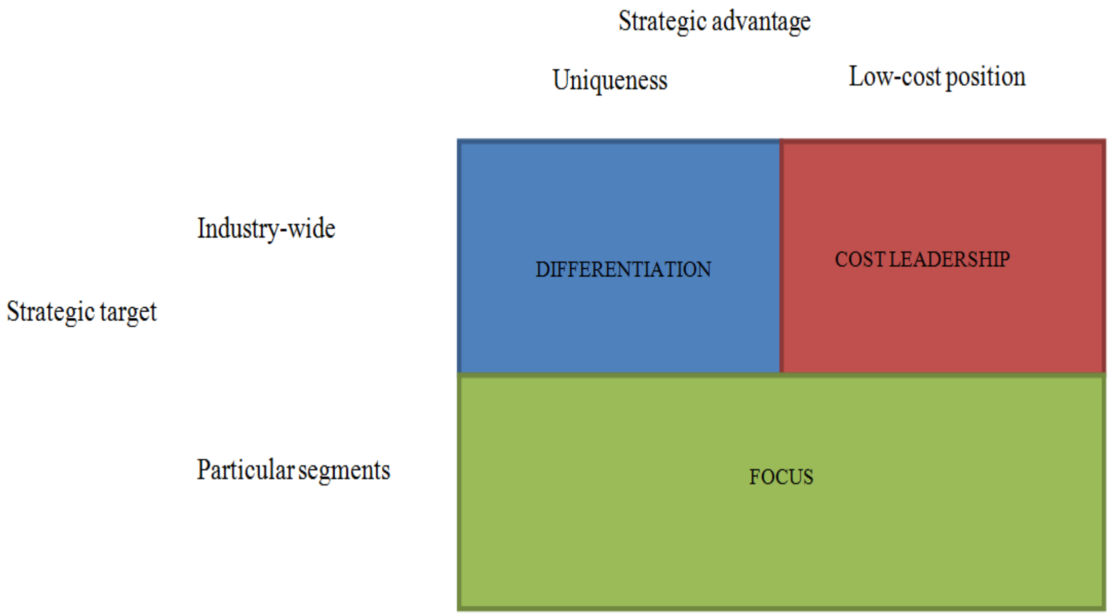


Figure 2.8: The competitive advantage of strategies with respect to marketing (Porter, 1985)

Some authors have taken attempts to apply contextual considerations from other industries to the construction industry. As example, when a British professor showed Porter's models to a senior manager of a major construction firm, the professor was dismissed by saying 'get out of here; I have a construction company to run' (Betts & Ofori, 1992). Tran and Tookey (2012) have found similar concepts to Porter's (1985) competitive advantage. For example, when inflation is high in the boom phase of NZ economy, competition becomes low due to full order books. Since competition is low, Tran and Tookey (2012) recommend that construction companies can establish themselves in the market by delivering higher quality products. Conversely, they have found that competition becomes high in the bust cycle of NZ economy. Therefore, construction companies have to survive with cost-cutting strategies such as delivering lower quality products (Tran & Tookey, 2012). However, Tran and Tookey (2012), as well as Porter's (1985) model, focus on company level strategies, but not project level strategies which is the context of the current study.

Therefore, it is required to consider what should be taken into account as the context of project level strategies. The current study's position is to consider project stakeholders under strategy context. Stakeholders are recognized as an important asset in any construction project context to achieve successful outcomes (Bourne & Walker, 2005; Fryer, 2004).

Stakeholders of Strategy Context

Strategy context is where strategies are embedded (Price & Newson, 2003). Further, Bourne (2007) mentions that construction project context is mainly developed by relationships which exist between the project manager and other stakeholders as well as project stakeholders themselves.

Previously, in the current study, construction project managers have been identified as the most important stakeholder in project implementation. Similar depiction is given by Bourne (2007), recognizing construction project managers as the focal point or inward direction of construction project environments. Bourne (2007) opines that all other directions of construction project environments are directly related to the construction project manager. The stakeholders and other major concerns (such as planning strategies and monitoring) related to construction project contexts are graphically illustrated in Figure 2.9.

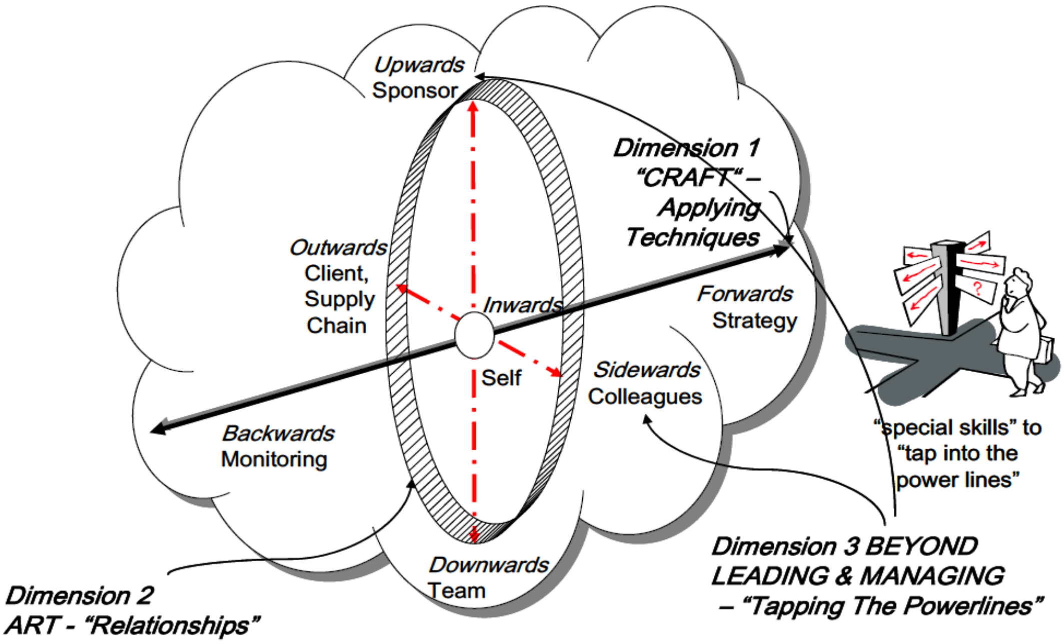


Figure 2.9: Seven dimensions in a project environment (Bourne, 2007)

In construction project environments, the forward and backward directions imply planning implementation: Bourne (2007) mentions 'strategy' as the forward direction which includes planning and anticipating. In addition, the backward direction of construction projects stresses the importance of proper control systems including historical records as well as explicit and implicit knowledge. The remaining direction describes stakeholders.

The outward direction and downward direction can shape project managers' leadership style. The client, end-users and external stakeholders represent the outward direction. Similarly, the downward direction represents the team, which site managers, site engineers, construction workers, sub-contractors and suppliers are included (Bourne, 2007). Further, project politics are important in construction project environments (Bourne, 2007). These project politics are determined by the upward direction (the owner) and the sideward directions (project manager's peers). Therefore, Bourne (2007) clarifies the importance of strategies, the construction project manager and other stakeholders to achieve successful project outcomes. Further, Bourne (2007) mentions the necessity of integration into project contexts through different policies such as vision, mission and transaction among stakeholders.

For example, construction project managers do not take decisions always by themselves, but sometimes they need to rely on group discussions (Fryer, 2004). Group discussion can bring more information and ideas; members can spot other mistakes; it can increase their commitment, motivation and satisfaction towards the task (Fryer, 2004). Conversely, sometimes group discussions could result in frustrations, annoyance and domination (Fryer, 2004). Therefore, there can be many policies which project managers use to integrate stakeholders into project implementation.

Table 2.6: Different stakeholder integration methods toward construction project implementation

Stakeholder's contribution	References
Vision is created to give an identity for employees and project activities.	(Chan et al., 2004; Cheunga et al. , 2003; Fryer, 2004)
Mission is given for specific targets to inspire employees to achieve high levels of performance	(Chan et al., 2004; Cheunga et al., 2003; Fryer, 2004).
Transaction with stakeholders and link outcomes overtime to decide strategic directions	(Bourne, 2007; Bourne & Walker, 2005; Fryer, 2004; Hart & Banbury, 1994)
Employees are supposed to learn and improve	(Fryer, 2004; Hart & Banbury, 1994)
Employees are encouraged for experimentation and risk taking	(Fryer, 2004; Hart & Banbury, 1994)
Employees are responsible for performance benchmarked against the plan	(Fryer, 2004; Hart & Banbury, 1994)

For example, Cheunga et al. (2003) describe how vision can be used to give an identity to stakeholders as well as to project activities. Similarly, Hart (1994) and Fryer (2004) describe how stakeholders can be integrated toward critical decision making. However, Fryer (2004) mentions that sometimes stakeholders are limited to carry out activities as they are designed by the project manager. Conversely, Hart (1994) opines that employees are allowed and expected to be willing to take risk through experiments and learning. Considering these suggestions, the current study identifies six policies to integrate stakeholders: vision, mission, transaction with stakeholders, allow learning and improving, permission to experiment and risk taking as well as assigning responsibilities toward performance benchmarked (Table 2.6). The current study investigates how project managers use these politics towards strategy crafting and implementation in construction projects.

After the three dimensions are discussed in-detail, purposes of strategies are considered. In this way, the link between strategies and construction project planning can be made.

2.3.3 Purpose of Strategies in Construction Project Planning and Implementation

This section describes comprehensively on the purpose of using strategies. Therefore, the section explains the fourth section added to the three dimensions of strategies De Wit and Meyer (2004).

As mentioned in section 2.2.2, complexity, dynamism, uncertainty and uniqueness are challenges for construction project implementation. The current study reviews capabilities of current planning tools to cope with challenges. Then, the research continues to find out the scope of strategies to minimize insufficiencies that is found in current planning tools.

Past studies show that current engineering practices are not capable to handle complexities and uncertainties because many engineering curricula are underpinned by Technical Rationality (TR) (Dias, 2002). TR approaches describe most physical phenomena in terms of engineering science and mathematics and are inadequate to handle complex situations (Dias & Blockley, 1995). Thus, Schon (1992) introduced another paradigm, 'reflective practice' (RP), as an alternative to solving practical problems. Similarly, Winch (2010) recommends that construction practitioners must become reflective practitioners and apply holistic disciplines from inception to completion of a construction project. This study recognizes the purpose of strategies to eliminate deficiencies of TR by introducing philosophical concepts of RP. The following section would therefore describe both paradigms (TR and RP) as possible tools for planning construction project delivery, and present their limitations to give credence to a complementary approach to construction project planning and implementation.

2.3.3.1 Concepts of Technical Rationality (TR)

Kinsella (2007) uses the following definition given by Schon (1987) to differentiate TR from RP:

> "Technical rationality holds that practitioners are instrumental problem solvers who select technical means best suited to particular purposes. Rigorous professional practitioners solve well-formed instrumental problems by applying theory and technique derived from systematic preferably scientific knowledge" (Schon (1987) as cited by Kinsella (2007, p. 104)).

According to the definition, TR is characterized by 'selective inattention' and can provide solutions for problems which are described through theoretical phenomena only (Kinsella, 2007). However, most social, political and cultural issues, which may be the ones that mostly influence construction project success, are very difficult to describe in scientific or mathematical terms (Dias & Blockley, 1995). The statements of Construction Manager of the Year Award (CMYA) winners, UK, provide credence for

Dias and Blockley's (1995) statement that theoretical formulation cannot describe real world's problems:

> *Tottenham Court Rd, London*- "Surrounded on three sides by third parties - a grade II listed theatre and a foreign embassy at that - the project was uncomfortably tight" (CMYA, 2010a, p. 2).
>
> *UK Supreme Court, London*- "…. remedial works would take 14 weeks …. need scaffolding around the entire building perimeter…. associated delivery and craneage requirements risked jeopardizing the fit-out client would entertain no extension of the program" (CMYA, 2010b, p. 1).
>
> *Manchester Joint Hospitals*- "With program, quality and financial challenges mounting, a senior management shake-up two years into the project included the arrival of Keith Lovell to take charge of a demoralized team" (CMYA, 2010c, p. 1).

Further, Dias and Blockley (1995) articulate that TR provides a reductionist approach to issues. Therefore, practitioners are supposed to provide answers by dividing the whole into parts. However, one may ask: can separate parts replace or even explain the whole? For example, Dias and Blockley (1995) use biological phenomenon: living organisms are able to talk and walk due to cooperation amongst the sub-holons (such as skeleton and nervous system) that make up the body, but these sub-holons themselves do not contain those abilities. To achieve success in construction project, there can be several sub-holons such as time, cost, quality, sustainability and safety considerations. However, if anyone considers one dimension separately, projects may fail in other dimensions.

Further, it is necessary to understand basic behaviours of any project management environment before any decision is made (Rand, 2000). However, Dias and Blockley (1995) explain that TR paradigm is context independent. Therefore, applicability of TR is limited in real world scenarios. Table 2.7 provides credence to support the context dependency/independency nature of construction projects by summarizing some past studies from literature that the focus is on critical success factors in construction projects belonging to different contexts. It is observed that inclement weather, low labour productivity and subcontractors' issues become prominent sources of delays in US construction projects (Table 2.7). However, when it comes to Hong Kong, the most severe delay factors are completely different from those in the USA. Even within the same country, different delay factors have been found by different authors (UK [13] and

UK [18] of Table 2.7) according to the summary given by Chan and Kumarswamy (1997). Therefore, contextual influence becomes essential to consider in any valid planning approach.

In addition to context independency, TR paradigm is criticized as being practitioner independency (Dias & Blockley, 1995). Many past studies express that construction project success or failure is highly influenced by the project manager and other stakeholders (Akintoye, 1997; Bourne, 2007; Fryer, 2004; Walker, 2007). According to these natures, TR approaches are not reliable to practical situations (Dias, 2002).

Table 2.7: Factors causing construction project delays in different contexts (Chan & Kumarswamy, 1997)

Factors affecting project delays	**US [12]**	**UK [13]**	**developing countries [14]**	**Turkey [15]**	**UK [16]**	**Nigeria [17]**	**UK [18]**	**Nigeria [19]**	**Saudi Arabia [20]**	**Hong Kong [21]**	**Indonesia [22]**
Inclement weather	*	*			*						
Labour shortage/low labour productivity	*			*					*		*
Poor sub-contractor’s performance/high degree of sub contracting	*	*			*				*		
Variation (Design changes/extra work)		*		*	*				*	*	*
Unforeseen ground condition		*			*					*	
Material shortage/late material delivery		*		*	*	*		*			*
Inadequate construction planning			*	*							*
Financial difficulties				*		*		*	*		
Delays in design work/lack of design information				*	*						
Poor site management						*		*	*	*	
Impractical design					*						
Poor communication					*					*	
Inappropriate type of contract used					*		*				
Lack of designer’s experience							*				
Inaccurate estimation								*	*		*

Dias and Blockley (1995) state that TR approaches follow Hard Systems Methodology (HSM) for which problems and solutions are considered as well-defined (Al-zahrani, n.d; Checkland & Scholes, 1990). However, under messy and complicated situations, problems cannot be well-defined and there are no exact solutions (Dias, 2002). Having recognized these deficiencies in TR, the following section reviews current planning tools related to construction project implementation to identify their TR natures.

2.3.3.2 Technical Rationality (TR) Natures in Planning Tools

Mensi (2010) says that project scheduling can be considered as one of the most important part in project management. More importantly, Belassi and Tukel (1996) mention that many people try to find solutions for construction project failures through development of better scheduling techniques. Similarly, Sawhney et al. (2003) stress that scheduling facilitates practitioners to have clear pictures of construction activities as well as their sequences and resource requirements. The current study reviews four project scheduling techniques: Critical Path Method (CPM), Project Evaluation and Review Technique (PERT), Critical Chain Planning Method (CCPM) and Earned Value Management (EVM). In addition, the section describes cash-flow forecasting related to construction project planning. Systematic review on these traditional planning tools can help the study to identify pitfalls associated with them consequently to identity the complementary role of strategies to improve the reliability of construction project planning.

Critical Path Method (CPM)

CPM seems to be the most widely used scheduling technique in construction project planning (Yang, 2003). Mensi (2010) has found that 98% of the top 400 contractors from the Engineering News Record in the USA use CPM for planning and scheduling. Further, as cited by Mensi (2010), Hawkins (2007) has investigated that all small and medium scale construction firms use CPM at least sometimes in their projects. Therefore, significant improvements can be expected if CPM is reliable or can be developed to be adequately efficient. Regardless of its heavy usage, there are criticisms related to the reliability of CPM in project planning (Rand, 2000).

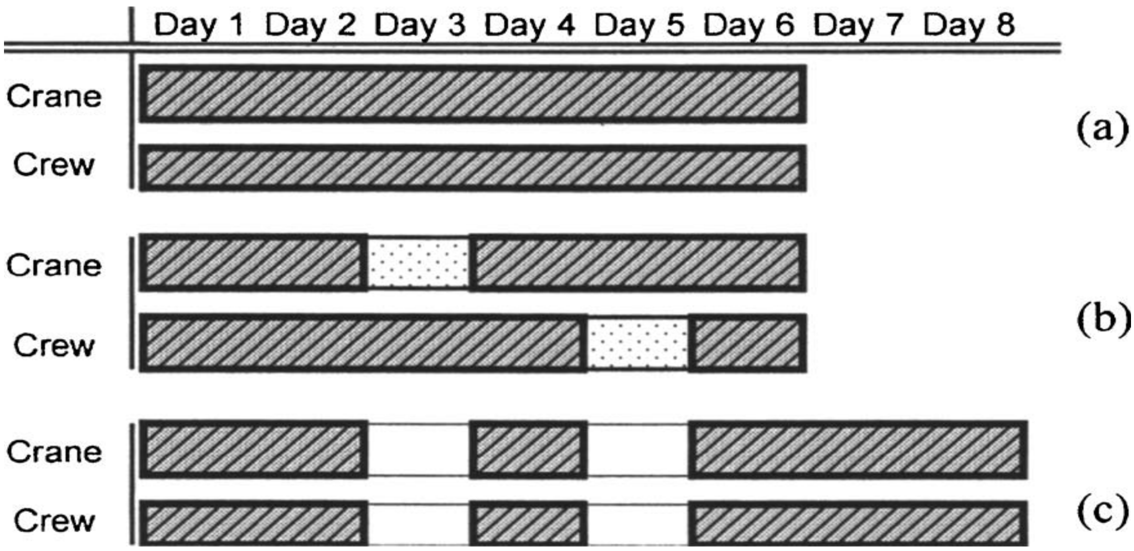


Figure 2.10: Early start time (EST) and early finish time (EFT) adjustment in critical path method (CPM) under resource constraints (Lu & Lam, 2008)

Rand (2000) says that CPM as well as PERT have limitations with respect to the applicability in the industry. CPM assumes unlimited duration and infinite resource availability, and hence indicates that it is somewhat impracticable for the uncertain conditions of the industry (Lu & Lam, 2008; Yang, 2003). Complementary analyses such as cost-time trade-off analysis, resource levelling and cash flow management are suggested to eliminate these inappropriate assumptions, but these complementary analyses are criticised similarly for the reductionist characteristics they contain (Mensi, 2010). Lu and Lam (2008) depict one complementary approach, which is early start time (EST) and early finish time (EFT) adjustments in CPM under resource constraints, as shown in Figure 2.10. The diagram can be used to explain the disadvantages associated with reductionism in CPM.

Although case (a) assumes infinite resource limits in the conventional CPM, it does not happen in actual practice. Case (b) shows the actual case where crane and crew are not available at two different times. Under these resource constraints, case (c) becomes the possible solution. In this case, the reductionist planning methodology focuses only on resources. Therefore, the solution seems to extend the duration of the activity and hence conflicts with timely completion objectives. Under these kinds of situations, project managers may have to make some arrangements to keep all concerned satisfied, such as using different construction methods or balancing the workforce with other activities. CPM itself does not have the ability to handle multiple constraints (Hegazy & Menesi, 2010). Having noticed that the traditional CPM alone seems to be unreliable, sometimes, the traditional CPM together with its software applications are recognized as useful only for reporting purposes, but not for decision making (Kuhn, 2006). Because of these limitations, several studies have focused on improving the traditional CPM to increase its reliability (Hegazy & Mensi, 2010).

As an example to improvements, Lu and Lam (2008) introduce a transformed scheduling scheme that is applicable to non-finish-to-start relationships (i.e. start-to-start, finish-to-finish and start-to-finish) in project network diagrams (PDM). The aim is to avoid errors in float calculations as well as to minimize consequent misleading interpretations with critical path identification. The scheme transforms all precedence relationships into finish-to-start relationships, allowing software packages (e.g. MS Project, Primavera, and others) to detect floats accurately when only a part of an activity becomes critical as opposed to the whole activity (Lu & Lam, 2008). However, these solutions focus on calculation errors only. They cannot deal with fundamental deficiencies associated with basic assumptions such as limited resource constraints.

Further, Hegazy and Mensi (2010) make fundamental differences to the conventional CPM. They stress that CPM uses the activity level as the analysis block under planning. The activity level is a rough level for construction project planning and micro planning is necessary within the activity level to make schedules more reliable. Therefore, Hegazy and Mensi (2010) developed the Critical Path Segment (CPS) method, which separates the duration of an activity into its segments to enable micro planning (see Figure 2.11). As opposed to CPS, CPM considers activity durations as continuous blocks of time (Hegazy & Menesi, 2010).

Ability to convert fuzzy non finish-to-start relationship into simple finish-to-start relationships, improve decision making through detailed representation of actual progress (Figure 2.11) are some advantages of CPS over CPM. However, the current study perceives that still CPS does not handle project contingencies effectively. For example, Hegazy & Menesi (2010) as well as Jaafari (1984) opine that the reliability of schedules depends on the correct estimation of a crew's productivity. Neither CPM nor CPS explains methods to estimate labour productivity accurately.

Suggested improvements have sometimes been criticized by saying that developments have contributed to additional issues rather than giving solutions (Rand, 2000). For example, to eliminate uncertainties in schedules, Hegazy & Menesi (2010) recommend adding buffers in-between activities, but this suggestion is criticized in construction management discourse (Fallah et al., 2010).

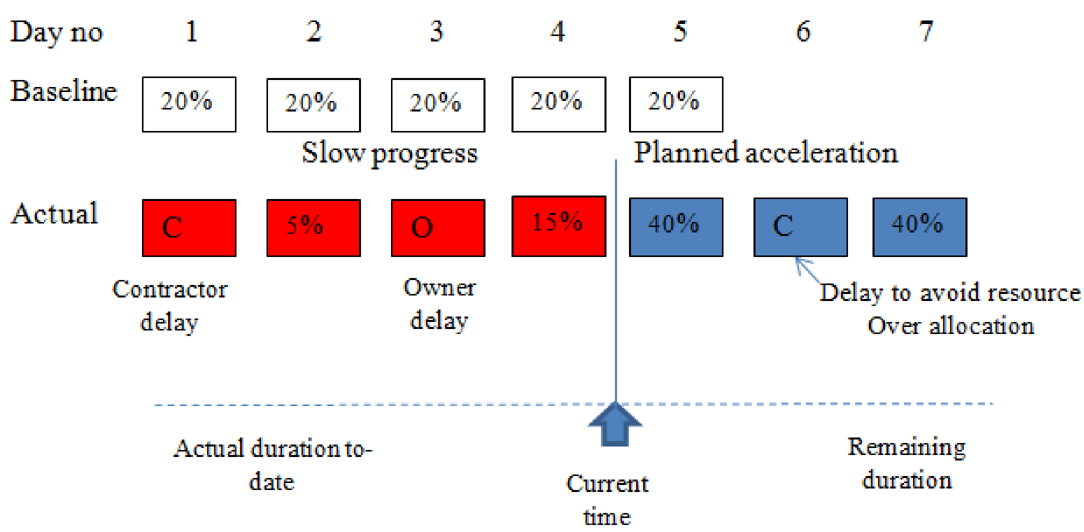


Figure 2.11: Sample representation of a critical path segment (CPS) within an actual progress (Hegazy & Mensi, 2010)

Fallah et al. (2010) find that there is a tendency in humans to leave work to the last moment. This is known in project management discourse as the 'student syndrome' (Fallah et al., 2010). Further, because reasonable safety time is added to all activity durations through probabilistic calculations, Rand (2000) sees that buffers are unnecessary. Similarly, Yang (n.d) mentions that given schedules have much safety time, buffers make schedules uncertain and unreal. However, Rand (2000) questions: if enough safety times are added, why are construction projects not completed on-time? Similarly, adding buffers is identified as a reason to hinder smooth workflow because buffers maintain a redundant capacity without adding any value to a project (Lee et al., 2006). Therefore, under the current study, the addition of buffers is recognized as another reductionist approach which concerns only time, but not productivity. Even with redundant capacities, buffers may be used just-in-case when high uncertainties and risks are associated with construction projects (Lee et al., 2006). Reflecting on these opinions, the current study considers that the addition of buffer is not a universal theory. Rather, buffers may be applied in some projects after considering particular contexts.

In addition to planning and scheduling, CPM is widely used for progress monitoring and decision making. However, Mensi (2010) criticized CPM as a tool only for progress monitoring by saying that CPM does not show the real cases which construction project delays are caused consequently CPM is inadequate to make decisions.

Further, Clough et al. (2008) mention that there are many salient activities for which strategic thoughts are required that CPM cannot reflect. Examples include (Clough et al., 2008): What should be done? How should it be done, and in which means? What is the optimal start and finish times for an activity? Although the aim of CPM is at explaining some of these aspects, CPM does not explain procedures to decide these criteria in a reliable manner (Clough et al., 2008). Further, Glenwright (2004) mentions that scheduling, which CPM focuses on, is only one ingredient of planning. As he mentions there are many other things that can govern project success such as planning resources, operations, facilities and interfaces together. These critics imply that traditional CPM as well as suggested improvements (such as CPS) cannot provide realistic solutions for construction project implementation alone. Therefore, the current study focuses on finding the suitability of a strategy-led approach as a complementary planning tool for construction project planning.

Program Evaluation and Review Technique (PERT)

PERT is a widely used planning tool to estimate activity durations under uncertainties and which has its rigors on probabilistic methods (Cottrell, 1999).In this section, the current study reviews literature on two approaches related to PERT: the conventional PERT and Cottrell's simplified PERT. Their reliability and usability are considered in the review. PERT pays considerations to calculate durations of activities under uncertainties (Cottrell, 1999).

$$T_e = \frac{(a + 4m + b)}{6} \qquad \text{Equation 2.1}$$

T_e - Estimated time
a – Optimistic duration
b – Pessimistic duration
m – Most likely duration

Activity durations (T_e), which is shown in Equation 2.1, are based on probabilistic methods and derived by assuming a beta distribution. PERT estimates probable activity durations by using three parameters based on historical data: optimistic (a), pessimistic (b) and most likely (m) durations. However, criticisms based on the reliability of the calculations doubt the procedure since 1960's(Cottrell, 1999).

Although Equation 2.1 is based on a beta distribution, there seems to be no empirical study available to find out typical distributions of activity durations at the time when PERT was developed (Cottrell, 1999). Because of the assumption of beta distribution, Cottrell (1999) says that estimations of mean durations and variances can vary from actual values in significant amounts. Similarly, MacCrimmon and Ryzvec (1964) quantify that errors of activity duration estimations can be up to 33% in actual (as cited in Cottrell, 1999). Therefore, the reliability of PERT seems questionable.

In addition, scholars opine that it is difficult to calculate the parameters a, b and m for each activity (Cottrell, 1999; Lau et al., 1996). Since people are not good at extreme values, Lau et al. (1996) state that optimistic and pessimistic durations are usually ambiguous. Therefore, Cottrell (1999) proposes a simplified approach for PERT calculations.

Cottrell's (1999) simplified approach considers only the most likely duration of an activity consequently it reduces the amount of calculations dramatically. Instead of beta distribution in the conventional PERT, Cottrell's (1999) method assumes a normal distribution of the data. Table 2.8 compares estimates of project durations for both conventional and simplified PERTs by using values given in Cottrell's (1999) study.

Cottrell (1999) calculates project durations with 80% probability (T_{80}) for 12 construction projects. T_{80} values are given according to the conventional and simplified PERT (2nd and 3rd columns of Table 2.8) in line with Cottrell's (1999) study. Based on these values, the current study calculated the ratio of $T_{80\ conventional}/ T_{80\ simplified}$ as shown in the last columns to compare conventional and the simplified PERT estimations.

Table 2.8 shows that the ratio of $T_{80\ conventional}/ T_{80\ simplified}$ is close to 1. Therefore, there are no considerable differences between conventional and simplified PERT's project durations. Therefore, one can argue that there is no use of doing so many calculations on the conventional PERT. From a statistical point of view, beta distribution tends to be normal when its shape factors, α and β, are larger and approximately equal (Alfers & Dinges, 1984). This can be the reason to have almost similar results under the two approaches. On the other hand, giving approximate estimates to the conventional PERT leads to the conclusion that Cottrell's simplified version is similarly unreliable as the conservative method.

Table 2.8: Experienced PERT project duration probabilities for conventional and simplified PERT, adopted from Cottrell (1999)

Project	**T_{80}**		**$T_{80\ conv}$ / $T_{80\ simpl}$**
	Conventional PERT	**Simplified PERT**	
A	94.1	94.8	0.99
B	58.4	58.3	1.00
C	44.7	44.7	1.00
D	62.9	62.6	1.00
E	302.9	301.5	1.00
F	13.9	13.9	1.00
G	75.9	74	1.03
H	14.5	14.4	1.01
I	13.4	13.4	1.00
J	52.8	53.2	0.99
K	8.6	8.5	1.01
L	78.3	77.3	1.01

Finally, Cottrell (1999) compares hypothetical values gained through the simplified approach with actual project durations and has found that errors in mean and variance are slightly higher than conventional PERT calculations. It is not surprising to see slightly larger errors in simplified PERT calculations because it has the limitation that activity durations are assumed to follow a normal distribution as opposed to a beta distribution: beta distribution uses non-zero skewness and non-zero kurtosis in addition to population mean and standard deviation. Previously, Cottrell (1999) criticizes the use of beta distribution without empirical evidences, but assumes normal distribution only because it was the only option left to retain a probabilistic procedure under the simplification. However, at the end of his analysis, Cottrell (1999) found that actual activity durations show considerable absolute values for skewness which is a controversial observation to his normality assumption. This implies the limitations of mathematical procedures to solve real world problems as described under TR. Scholars have suggested that objective calculations in PERT should be replaced with subjective interpretation (Long & Ohsato, 2007; Moder et al., 1983).

PERT encourages practitioners to use historical records objectively. For example, probabilistic calculations do not use any information with respect to contexts (quality standards, technology used, time period, and the amount of complexity) from which historical data has been taken. In statistical perspectives, it can be said that these estimates are underpinned on classical statistics and dominated by academic research. However, in methods designed for practical situations, it is required to use prior knowledge (Long & Ohsato, 2007), which is one rigor of Bayesian statistics (Lynch, 2007).

As a general case, imagine All Blacks has a statistical mean for winning of 75% with a standard deviation of 5%. Classical statistics encourages All Black supporters to think that there is a chance of 65-85% ($\mu \pm 1.96\sigma$) to win the next game with 95% confidence. However, if supporters know that their top five players are not in the game (kind of prior information according to Bayesian statistics),would they still have the same confidence and chances about winning the game? Therefore, when the theories are applied into practice, subjective interpretations seem to be required in cases where situations are not 100% defined and well certain.

In the context of PERT, Moder et al. (1983) say that parameters such as ‘a’, ‘m’ and ‘b’ must be subjective and hence are based on judgment. According to their opinions, actual parameters may or may not be related to statistical samples taken into account. Therefore, practitioner dependency seems dominant over practitioner independency. Further, the construction industry is identified to be unique in nature. Therefore, adequate historical data may not be available for all activities (Long & Ohsato, 2007). In which case, practitioners need to implement corrective actions when estimations go wrong. Therefore, as similar to CPM, the current study posits that a complementary approach is required to eliminate these deficiencies in PERT.

Critical Chain Planning Method (CCPM)

CCPM is a planning method developed from the Theory of Constraints (TOC) (Rand, 2000). Rand (2000) describes five steps involved in TOC:

1. Identify the system’s constraints
2. Decide how to exploit the system’s constraints
3. Subordinate everything else to the above decision
4. Evaluate the system’s constraints and,
5. If in the previous steps, a constraint has been broken, go back to step 1.

According to Rand’s (2000) steps of TOC, CCPM demands personal skills to identify problems and create solutions and hence the requirements are in line with RP. Therefore, the basis of CCPM needs complementary methods or more clarifications which can enhance making corrective actions. In addition to these fundamental steps, calculation procedures of CCPM are considered.

Unlike CPM and PERT, CCPM can consider resource constraints and logical constraints simultaneously (Zhao et al., 2010). Further, addition of buffers in CCPM is prominent over CPM. CCPM adds three kinds of buffers to project schedules: project buffer, feeding buffers and resource buffers (Rand, 2000).

A project buffer is added at the end of a project to protect the program from time overruns. This is a strategic way to add safety (Rand, 2000). Unlike in CPM, where safety times are added at the end of each and every activity, the student syndrome is not present in CCPM project buffers (Rand, 2000). Feeding buffers, which is present only in CPM, are added at the end of all non-critical activity chains. Therefore, non-critical activities could not be in the critical path at later stages (Fallah et al., 2010).

However, despite the advantages mentioned above, there are many criticisms developed around its reliability and applicability. One of the major controversies revolves around its project buffer, saying that buffer calculation procedure has no dynamic nature. CCPM adds 50% from the sum of the critical chain duration as the project buffer. This is recognized as misleading, for example a 10-year project needs to consider a 5-year buffer. For projects in low risk environments, this is a misleading provision (Fallah et al., 2010). Addition of project buffer seems to be based on mathematics which is the fundamental of TR. Considering these facts, Fallah et al. (2010) introduce a new method for buffer sizing by considering level of uncertainties individually at the activity level.

Fallah et al.'s (2010) procedure assume Lognormal distribution for activity durations. The modified analytical procedure calculates risk or uncertainty by using four parameters: the difference between mean and median, coefficient of variation, skewness and kurtosis. Further, for each and every activity, these four parameters must be calculated and compared to find out combinations before the project buffer is estimated (Fallah et al., 2010).

Over conventional CCPM, the procedure seems to have improvements such as consideration of activity natures separately. However, the method concentrates on mathematical techniques (probability) and historical data. Therefore, the procedure is still context and practitioner independent consequently its roots are in TR paradigm.

Earned Value Management (EVM)

The main focus of EVM is to compute performance indicators in terms of cost and time subsequently to decide necessary corrective actions (Fleming & Koppelman, 2002). As shown in Figure 2.12, EVM is used to measure schedule and cost variances at a given time based on three parameters: actual cost (AC), planned value (PV) and earned value (EV). Using these three parameters, EVM is able to predict probable cost and schedule variances at completion.

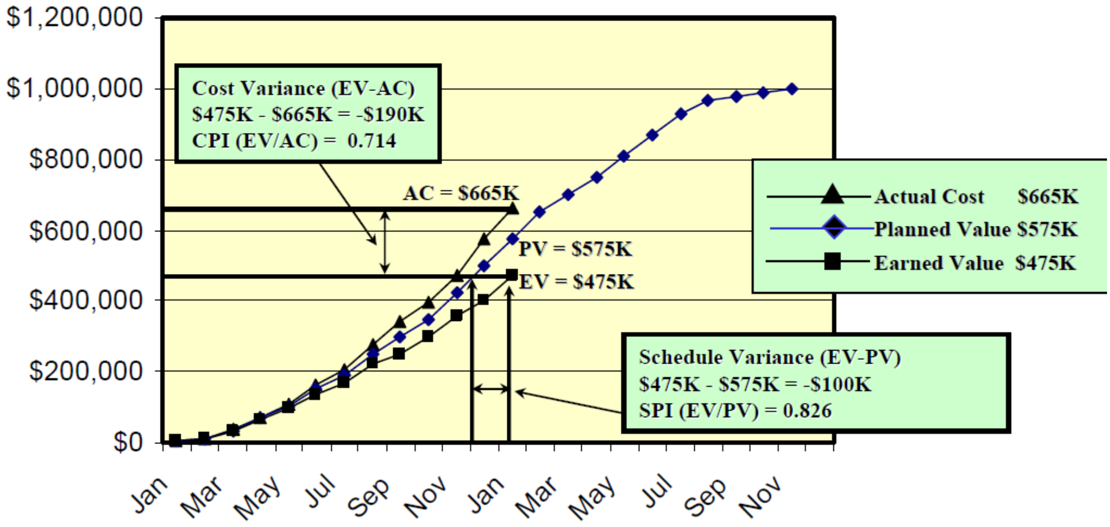


Figure 2.12: Calculating cost and schedule variances (USAID, n.d)

It seems that EVM can assist construction project planners to understand situations better through the parameters calculated. For example, EVM calculations can be used to identify the severest variance among cost and schedule variances. Therefore, construction project planners can pay more attention to the most curtail variance to take immediate actions. Further, EVM parameters give an independent estimate about completion time that can be compared with critical path to predict planning accuracy(Jones, Meyer, & Flanagan, 2009). Similarly, construction project managers can calculate Schedule Performance Indicators (SPI) regularly and represent them graphically to identify causes and effects for either effectiveness or ineffectiveness (Jones et al., 2009). However, there seems to be additional and important considerations to use EVM effectively (USAID, n.d).

The US Department of Defence articulates that practitioners must decide the right time to perform cost and schedule calculations (USAID, n.d). In addition, identification of causes of variations, deciding appropriate corrective actions and preparing reliable future schedules need practitioners artistry (USAID, n.d). Therefore, it seems that complementary tools that focus on decision making are required to work with EVM.

Further, EVM considers cost and schedule variances separately; it is hence a reductionist approach. The overall effect of both cost and time variance can have a different effect toward project success. In addition, EVM estimates of cost and time at completion are based on an assumption that further works continue at linear rates and hence again characterized by mathematics. Since construction projects progress usually with varying rates (Lee et al., 2006), these estimations seem to give misleading interpretations. Therefore, the current study posits that EVM need complementary approaches that introduce RP natures such as the actual nature of construction projects in its calculations.

Cash-flow Forecasting

Finally, to show the limitations of TR, the study considers cash-flow forecasting which focuses on financial management. Construction companies use standard value S-curves as a simple and fast method to forecast cash-flow into their projects (Kaka & Price, 1993). However, many post-studies provide credence against the applicability of nomothetic models to forecast cash flow without considering particular project contexts (Kaka & Price, 1993).

From an experiment carried out by using 25 construction projects, Hardy (1970) finds that there is no such correlation (S-curve) between project cash flow even after projects are filtered into different groups based on payment types (Kaka & Price, 1993). Further, Oliver (1984) analyses cash flow details from three construction companies, saying that historical data are not capable of estimating any individual project cash-flow. Finding unique nature as the reason for violating unified rules, the aforementioned scholars acknowledge idiographic approaches into construction project management practice.

Misleading cash-flow forecast can produce deficits of money in construction projects according to the above discussions. This seems to be a very crucial issue when scarcity of money occurs at the beginning of a project because contractors need to provide money from their companies to keep constructions in progress. Kaka and Price (1993) find that deficits in projects can impact the overall liquidity of companies (Kaka & Price, 1993). This is specifically crucial for the construction industry because the industry has a very high level of bankruptcy rate (20.37%) due significantly to the scarcity of money (Shim & Kim, 2011).

Therefore, if the construction companies use standard S-curve models as an easy method to forecast cash flow there can be variations when implementations are carried out and, consequently, corrective actions may become necessary. Therefore, the current study perceives cash-flow forecasting through S-curve as another context independent planning tool where its rigors are in TR. Having noticed that the planning tools are characterized by TR, the study summarizes limitations of TR.

In conclusion, the examination of current planning techniques rationalizes limitations of TR and gives credence to limitations associated with planning tools. Table 2.9 provides an overview of four planning tools: CPM, PERT, CCPM and EVM. The planning tools are explained under four TR deficiencies: Reductionism (R), Selective Inattention (SI), Context Independency (CI) and Practitioner Independency (PI). Table 2.9 is a summary to the facts that the current study discussed previously under planning tools.
Dias and Blockley (1995) explain that TR approaches had worked successfully for about 300 years until the middle of the 20^{th} century. Since then, limitations of mathematics have emerged through several theorems such as Godel’s theorems, Heinsenberg’s uncertainty principle, Chaos theory and complexity theory (Dias, 2002). Therefore, an alternative paradigm, RP, is suggested to cope with complexities and uncertainties.

The study articulated above that the discussed planning tools cannot provide holistic solutions. Estimates underpinned on probabilistic and/or mathematical calculations do not adequately consider construction project context and its unique features. Further, even though careful consideration is given to estimates, contingencies can cause variations. Methods suggested in literature to cope with variations (such as addition of buffers) have contributed to additional problems as discussed above. These factors limit the transfer of planning results toreal-world application (Schon, 2001).

Despite these inefficiencies, past literature shows that planning tools are one of the key factors for construction project success (Hegazy & Menesi, 2010; Lu & Lam, 2008). Lu and Lam (2008) explain that activity nodes together with precedence relationships can represent construction technology and other constraints of complex projects. The purpose of the current study is to explore a complementary planning approach to eliminate these deficiencies discussed above. In literature, complementary approaches have been suggested as supplements to sub-optimal planning tools.

Table 2.9: TR natures in commonly used planning tools (CPM and PERT show the same characteristics)

	CPM/PERT
R	Managing time, quality and cost as separate sub-problems and violating other requirements when one sub-problem is addressed. Considering non-critical activities separately may cause them to happen in critical path later.
SI	People's attitudes such as 'student syndrome' cannot be formalized.
PI	Activity durations are based on probabilistic mathematical procedure. Practitioners are not encouraged to use their judgment and experience.
CI	Nature of the activity, construction pace and site conditions are not considered.
	CCPM
R	Quality considerations must be considered separately.
SI	Though constraint removal is reduced, identifying constraints and taking decisions demand practical skills in addition to engineering knowledge.
PI	Buffer calculations are dominated by probability based mathematics.
CI	50% duration from the sum of critical activities is added as the project buffer without considering actual risk levels.
	EVM
R	No way to account for the whole extent of the effect of cost and schedule variances.
SI	Difficult to find the optimum time for performance calculations based on theories.
PI	Variances are predicted from monitoring records, practitioners work as calculators.
CI	Predictions do not consider wavering progress in projects.

R - Reductionism **SI** - Selective Inattention **PI** - Practitioner Independency **CI** - Context Independency

There are past studies which have suggested using complementary approaches to minimize inefficiencies associated with traditional planning tools. As a case in point, Oloufa et al. (2004) suggest to use Design Structure Matrix (DCM) with CPM to make use of opportunities for optimization during the design phase. CPM alone does not have this feature. Similarly, since the manufacturing and aerospace industries are the origins of network-based scheduling, Sawhney et al. (2003) mention that scheduling techniques generally disregard the context of construction projects. Therefore corresponding modifications or complementary approaches are needed to merge characteristics which are specific to the construction industry. Chen, et al. (2003) find that contemporary scheduling techniques need to use complementary approaches to cope with complexities and uncertainties. Therefore, the current study takes a position that reliable complementary methods are required and should be based on the characteristics of RP to minimize deficiencies of TR.

2.3.3.3 Concepts of Reflective Practice (RP)

Kinsella (2007) use the following quotation given by Schon (1987) to describe on who is a reflective practitioner:

> "In a practitioner's reflective conversation with a situation that he [or she] treats as unique and uncertain, he functions as an agent/experimenter. Through his transaction with the situation, he shapes it and makes himself a part of it. Hence, the sense he makes of the situation must include his own contribution to it. Yet he recognizes that the situation, having a life of its own distinct from his intentions, may foil his projects and reveal new meanings" (Schon (1987) as cited by Kinsella (2007, p. 108)).

As opposed to selective interaction in TR, RP is characterized by reflective interaction. Thus, by reflecting in-action and on-action, practitioners become encouraged to act on problems through a learning process with a high level of thoughtfulness (Schon, 1992). Dias (2002) articulates that reflective interaction helps to provide answers for problems which cannot be clarified through engineering phenomena.

RP is not reductionist, but encourages practitioners to think about entities both as a whole and in parts (Dias & Blockley, 1995). This is known as holism and it encourages project managers to obtain global understanding about decisions. In the context of construction project management, Rand (2000) opines that stakeholders must consider all project objectives holistically in terms of cost, time and quality.

On the other hand, RP encourages decision makers to modify unified theories by considering the context of a problem (Schon, 1992) and hence solutions are context dependent (Dias, 2002). RP demands practitioners' artistry and experience to tackle real world problems (Dias & Blockley, 1995) and hence the paradigm is known to be practitioner dependent. Practitioner dependency is recognized as a requirement to making construction project implementation reliable.

For example, Akintoye (1997) analyses risk factors associated with construction project management and articulates that mitigation actions mainly depend on the amount of intuition, judgment and experience. Probably along a similar line of thought, Ganaway (2006) suggests that lack of experience is a main trigger for both project and company level failures in the construction industry. Bourne (2007) also recognizes that instinct and experience are the primary means to acquire knowledge in construction project implementation. Having recognized RP characteristics, the study considers tools required to implement RP.

2.3.3.4 Approach to Practice of Reflective Practice (RP)

The purpose of RP is to provide solutions to messy situations through heuristic procedures (Dias, 2002). Dias and Blockley (1995) suggest the use of Soft System Methodology (SSM) to practice RP.

As opposed to Hard System Methodology (HSM) in TR, SSM posits that the world is complex and confusing (Masurier, 2001). Problem identification is not straightforward and hence Checkland (1981) opines that the practitioner has to begin from identifying where to improve. As well as problem identification, there are no exact answers to be provided (Checkland, 1999). Al-zahrani (n.d) gives an example of how the transfer of highly sophisticated technology from Western countries to Saudi Arabia can be achieved. Entirely different political, cultural and social considerations must be taken into account when potential solutions are decided. SSM is based on the principles of multiplism, which usually generates answers from heuristic procedures (Al-zahrani, n.d) consisting of iterations and learning that are similar in RP.

SSM encourages practitioners to solve complicated and messy problems through two core concepts: interconnectedness of hierarchically arranged concepts and process loop with interaction and feedback (Dias & Blockley, 1995). The interaction between hierarchical elements facilitates the practitioner to perceive an issue as both a whole and a part, i.e. a holon (Dias & Blockley, 1995). Further, the process loop, also known as the RP loop, suggests to find answers through personal interactions with the situation. The loop consists of four elements: the physical world, perception, reflection and action (see Figure 2.13). In addition to methodologies, Dias and Blockley (1995) mention tools which are applicable to RP.

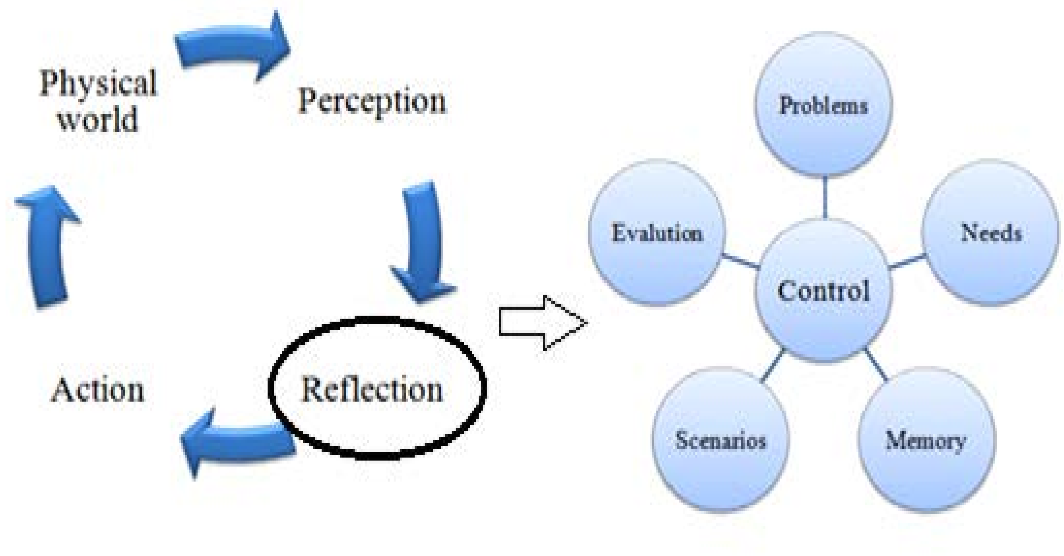


Figure 2.13: The reflective practice (RP) loop and the process of reflection(Dias & Blockley, 1995)

There are several tools suggested for heuristic procedures such as Decision Support System (Kassab et al., 2010), Innovative Critical Chain Method (Zhao et al., 2010), microcomputer solutions, such as Artificial Intelligence (Dias, 2002), and strategies (Kumar, 2002).

Decision Support System (DSS): A Graph Model to Make Decisions Under Conflicts

Kassab et al. (2010) developed a decision support system (DSS) to resolve conflicts among project stakeholders. The graph model developed by them is shown in Figure 2.14. Kassab et al. (2010) articulate that conflicts can cause severe construction delays, low productivity as well as litigation due to disputes. They articulate that use of a DSS can minimize conflicts and hence contributes to project success. According to Kassab et al. (2010), DSS has the attributes of RP such as context dependency and allows decision makers to consider project context through several parameters such as ranking criteria (e.g. project delays, project cost increase etc.) and threshold limits (e.g. allowable amount of maximum delay). The graph model helps the decision makers to move between different decision making option and compare each other's preferences (Kassab et al., 2010). Further, parties involved in a conflict need to decide their preference levels on resolution alternatives based on threshold rules (see Table 2.10).

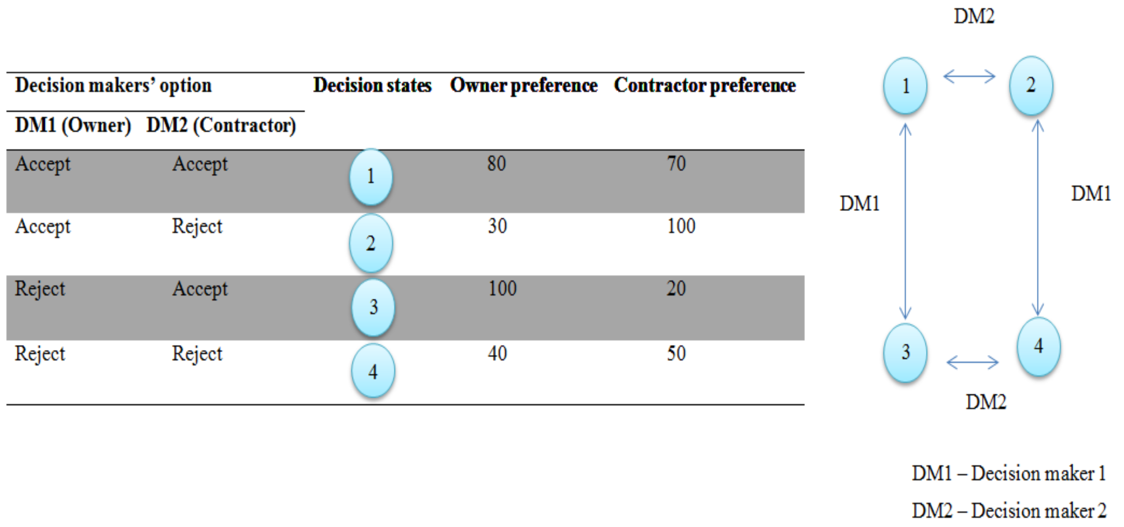


Figure 2.14: Conflict resolution between two decision makers (Kassab et al., 2010)

For example, the first column of Table 2.10 shows different criteria that should be considered to make a decision about the best resolution among five alternatives. The second column sets threshold limits for each criterion and based on these limits resolutions are categorized as either accepted or rejected. The last columns show scores given for five alternative solutions.

Table 2.10: Exemplary application of the elimination procedure (Kassab et al., 2010)

Ranked criteria	Threshold rules	Scores for resolution alternatives				
		Solution1	Solution 2	Solution 3	Solution4	solution5
Project delay (days)	≤15	5	100	50	60	5
Project cost increase (%)	≤10	10	100	60	50	15
Contractor reputation	≥B	B	D	C	D	B
Continuity of existing projects	≥B	C	D	C	C	A

The model can work in conflict resolution, but the current study believes that the industry needs innovative approaches to support decision making in a higher hierarchy level than what a DSS offers. As a support to this proclamation, the study stresses the fact that conflict resolution comes only after identifying problems and deciding alternative solutions. Further, quantification of threshold limits as well as deciding preference levels among threshold criterion would become a sophisticated process that seeks education, experience and qualities of the decision maker. Thus, the current study perceives DSS as a part of decision making process. The next section considers the pros and cons of Innovative Critical Chain Method (ICCM) which is another heuristic procedure.

Innovative Critical Chain Method (ICCM)

Zhao et al.(2010) introduce ICCM as a tool that could help manage messy and uncertain situations based on an improved genetic algorithm. Calculating buffers comprehensively, the algorithm modifies CCPM to provide more realistic project schedules. ICCM intends to identify the critical chain of a project and develop a revised algorithm to estimate both project and feed buffers. ICCM is considered under RP in the current study since it encourages the use of heuristic procedures similar to SSM.

However, even for CCPM, a few software packages have been developed such as Prochain, CCPM+ and Scitor Pro Suit whose capacities are limited to basic calculations only (Patrick, 2004). The second scepticism is the lack of reliability associated with these computer programs to implement heuristic procedures (Underhill, 1994). Underhill (1994) explains further that these computer manifestations are recognized as 'greedy algorithms' by mathematicians. Underhill (1994) experiments a reserve selection algorithm for Biological Conversation and finally comes to the conclusion that greedy algorithms deliver correct solutions occasionally, but there is no certainty that they do. Underhill (1994) found that computer manifestation may also produce grossly suboptimal results. Use of microcomputer solutions are also suggested by scholars(Dias & Blockley, 1995; Fryer, 2004) as alternatives to make decisions through heuristic procedures.

Using Microcomputer Solutions to Make Decisions

Dias and Blockley (1995) mention Artificial Intelligence (AI) as the suitable tool to implement RP. AI has abilities to capture and store experts' knowledge and can consider human intelligence, experience as well as artistry (Dias & Blockley, 1995). Further, it can recommend alternative solutions and identify possible strategies (Fryer, 2004). Therefore, unlike DSS, AI seems to consider decision making process as a whole. Further, Kumar (2002) mentions the applicability of advanced software packages to enhance construction managers' capabilities. However, regardless of competencies, AI is recognized as unsuitable for the construction industry.

Kumar (2002) has found that micro computer technologies involve hefty investments. Conversely, Betts and Ofori (1992) as well as Ramanayaka and Rotimi (2011) have found that the majority of construction enterprises are of small scale. Therefore, the ability of construction companies to invest money on costly solutions is questionable. Further, if cost is a major concern of construction project success it will be cynical to apply an additional overhead cost to cover these expensive solutions.

Further, artificial neural networks (ANNs) related to AI should be nourished with expertise knowledge and training before they start simulating actual situations (Boussabaine, 1996). Therefore, in the context of construction management, ANN is similar to create artificial project managers. However, Fryer (2004) believes that human brain is much more elaborate than even the most advanced AI models. Boussabaine (1996) and Rand (2000) make similar conclusions that even the most expensive software packages cannot duplicate functions of the human brain completely.

Dias and Blockley (1995) describes the purpose of AI tools in the context of structural design:

> "…rules such as found in a design manual regarding sizing could be fed into a knowledge-based system that could be used to perform the initial sizing. Such a system would contain rules such as if a beam is of type continuous and carries a uniformly distributed load of value medium then the beam depth is span/12" (Dias & Blockley, 1995, p. 164)

Reviewing the above quote, one can see that AI is supposed to store knowledge and to work on that storage. When there are so many variables to handle, AI may provide solutions faster than the human brain if required knowledge has been fed correctly. Hence, AI related to construction project planning seems to duplicate an experienced construction project manager. Since these microcomputer solutions are costly for the construction industry, Kumar (2002) suggests that strategies are the most important single factor to improve systems.

Strategies as a Human-centred Approach to Practice Reflective Practice (RP)

Rand (2000) suggests using human-centred approaches to make decisions through identifying core problems and inventing breakthrough solutions. The process includes many questions: ‘what to change’, ‘to what to change’, and ‘how to cause the change’, etc. (Rand, 2000). Similarly, De Wit and Mayor (2004) introduce ‘strategic reasoning’, which includes identifying, diagnosing, conceiving and realizing as the elements of process, to make decisions generatively.

In addition, the strategy process loop introduced by De Wit and Meyer (2004) seems to provide some properties of RP. For example, problem identification as well as the creation of a solution is considered as messy and ambiguous in the strategy process loop similar to SSM. Interconnectedness between stages of the strategy loop encourages the practitioner to consider facts both as a part and a whole. In addition, the strategy process loop as well as the strategic reasoning loop facilitates the strategist to improve systems through learning and feedback.

There are both positive as well as negative aspects about ‘strategy’ and its applicability to generative decision making. Some authors argue that strategic approaches can only support rational methods (Andrews, 1987; Porter, 1998). Conversely, there are scholars who suggest that strategic approaches can only support generative methods (Ohmae, 1982). However, more recent studies conclude that there is no exact way to craft strategies (Abeysekara, 2007). Rather, it can be either rational or generative (Abeysekara, 2007). Similarly, successful strategy making should be a right combination of logic and creativity (Mintzberg et al., 1998; Price & Newson, 2003). According to these perceptions, it seems that the scope of strategies extends in a spectrum of methodologies as discussed under strategy typologies. The current study considers the advantage of strategies to work as both rational and generative in construction project panning because engineering practice is a combination of both TR and RP paradigms (Dias & Blockley, 1995).

2.3.3.5 Relationship between Technical Rationality (TR) and Reflective Practice (RP)

As shown in Figure 2.15, Dias and Blockley (1995) identify three kinds of relationships between the two paradigms: TR can become the context of RP, RP can become a precondition to TR and RP becomes a constraint of TR.

In practice, TR can become the context of RP. Dias and Blockley (1995) describe the choice of a building layout as an example of this relationship. In this process, cost minimization, which is a focus of TR paradigm, becomes one consideration among several variables such as client’s requirements, soil conditions and past experience. Dias and Blockley(1995) articulate that these other factors can be interpreted by using RP knowledge and hence, TR can be considered within the context of RP.

Likewise, RP can become a precondition to TR. For example, in structural analysis, the designer idealizes initial sizes based on his experience and this idealization process can be taken under the RP paradigm. With this precondition, frame analysis, which is based on the principles of TR, is carried out to find out structural responses.

The third relationship is where RP becomes a constraint to TR. Dias & Blockley (1995) describe this relationship by using structural element design: determination of reinforcement quantities by using the laws of statistics is a TR approach. However, they explain the necessity of RP considerations to make the design rational. For example, different reinforcement combinations and bar spacing must be considered to facilitate field construction and based on market availability of bar sizes. The above discussion shows that both TR and RP paradigms are necessary to be integrated to nearly represent actual situations.

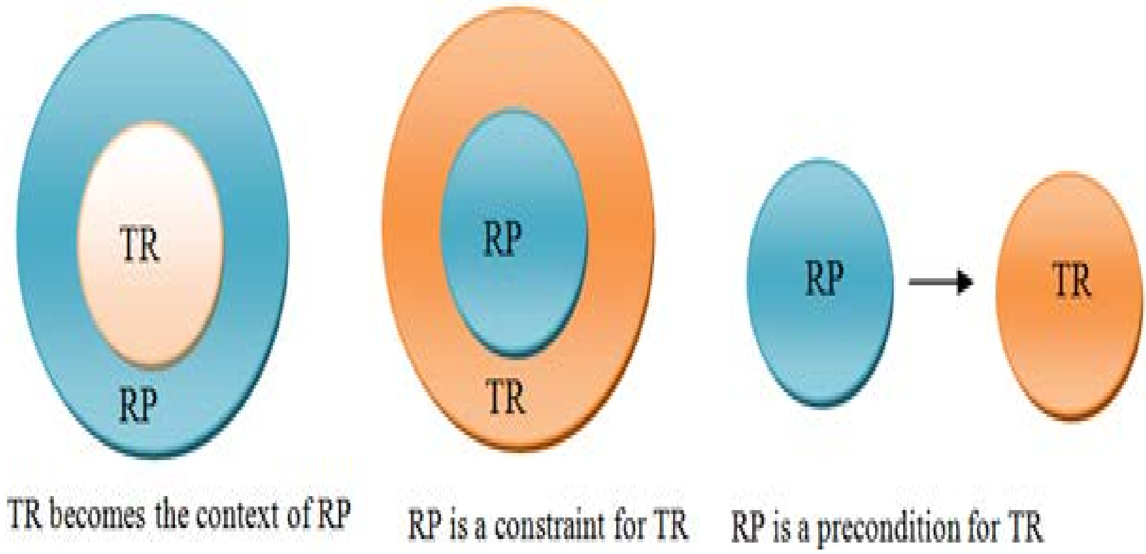


Figure 2.15: Possible relationships between technical rationality (TR) and reflective practice (RP) (Dias & Blockley, 1995)

Figure 2.16 is a framework for activity duration estimates and can be used to describe the necessity of both RP and TR paradigms related to construction project planning. As the first step, an appropriate hourly output should be selected.

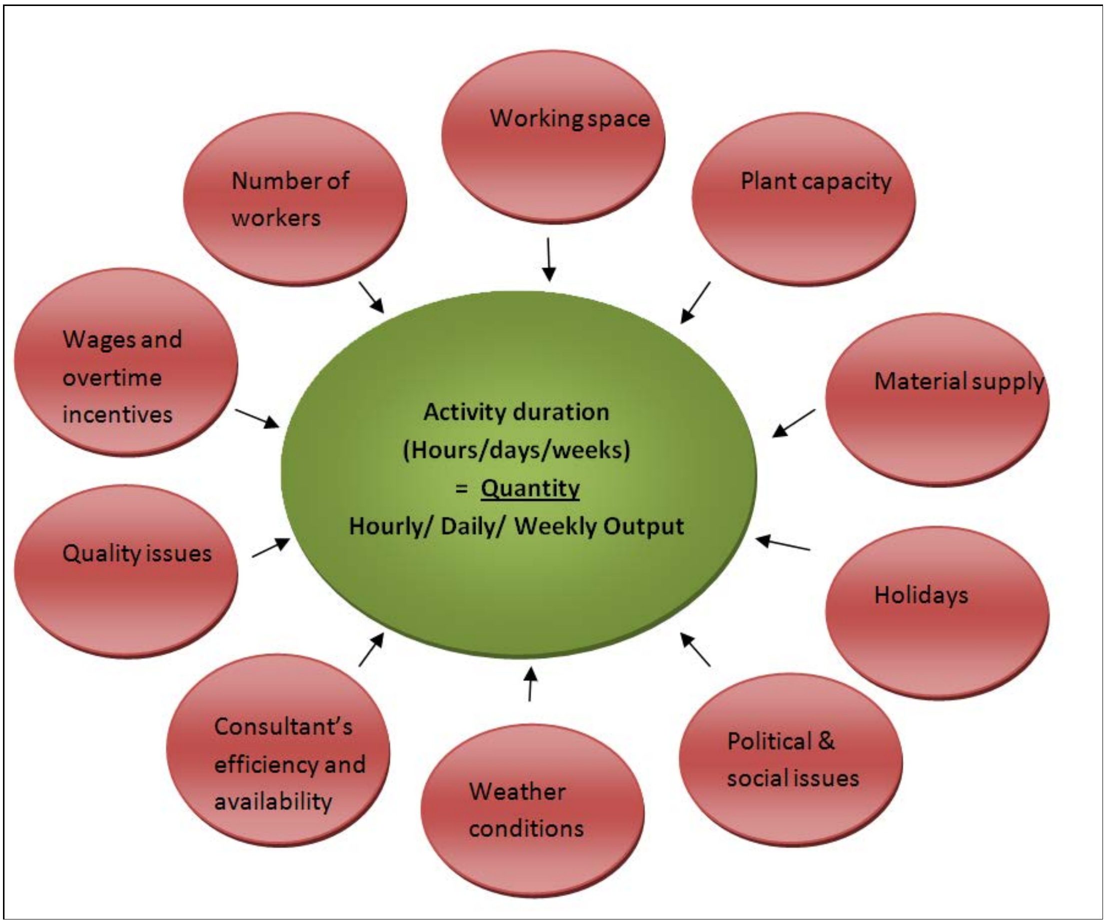


Figure 2.16: Factors to estimate activity durations in construction projects

TR paradigm encourages practitioners to select an hourly output from work norms or historical data such as ‘a’, ‘b’ and ‘m’ in PERT. However, RP can become more sophisticated than TR, encouraging practitioners to consider factors that influence the hourly output in practice such as material supply, number of workers, consultant’s efficiency, required quality and working space etc. Further, based on timely and budgetary constraints, several construction methods may be considered before deciding an optimistic hourly output. After deciding an appropriate hourly output, the estimation process becomes simplified to basic mathematical operations which can be described through TR. The example shows that the two paradigms together can create a realistic end result. Therefore, while finding the suitability of strategies for project planning, the current study investigates the contribution from TR and RP paradigms toward the strategy-led approach.

Further, TR is theoretical while RP is based on experience and artistry (Dias, 2002). Therefore, a methodology that combines TR and RP encourages the use of education, experience and qualities together to solve problems. Education is regarded as explicit knowledge which is documented, structured, fixed, externalized and conscious (Egbu, 2004). As example to explicit knowledge of construction management, theoretical rigors of CPM, PERT, CCPM and EVM can be given. Egbu (2004) articulates that someone's experience and qualities together make another form of knowledge called 'tacit knowledge', which Dias and Blockley(1995) recognizes as knowledge required to solve practical problems under RP. Therefore, use of education, experience and qualities can be considered as another indication to perceive strategy-led approach as a combination of TR and RP. The usage of explicit and tacit knowledge is to be investigated under the current study. Since strategies are supposed to ultimately achieve success, it is required to understand what 'success' means in the construction industry.

2.3.4 Ultimate Aim of Strategies: Construction Project Success

It seems from literature that an exact definition or nomothetic measurements cannot be given to measure construction project success. Belassi & Tukel (1996) stress that cost overruns and time extensions are no more suitable to consider as failures now, because these incidents are widespread in construction projects today. Further, Belassi & Tukel (1996) articulate that despite delays contractors make profits. Similarly, Gardiner and Stewart (2000) opine that neither project managers nor project sponsors believe anymore in projects to be delivered on time and within budget.

Project failure may refer to situations where a project is terminated prior to its completion due to legal, social, political, technological, environmental or budgetary constraints (Pinto & Mantel, 1990). In the current study, these kinds of situations are not considered failures. People see project success and project management success as two different things because objectives of a project and project management are two different things (Bourne, 2007; Munns & Bjeirmi, 1996). Munns and Bjeirrmi (1996) clarify that time, cost and quality, which are the objectives of project management, are not suitable criteria to measure project success. For example, although The Millennium Dome Project in London, UK, could meet its project management objectives, now it is considered as a white elephant due to the insufficient benefits it has delivered (Bourne, 2007) . Vice versa, construction projects that are completed with cost overruns and delays such as the Sydney Opera House in Australia can still deliver significant benefits to societies over their life spans (Munns & Bjeirmi, 1996). In spite of these arguments, the current study does not consider any life time benefits as success; the scope of success is limited to the project implementation stage only.

Table 2.11: Commonality of different factors to measure construction project success (Chan et al. 2002)

Success measures	No of projects	No of projects %
Time and cost	15	75
Quality	15	75
Satisfaction of project stakeholders	7	35
Health & safety	5	25
Budget/financial performance/profitability	5	25
Meeting technical performance specifications	3	15
Productivity/efficiency	3	15
Project objectives/goal attainment (technical)	2	10
Completion	2	10
Functionality	2	10
Expectation of project stake holders	2	10
Dispute resolution satisfaction/conflict management	2	10
Absence of conflicts/legal claims	2	10
Environmental sustainability	2	10
Professional image	1	5
Aesthetics	1	5
Educational, social, and professional aspects	1	5

Chan et al. (2002) explain success measures used by different studies to evaluate project success over a decade. Although the aim of their study is to develop a framework to evaluate success in design-build projects, they tabulate success measures without considering contract types as a variable. There are 17 factors which they have identified and the current study frequency counted them to perceive their commonality (Table 2.11). There is no study considering all 17 exhibited criteria to measure construction project success. Out of 20 research studies referred by Chan et al. (2002) , 75% of the authors consider four or less than four criteria to measure success . Parfitt & Sanvido (1993) use the highest number of measures which is equal to 11, but their expectation is to provide a checklist that allows professionals to predict potential pitfalls and corrective actions that should be taken before their occurrence. According to the frequency count shown in Table 2.11, cost, time and quality are the most frequently used success measures that account for 75% of the studies for each measure. These gauges are followed by client satisfaction (35%). Finally, based on the perceptions of literature, cost, time, quality and client satisfaction are selected as the most relevant success measures for the current study.

2.4 Conclusion of the Literature Chapter

This chapter has reviewed past literature and identified that project failures and productivity issues are common in the construction industry according to global and NZ contexts. The review of literature implied that complexity, dynamism, uncertainty and uniqueness are key characteristics which project planning and implementation is made difficult (Wong, 2010; Zhao, 2010 & Abesekera, 2007). Evolvement of management encourages practitioners to solve problems in real-world practice through innovations to cope with the key characteristics of construction projects (Fryer, 2004).

The review of literature shows that there are several innovations and advancements which are suggested over decades to cope with complexity and uncertainty in the context of construction project planning. However, most of those suggestions are conceptualizations where implementation is not done in the industry. Critics are developed around those suggestions regarding their reliability and adequacy (Rand, 2000). Through investigating the underpinnings of those suggestions, this chapter could identify that their roots are on the hard systems methodology where both problem identification and solutions are considered as straightforward methodologies through the use of mathematical procedures such as probability (Dias & Blockley, 1995). However, within uncertainty management through probabilistic procedures, there are certain assumptions such that calculations are based on a particular data distribution. This chapter corroborate facts from past literature that such certain assumptions are not applicable to dynamic sectors like the construction industry. Hence, the current study evaluates a planning methodology where contexts of a project can be integrated into traditional planning algorithms by the use of subjective knowledge that comes from personal experience and skills. Further reviews indicated that a strategy-led approach is suggested in literature to cope with increasing complexities in construction project planning by replacing or at least embedding tactical considerations within the context of strategic thoughts (Abeysekera, 2007 & Kumar, 2002).

However, literature on strategies highlights the fact that strategies are not investigated to a satisfactory level related to the construction industry. Betts and Ofori (1992) have found this gap about two decades ago, but still researchers stress that strategic model developments are relatively new in the industry (Kassab et al., 2010). Ofori (1990) opines that the relative simplicity related to construction activities can obstruct strategic adoptions in construction projects. However, what Ofori (1990) means by simplicity seems to be controversial when other scholars' reviews are considered: since the 1950s, the construction industry is recognized as complex (Fryer, 2004). Considering these arguments, the current study deems to evaluate strategy-led approaches regarding their suitability towards construction project planning and implementation.

One of the major objectives to fill the gap is to evaluate the behaviour of projects success (in terms of cost, time, quality and client satisfaction) under project characteristics (complexity, dynamism, uncertainty and uniqueness) if planning and implementation are done through a strategy-led approach.

To describe the strategy-led approach, this chapter found that the use of the three dimensions (i.e. process, content and context) can provide a holistic view. In other industries like manufacturing, marketing and business, these three dimensions are evaluated satisfactory (Thompson, Strickland & Gamble). However, there is no study that the three dimensions are evaluated in the context of construction project planning and implementation. There are a few studies (Abesekera, 2007) that some concepts of the strategy content are suggested. However, this chapter found that those suggestions are also characterised by the dominance of mathematical procedures which are now considered as inadequate by their own (Dias, 2002).

Under strategy process, there are some steps identified in literature related to reasoning and implementation. Those steps are evaluated in the contexts of construction project planning under the scope of this study. Under strategy process, the role of construction project manager is identified with particular emphasizes to strategy crafting and implementation, which is another objective of this study. Further, timely influence towards construction project strategies is identified by using the conceptual and implementation stages of a construction project.

Under the content, strategy focus is evaluated by using critical success factors. Thus, this evaluation of the influence of construction project strategies towards critical success factors implies the suitability of the strategy-led approach in another way to plan and implement construction projects. Another major concern of strategy content is to evaluate the strategy-led approach as a combination of several typologies. There are a few typologies suggested by past scholars as paradoxes, which are rational versus generative, spontaneous versus deliberate and transformational versus revolutionary. Although the right combination is found in other industries (Hart & Banbury, 1994), there are no past studies which the compositions of these typologies are identified in the context of construction projects.

In this chapter, stakeholders were identified as one of the major constitutes of strategy context. In literature, the contribution of different stakeholders towards strategy crafting and implementation is still to be evaluated. From the review of literature, there are different integration strategies (vision, mission, experiment and risk taking, etc.) that construction project managers can use to integrate other stakeholders, but their suitability is also to be identified yet. Therefore, the findings of the three dimensions of the strategy-led approach are considered as useful within the scope of this study.

In addition to the three dimensions, Betts and Ofori (1992) articulate the necessity to understand the purpose of strategies. By reviewing CPM, PERT, CCPM, EVM and cash flow forecast techniques such as S-curve, it was identified that traditional planning tools are characterized by selective inattention, reductionism, context independency and practitioner independency which are the natures of TR. The alternative paradigm of TR proposed in the current study, RP, encourages practitioners to solve problems through a learning process. Past scholars have suggested heuristic processes such as DSS, ICCM and AI, but the current study identifies limitations with these suggestions. Kumar (2002) hence suggests strategies as the best alternative approach. Therefore, the purpose of the strategy-led approach is to eliminate these deficiencies of traditional planning algorithms by introducing reflective interaction, holism, context dependency and practitioner dependency into construction project planning. Further discussion of this chapter found that a combination of TR and RP can make realistic schedules and plans for construction project implementation. However, the suitability of the strategy-led approach to integrate TR and RP characteristics into construction project planning is not investigated in actual. Thus, the current study focuses on filling this gap in the context of construction project planning and implementation.

Chapter 3. Theoretical Framework

3.1 Introduction

This study uses a theoretical framework to create a coherent perception about the relationships between the variables that the current study considers as relevant. Provision of clarification toward the relationships can help to understand the rationale behind the theorized relationships within the study. This chapter discusses the conceptual relationship between the major concepts of the current study, which are: strategy, project contingencies and project success. It discusses hypothetical constructs which can be used to explain a strategy-led approach in terms of three dimensions: process, content and context. Finally, the chapter defines clearly how the relevant variables are measured with their operational definitions whenever they are necessary. The theoretical framework provides directions for data analysis by clarifying the measurements of the current study and the investigated relationships.

3.2 Construction Project Success

Project success is a subjective measure which different stakeholders perceive in different ways and hence difficult to set exact measures to assess it in construction projects (section 2.3.4). This section discusses the meaning of 'success' within the context of the current study and clarifies how it is measured.

The study investigates the influence of strategies on success at the implementation stage of a construction project. Therefore, long term benefits that could be delivered to society over the life spans of projects are not considered within the scope of this study. Further, project termination prior to the completion due to legal, political and cultural issues is not taken into account.

As described in section 2.3.4, there are 17 measures which are used to evaluate project success at the implementation stage of construction projects. Different authors used different measures according to the scope of their studies, but cost, time, quality and client satisfaction have become the widely used success measures by majority of scholars (section 2.3.4). The current study is in a similar position that cost, time, quality and client satisfaction are the most relevant success measures for construction project planning. In addition to these four measures, overall success is considered as a holistic measure of success.

Sometimes project managers are expected and able to finish the projects within the original budget and duration although variations occur outside the scope, but there are other situations, in which the project managers are given additional time and extra budgetary requirements (CMYA, 2009a, 2009b, 2010). However, according to the CMYA award statements, projects, which are finished within time and without cost overruns because of variations, are considered by the industry as successful. Due to these subjective perceptions, the current study decided to consider construction projects which are already perceived as successful by the industry. The selection procedure is described later in section 4.6.3.2. The equations 3.1 to 3.5 given below describe how the measures are set in the current study.

The first four equations given below are set to compare initial goals with actual achievements in terms of cost, time, quality and client satisfaction. The last equation is set to indicate project success at delivery in a holistic manner. It combines the achievements of cost, time, quality and client satisfaction with weighting factors which the participants would specify in their responses.

$$Cost\ achievement\ (C) = \frac{\text{(Initial cost+Amount of outscope variations in terms of cost)}}{\text{Actual cost}} \ldots \text{.....Equation 3.1}$$

$$Time\ achievement\ (T) = \frac{\text{(Initial duration+Amount of outscope variations in terms of time)}}{\text{Actual time}} \text{.. Equation 3.2}$$

$$Quality\ achievement\ (Q) = \frac{\text{(Perception on the final quality achieved)}}{\text{Intended level of quality achievement}} \ldots \ldots \ldots \ldots \ldots \ldots \text{ Equation 3.3}$$

$$Client\ satisfaction\ achievement\ (CS) = \frac{\text{(Perception on the client satisfaction achieved)}}{\text{Intended leve of client satisfaction}} \text{.Equation 3.4}$$

$$Overall\ success\ (O) = \frac{\text{w1C+w2T+w3Q+w4CS}}{\text{w1+w2+w3+w4}} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \text{.Equation 3.5}$$

The two concrete measures, cost and time, consider variations in achievements/ performance. Quality and client satisfaction are abstract measures, and the participants' perceptions on final and intended achievements were measured by using the scale given in Figure 3-1. The scale used is a modified version of the five point Likert scale, where, '0-20' is equivalent to 'very poor' at one end of the scale and '80-100' equivalent to 'very good' at the other end of the scale. This way, the participants are provided with more points to rate their perceptions, assuming that more points could help to increase the accuracy of the statistical analysis intended for study.

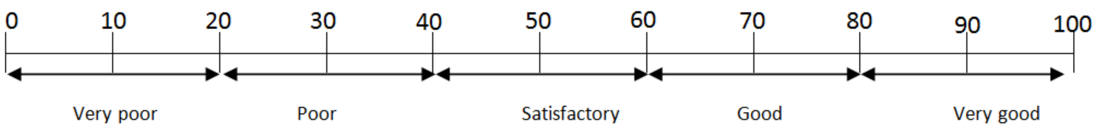


Figure 3.1: The scale used to measure actual and intended achievements for quality and client satisfaction

3.3 Characteristics of Construction Projects

The current study selected four key terms that are commonly used in literature to describe the characteristics of construction projects. The key terms are complexity, dynamism, uncertainty and uniqueness which project implemnatation is determined significantly (section 2.3.3). The preliminary research investigation further revealed that these four key terms affect construction project planning and implementation negatively. One of the objectives of the current study is to determine the extent to which the key terms are associated with construction projects. For the quantification, it is necessary to set measures as well as operational definitions for the four key terms related to the characteristics of construction projects.

The current study postulates that the four terms cannot be considered as mutually exclusive due to their inter-relationships. For example, a cause that adds complexities to a project can also lead to uncertainties. However, the study differentiates the four key terms by using operational definitions because potential differences between the four characteristics could affect strategy making differently. For example, complexity and uniqueness can be identified at the conceptual stage of a project and hence the strategist can craft strategies in advance. However, dynamism is a sudden change and may be overcome by creating spontaneous strategies. By considering these likely characteristics, the researcher introduced four operational definitions to the participants as shown in Table 3.1 to differentiate construction project issues under the four key terms. The suitability of using these operational definitions was reviewed by obtaining opinions of construction practitioners at two conferences (AUBEA 37th and RICS COBRA 2012) before they were incorporated into the primary data collection instrument of the study (Appendix A).

These four contingency terms are abstract measures. In a previous study undertaken by Hart and Banbury (1994) to find out how strategy-making makes a difference in construction projects, the authors used a five point Likert scale to measure complexity and dynamism . The current study modified the scale similar to the two abstract success measures in section 3.2. Therefore, '0-20' represents 'very low' and '80-100' corresponds to 'very high'.

Table 3.1: The operational definitions for the key terms of construction project characteristics

Characteristics	Meaning	Example
Complexity	Difficulty to grasp due to complicated nature	Complex design, technology used, procurement methods, client requirements
Dynamism	Sudden and regular changes to project schedule	Change in scope, internal and external influences on project performance
Uncertainty	Unpredictable or unexpected project events	Unforeseen performance requirements (ground condition, resource supply)
Uniqueness	Novelty of approaches to project performance	Novelty in the use of construction methods, type of project, procurement type or stakeholders

The postulations that complexity, dynamism, uncertainty and uniqueness affect construction projects negatively are hypothesized as follow:

H1: Complexity can influence construction project planning and implementation.

H2: Dynamism can influence construction project planning and implementation.

H3: Uncertainty can influence construction project planning and implementation.

H4: Uniqueness can influence construction project planning and implementation.

The hypotheses H1 to H4 represent the influence of the four key project characteristics into construction project planning and implementation. These relationships are illustrated in Figure 3.2.

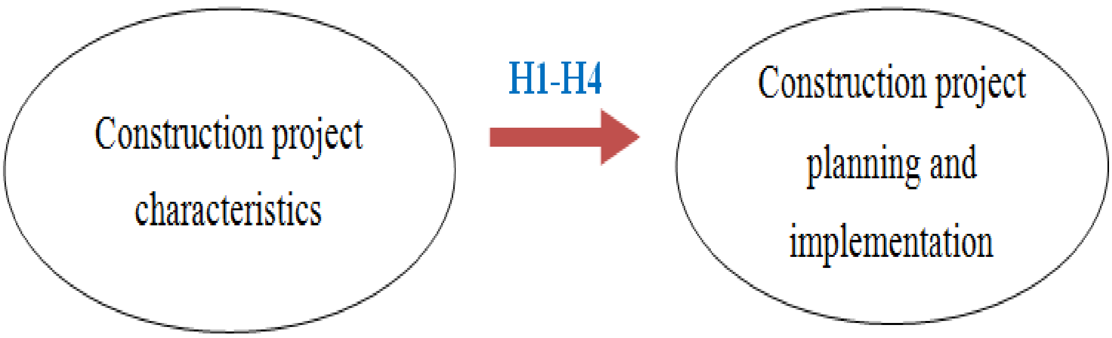


Figure 3.2: The conceptualized model between the contingencies, and construction project planning and implementation

3.4 Nature of Problems: Technical Rationality (TR) and Reflective Practice (RP)

As described above, the characteristic of construction projects is uncertain and complicated. Consequently TR approaches cannot provide solutions effectively due to their characteristics such as reductionism and selective inattention (section 2.3.3.1). As an alternative, from the review of lietarture, the RP paradigm is suggested based on reflective interaction and holism to solve problematic situations (section 2.3.3.3). Further discussions presented in the literature review chapter show that engineering practice requires the combination of characteristics of both TR and RP paradigms (section 2.3.3.5). The current study therefore determines the dominant paradigm with respect to the nature of problems. Two paradoxes are considered: selective interaction versus reflective interaction on one hand, and reductionism versus holism on the other hand.

Operational definitions are used within the study to investigate the nature of problems. These definitions were introduced to construction practitioners through the COBRA, 2012 conference before they were used in the primary data collection. The operational definitions are as follows:

Selective Inattention - Problem could be explained by using engineering theories.
Reflective Interaction - Problem could not be explained as a theoretical formation; experience and artistry was the key to explain problems.
Holism - Issues encountered on the project are interrelated with one another; each issue could not be dealt separately, without considering its interrelationship with other issues.
Reductionism - Issues encountered on the project are numerous but can be dealt with in isolation.

To measure different contributions from selective inattention and reflective interaction toward problem identification under construction project planning and implementation, the participants are asked to rate their overall perceptions about construction project issues on a scale given in Figure 3.3. The operational definitions of selective inattention and reflective interaction are assigned to point A (100,0) and point B (0,100) respectively.

Point A – Problem could be explained by using engineering theories
Point B – Problem could not be explained as a theoretical formation, experience and artistry was the key to explain problems

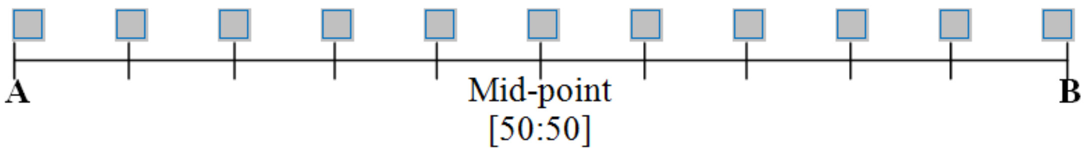


Figure 3.3: The scale used to measure selective inattention versus reflective interaction

Further, to determine the dominant nature among the two paradigmatic natures, the following hypothesis is set.

H5: Experience and artistry is more important than engineering theories to identify issues related to construction project planning and implementation.

The next paradox related to the nature of construction project implementation issues, and which is 'reductionism' versus 'holism', is measured by following the similar procedure to selective inattention versus reflective interaction. The following hypothesis is set:

H6: problems related to construction planning and to implementation are interrelated with each other.

With the introduction of H5 and H6, the conceptual model has been revised into Figure 3.4. RP and TR are considered in this investigation as two rival philosophies which are used to clarify problems that could be widespread due to the four characteristics (complexity, dynamism, uncertainty and uniqueness) of construction projects.

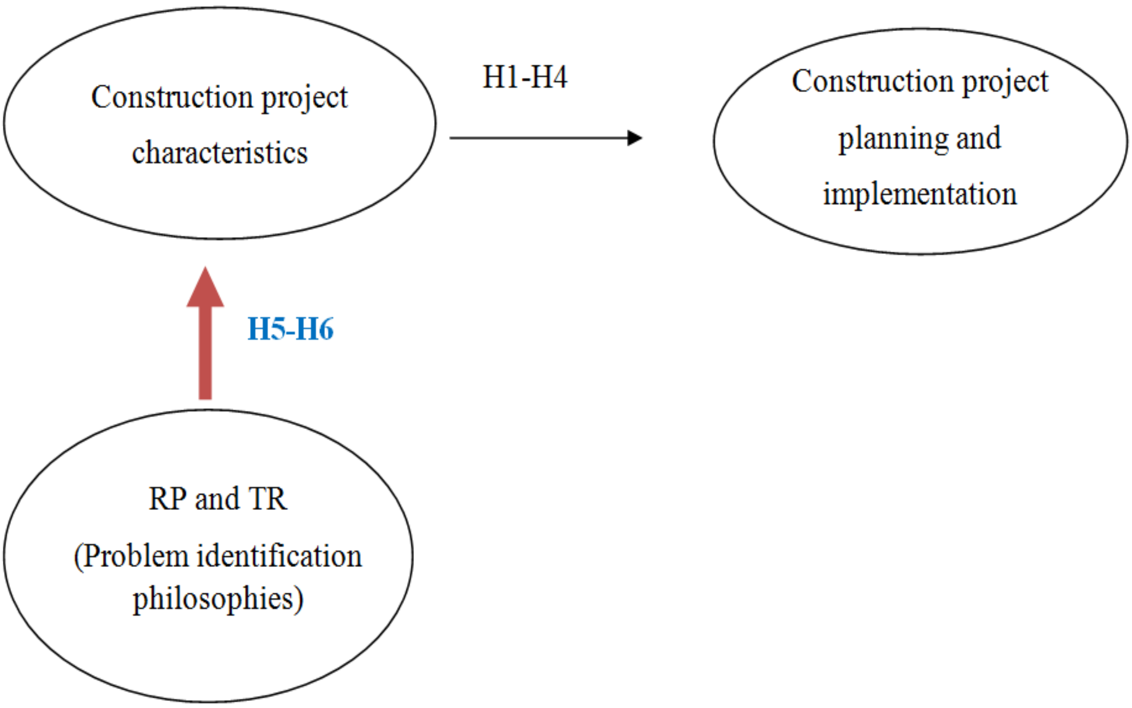


Figure 3.4: Modified conceptual model with H5 and H6

3.5 Strategies

The fifth research objective pursed by the study determines construction project implementation strategies. The current study focuses on determining project implementation strategies, which construction project managers use to handle their projects, in a systematic way according to the different stages of construction projects. The analysis is qualitative, consequently there is no hypothetical construct that can be used to integrate this analysis into the quantitative conceptual model. The analysis is depicted in Figure 3.5.

The participants of the study are given the operational definition for 'strategy' within the context of the current study as mentioned in section 2.3.1. They are asked to mention strategies that they have used to achieve ultimate success in their projects. However, strategies are supposed to be context dependent, which means that there could not be a list of universal strategies that are applicable to any construction project (Kumar, 2002). However, strategy focus can be more general as Kumar (2002) articulates. Therefore, the current study focuses on determining areas of strategy focus by analysing contents.

As shown in Figure 3.5, there are five contextual variables used to investigate relationships between the variables and strategy focus. Among the five variables, procurement type, payment type and type of projects are nominal variables. Two further variables, which are the duration and cost of projects, are measured using ratio scales. These five variables were selected under the thematic analysis since award selection procedures on successful projects by CIOB (relevant to the preliminary data collection) and NZIOB (relevant to the primary data collection) were done after categorizing projects into different groups by using these variables. Hence, the study is based on the assumption that these five variables can influence strategies that project managers use to achive successful outcomes at delivery. Under a thematic analysis, there are three kinds of strategies considered: conceptual, emerged and sub-strategies (Figure 3.5).

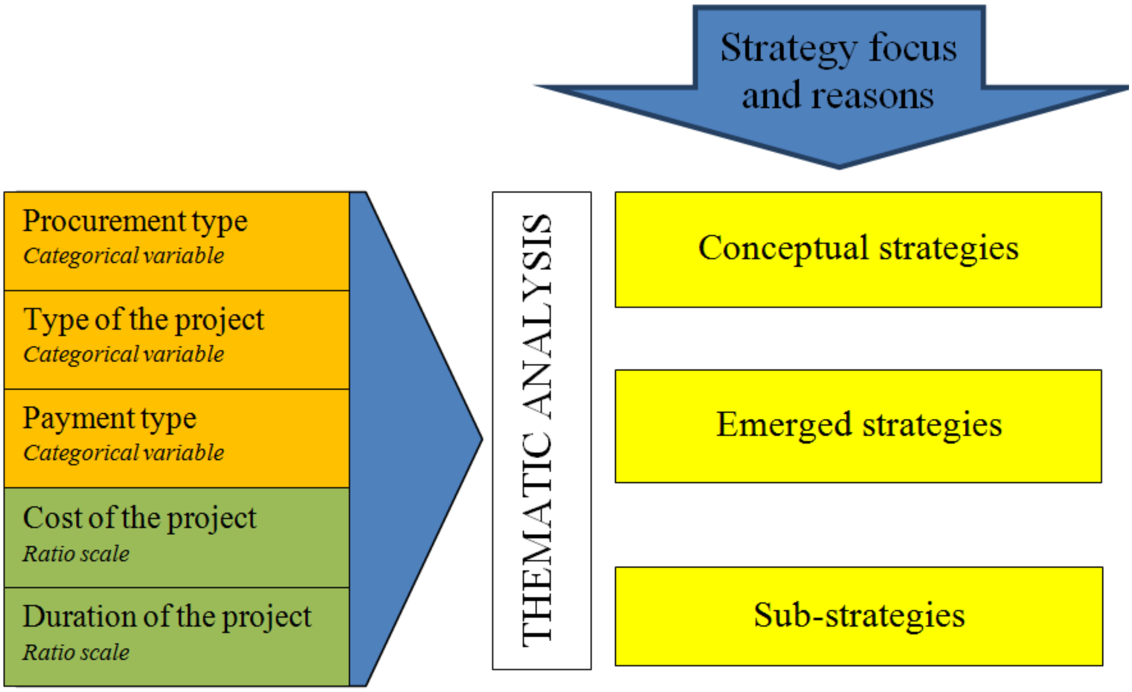


Figure 3.5: Conceptual model between the contextual variables and the strategy focus

3.6 Nature of Strategies: Technical Rationality (TR) and Reflective Practice (RP)

In section 3.4, the philosophical background related to problem identification in construction project implementation was discussed and consequently the hypotheses were developed. Similar to the approaches that are used to identify and clarify problems, solutions provided by current planning tools are usually criticized due to their inappropriate rigors. As mentioned in section 2.3.3.2, current planning tools do not consider the context which is particular to a construction project and hence planning tools are characterized under TR paradigm. Further, from the review of lietarture (Cottrell, 1999), existing tools handle uncertainties by using mathematical techniques such as probability, but do not encourage the use of practitioners' experience and artistry into handling uncertainties(section 2.3.3.2). Thus, in Chapter 2, those planning tools were identified as practitioner independent, in addition to context independent nature. By considering these facts, the current study postulates that strategies should be able to cope with these inefficiencies of current planning tools to become a successful complementary planning approach.

The following operational definitions are used to differentiate context dependency and context independency from each other throughout the study. The similar operational definitions were used in the COBRA 2012 conference where peer reviews were taken regarding the applicability of RP in construction project implementation.

Context Dependency - Strategic solutions created for construction project implementation issues is specific to the project context.

Context Independency - Strategic solutions created for construction project implementation issues can be applied generally to any project context.

The study postulates that if strategies are crafted by considering contextual variables that strategic solution is context dependent. The contextual variables considered are: value of the project, duration, scheduling, procurement, scope, design, legal conditions and site conditions. The influence of the contextual variables toward main and sub-strategies are measured by using a five point Likert scale, '5' being 'Very high' dependency and '1' being 'Very low' dependency. Having measured influences of the contextual variables toward strategies, the following hypothesis is set to find out the prevailing nature of strategies.

> H7: Strategies are made by considering the particular context of a construction project.

The next evaluation of strategies is related to practitioner dependency and practitioner independency. The operational definitions were open to peer reviewing in the COBRA 2012 similar to context dependency/independency.

Practitioner Dependency - Strategic solutions created for construction project implementation issues are greatly influenced by the practitioner's creativity and experience.

Practitioner Independency - Strategic solutions created for construction project implementation issues are straightforward and based on theoretical knowledge.

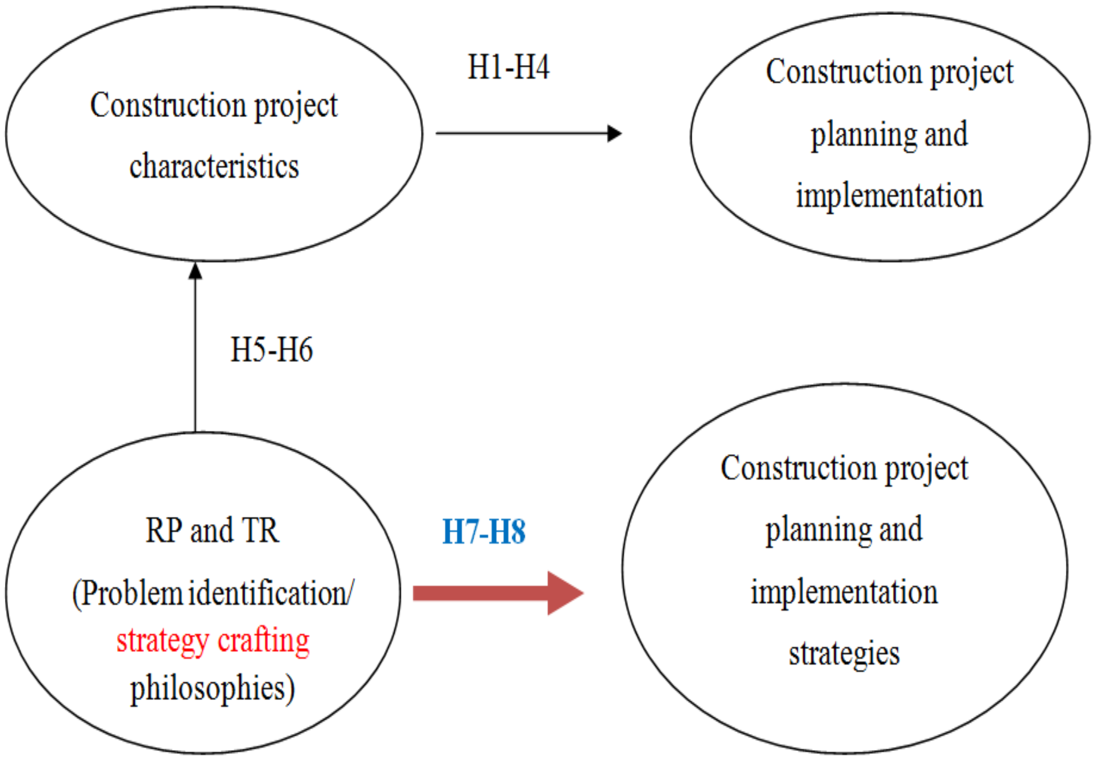


Figure 3.6: Modified conceptual model incorporating hypotheses H5 and H6

The strategy making process is used to find out how strategists use their education, experience and qualities in construction project planning and implementation strategies. The 7 steps of the strategy process identified in the literature review are:

1. Identify problems
2. Recognize needs to be addressed
3. Know strength and weakness of the organization
4. Craft strategies (solutions)
5. Set scenarios
6. Evaluate the solutions to find the best alternative
7. Implement the best strategy (including monitoring, feedback and adjustments)

Influence from education is considered as an indication of practitioner independency. Since tacit knowledge that comes from someone's experience and qualities depends on the person, use of experience and qualities are considered an indication of practitioner dependency. Research participants will be asked to rate the influence of their education, experience and qualities toward strategic solutions by using a five point Likert scale, '5' being 'Very high' influence and '1' being 'Very low' influence. The following hypothesis is set to evaluate the dominant characteristic among the two natures.

> H8: The strategy making process needs practitioners' experience and qualities more than educational qualifications.

In Figure 3.6, the circle related to TR and RP is modified by adding strategy making into the problem identification, which is another purpose of TR and RP as discussed in section 3.4. The two hypotheses, H7 and H8, related to strategy crafting can incorporate construction project implementation strategies into the conceptual model as shown in Figure 3.6.

3.7 Strategy Making Typologies

Strategy making typologies are another approach to express what kinds of strategies are used in construction projects and, therefore, the investigation is in line with the fifth objective of the current study.

According to the reviews of lietarture in section 2.3.2.2, strategy typologies should be selected according to the context of the study. With respect to the construction project implementation, strategy making typologies are defined in that section by using three bases: how are strategies made (rational and generative), what is the amount of preparedness (deliberate and spontaneous) and how stabile are strategies over time (transformational and revolutionary). Further, contradictory typologies are considered under opposites such as rational versus generative, deliberate versus spontaneous and transformational versus revolutionary. Although the review of literature showed that some authors mention the above six typologies as useful, these have not been evaluated by them in practice. Further, the current study determines what the predominant typologies in construction project implementation strategies are. In this process, use of different typologies should be measured. Consequently, operational definitions should be set for the six typologies. The operational definitions of typologies developed through reviews of relevant literature are mentioned in Table 3.2.

Table 3.2: The operational definitions of selected strategy typologies

Typologies	Operational definitions
Rational	Strategies are crafted in a logical manner by using engineering science and mathematical operations.
Generative	Strategies are crafted in a creative manner by using experience and personal skills.
Deliberate	Strategies are ready to be implemented.
Spontaneous	Strategy making is based on interaction and learning rather than the execution of pre-determined plan.
Transformational	Established strategies remain unchanged or changes incrementally with time.
Revolutionary	Developed strategies are changed and modified frequently.

In business administration, Hart (1994) uses a five point Likert scale to measure strategy typologies. Hart (1994) does not consider strategy typologies under opposites.

Considering this typology duality, the current study uses the scale shown in Figure 3.7 to measure the three paradoxes mentioned above.

Point A – Established strategies remain unchanged or changes incrementally with time.
Point B – Developed strategies are changed and modified frequently.

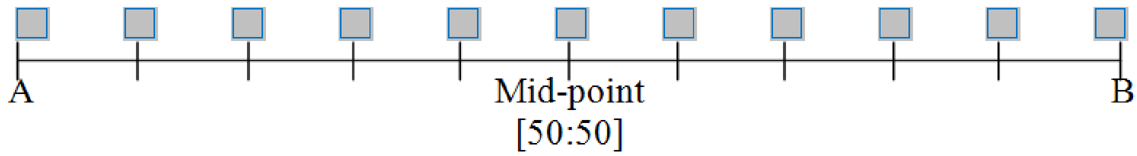


Figure 3.7: The scale used to measure the paradox transformational versus revolutionary

In Fugure 3.7, rival typologies related to the opposites of 'transformational versus revolutionary' are assigned to the two further ends: point A is assigned to a pure transformational typology while point B represents a pure revolutionary typology. The same scale is used for the other two opposites. To determine the dominant typologies in construction project implementation strategies, the following three hypotheses are set:

H9: Rational typology is more common in construction project implementation strategies over generative typology.

H10: Deliberate typology is more common in construction project implementation strategies over spontaneous typology.

H11: Transformational typology is more common in construction project implementation strategies over revolutionary typology.

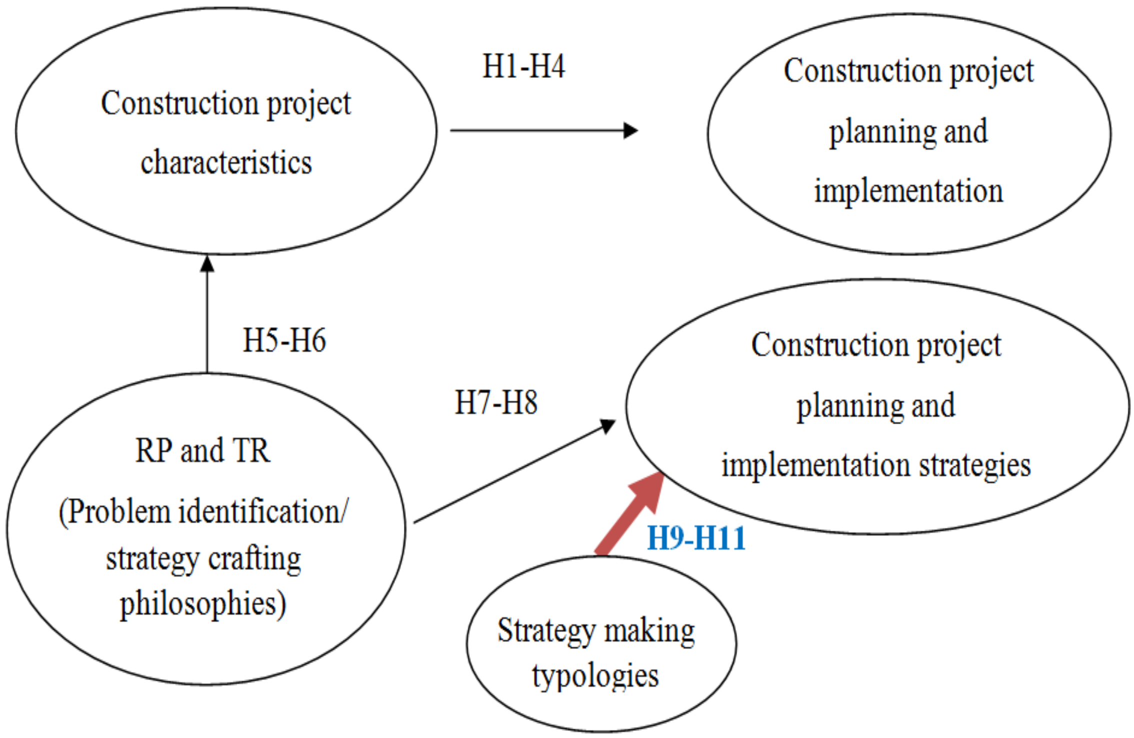


Figure 3.8: Modified conceptual model incorporating hypotheses H9, H10 and H11

With these three hypothetical constructs, the conceptual framework is modified as shown in Figure 3.8. Hypotheses H9 to H11 address construction project planning and implementation strategies related to the six typologies described above.

3.8 Stakeholders in Strategy Context

Identification of the project manager's role with particular emphasizes to strategy crafting and implemnatation is another objective of the current study. Construction project managers are identified as the centre for creativity and innovations, and their role throughout the project life cycle governs ultimate success (section 2.3.2.1). Therefore, the study postulates that construction project managers are the most appropriate person to gather information about strategy-led approaches.

Further, the preliminary investigation has found that there are two methodologies that construction project managers follow when strategies are crafted: in 'individual' methodology, the construction project manager crafts strategies alone (Point A of Figure 3.9); 'bottom-up' methodology integrate other stakeholders into strategy crafting process (Point B Figure 3.9). Under this investigation, the project managers are asked to rate their perception about importance of bottom-up and individual strategy making methodologies to craft strategies by using the scale shown in Figure 3.9.

Point A – The role of your employees is limited to the implementation of strategies articulated by you (project manager).

Point B – Employees are expected to participate in the strategy crafting process.

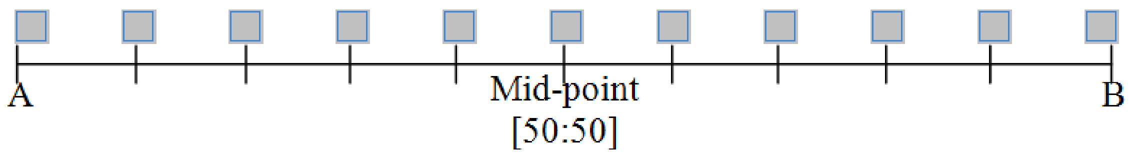


Figure 3.9: The scale used to measure bottom-up and individual strategy making methodologies

The operational definitions of individual and bottom-up strategy making methodologies are assigned to point A (100,0) and point B (0,100), respectively. Therefore, point A and B represent two extremes. The study expects the participants' responses anywhere within the spectrum of this scale. Further, to finding out the dominant methodology among the two, the following hypothesis is set to be tested:

H12: Individual (or bottom-up) strategy making is the dominant strategy making methodology in construction project implementation strategies.

The study keeps H12 as unbiased toward any methodology. Sample data will help the study later to determine the dominant methodology and hence to modify H12 accordingly. At the end of the analysis, the study will be in a position to recommend suitable methodologies for construction project managers to craft strategies. Further, H12 makes the link between construction project manager and strategy in the conceptual model shown in Figure 3.10.

However, as described under the strategy context (section 2.3.2.3) strategy crafting and implementation is a process of all stakeholders. The two operational definitions given for ‘bottom-up’ and ‘individual’ methodologies literally support it: bottom-up strategy making methodology essentially requires other stakeholders’ involvement to craft strategies whereas in the ‘individual’ strategy making methodology, other stakeholders have important roles under implementation of strategies crafted by the construction project manager. By considering these facts, the current study evaluates the contributions of all stakeholders in addition to the construction project manager toward construction project implementation strategies. To quantify those contributions, 10 different stakeholders are listed within the survey: project manager, client/project owner, consultant, top management, site managers, site engineers, foremen, sub-contractors, labours and others. The participants are required to rate their importance on a five point Likert scale, ‘5’ being ‘Extremely important’ and ‘1’ being ‘Not at all important’.

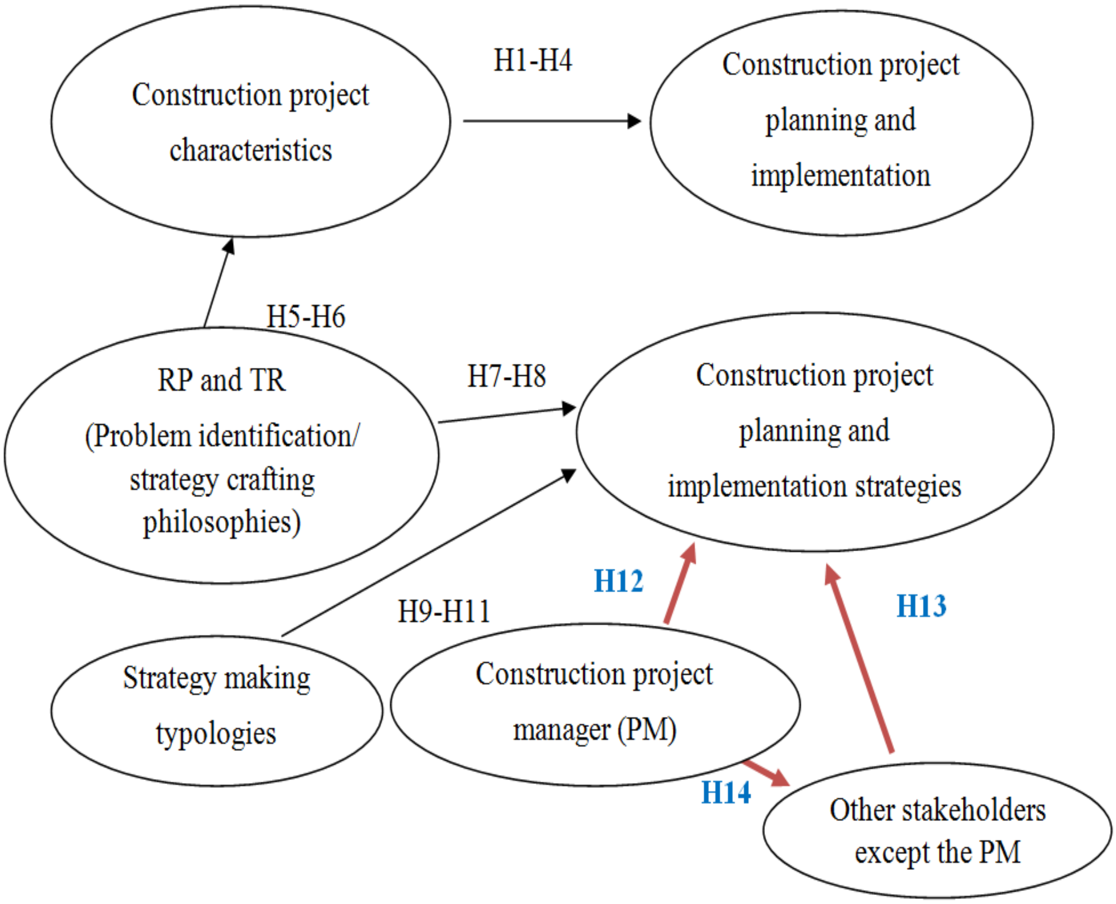


Figure 3.10: Modified conceptual model incorporating hypotheses H12, H13 and H14

H13 is set to compare the importance of other stakeholders into Construction project planning and implementation strategies. Since there are nine stakeholders to be compared with the construction project manager, H13 will have nine sub-hypotheses for each stakeholder. These sub-hypotheses integrate other stakeholders into construction project implementation strategies as shown in Figure 3.10

> *H13: The construction project manager's contribution is more important than client/consultant/top management………, labours and others toward construction project planning and implementation strategies.*

If the construction project manager has the main role in a strategy context but if other stakeholders are important as well, it will be necessary to know how the construction project manager integrates others into project implementation strategies.

As found in the literature review (section 2.3.2.3), there are six integration methods which are used in this study such as vision, mission, transact, learn and improve, experiment and risk taking, and responsibility toward performance benchmarks. However, are all these methods agreeable to construction project strategy contexts?

Therefore, the participants, who are construction project managers, are asked to recommend each of these integration methods by using a five point Likert scale, ranging from ‘strongly disagree’ to ‘strongly agree’. Through this investigation, it is possible in the current study to determine advantageous and disadvantageous integration methods. The construction project manager and other stakeholders are connected in the conceptual model through H14 which had six sub-hypotheses set for each integration methods. In Figure 3.10, H14 tests the association of construction project managers with other stakeholders.

H14: Construction project managers use vision/mission/transact/ learn and improve/ experiment and risk taking/ responsibility to integrate other stakeholders into strategy contexts so as to achieve performance benchmarks.

3.9 Influence of Strategies toward Construction Project Planning and Implementation

This section determines the influence of strategies toward construction project planning and implementation.

The current study assumes that a strategy-led approach is supposed to be a holistic methodology which can support construction projects from inception to completion, including providing estimates, setting goals, making schedules and plans, coping with variations, integrating stakeholders and operations management. In section 2.3.2.2, it was articulated that the whole purpose of construction project planning and implementation can be described through critical success factors.

To identify the scope of construction project planning and implementation, the current study uses information obtained from the review of past literature and the preliminary investigation of the archival analysis which is described later. The current study found 32 critical success factors in literature. Further, from a content analysis conducted in the preliminary study, three other critical factors were inductively found (see section 5.2.5). For the primary data collection, the current study assigned 35 critical success factors to five categories. These five categories are: project related, organizational, material supply, external and other factors.

The influence of strategies toward the 35 critical success are rated by using a100 points scale where ‘0-20’ represents ‘very low’ influence at one end of the scale and ‘80-100’ being ‘very high’ influence at the other end of the scale. To find out the influence form strategies, hypothesis H15 is set to test the overall influence strategy has on the critical success factors. The overall impact of strategies toward critical success factors is calculated by taking the mean influence of strategies toward the 35 items. In this way, the study can determine if a strategy-led approach can effectively influence construction project planning and implementation as a whole. With this set of information, the conceptual model for the study is modified as depicted in Figure 3.11. Since these 35 critical success factors represent construction project planning and implementation as a whole, H15 connects two entities (construction project planning and implementation, and construction project planning and implementation strategies) of the conceptual framework.

H15: The overall influence of strategies is very low/low/moderate/high/very high toward construction project planning and implementation.

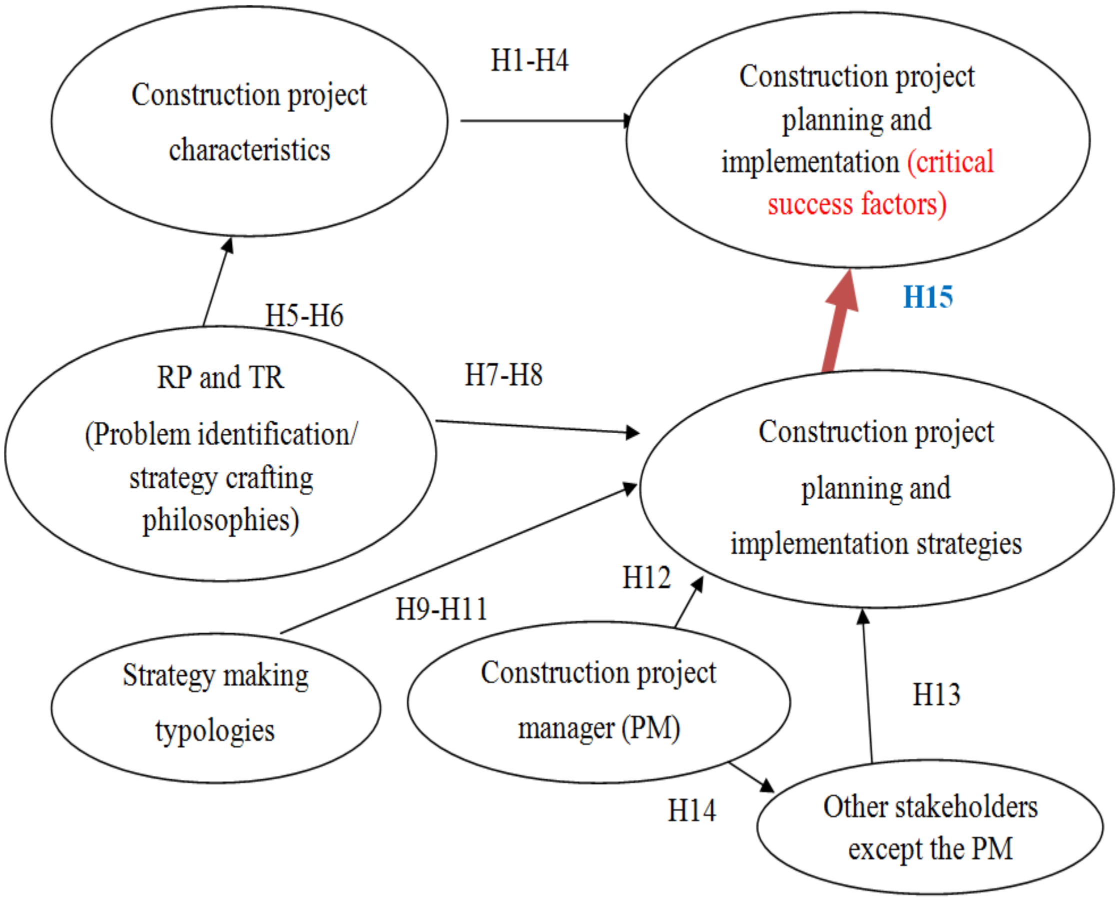


Figure 3.11: Modified conceptual model incorporating hypothesis H15

3.10 Relationship between Strategy and Project Characteristics

There are two objectives to develop a strategy-led approach to plan and implement construction projects: to cope with construction project characteristics (complexity, dynamism, uncertainty and uniqueness) and to increase productivity. This section focuses on the first objective that is to find relationships between construction project characteristics and strategies.

Sections 2.2.3 and 2.3.3 articulate that strategy can be used to mitigate increasingly complex and uncertain situations. Hence the current study assumes that there is a positive correlation between strategy and construction project characteristics. This study has one of its objectives to assess this relationship. As the measurements set for construction project characteristics and strategies have already been discussed under section 3.3 and 3.9 respectively, this section considers only the hypothesis associated with the analysis. Hypothesis H16 is thus formulated as follows:

> *H16: When the extent of the characteristics of a construction project increase, the influence of strategies on project planning and implementation increase.*

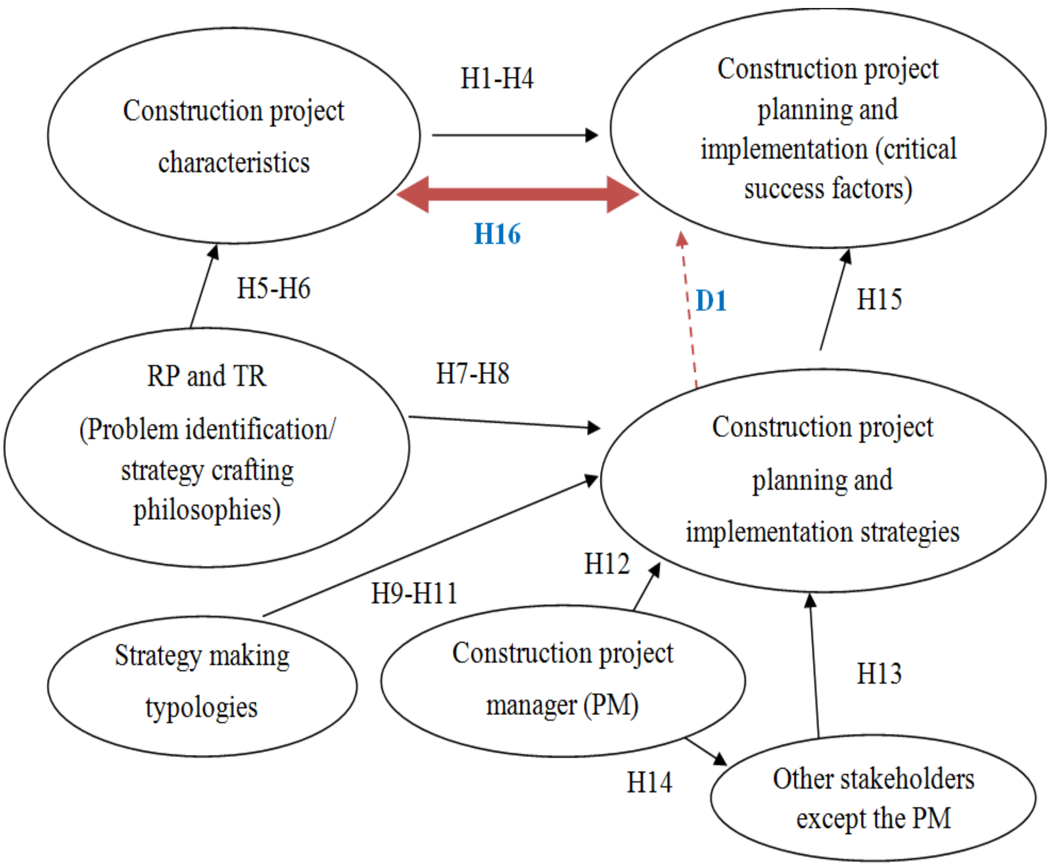


Figure 3.12: Modified conceptual model incorporating hypothesis H16

In Figure 3.12, H16 connects the two key variables of the study, which are construction project characteristics and construction project planning and implementation strategies. In the Figure, construction project characteristics are not directly connected to construction project strategies. Since the current study assesses the influence of strategies through critical success factors, which represent construction project planning and implementation, a dummy relationship (D1), as shown in Figure 3.12, establishes the connection between construction project strategies and critical success factors.

3.11 Relationship between Strategy and Productivity

The current study intends to find the suitability of a strategy-led approach to achieve successful outcomes in construction projects. This analysis can describe the relationship among strategies and productivity, which is the second purpose of proposing a strategy-led approach as a suitable planning method for construction project planning and implementation.

In section 3.10, strategies are conceptualized to have an increasingly positive influence on project success under increasing complexity, dynamism, uncertainty and uniqueness of construction projects, although these four project characteristics may still have a significant influence on success (productivity). By considering that possibility, the study integrates construction project characteristics into the analysis, which is focused on investigating the relationship between construction project strategies and productivity. In this analysis, the study makes use of mathematical modelling between the three variables. In this way, the resulting model can describe how success varies according to the characteristics of a project if the project is run employing construction project planning and implementation strategies.

The relationship can be described as shown in Equation 3.6.

Success = *f* (strategy influence on critical success factors, project characteristics) ... .Equation 3.6

There are five measures that would determine successful outcomes in construction projects. The measures are timely completion (time), costs within budgets (cost), good achievement in quality (quality), client satisfaction and overall success (overall representation of time, cost, quality and client satisfaction). These five measures work as the dependent variables of Equation 3.6. The procedure to measure these five variables is described in section 3.2. The independent variables are construction project characteristics and strategic improvements toward critical success factors, which are discussed in section 3.3 and section 3.9, respectively.

For the regression analysis shown in Equation 3.6, the hypothesis is set as follow:

H17: There is an overall influence toward project success from construction project characteristics and influences of strategies toward critical success factors.

Since the study considers five dependent variables, there will be five sub-hypotheses related to H17 under the analysis. Figure 3.13 illustrates on which entities of the conceptual model are connected by H17. One can see that influence of construction strategies is connected with the dummy relationship of D1 similar to the case of H16.

In addition to overall significance, the study considers influence from every single variable toward success measures by using H18.

H18: There is a significant impact from each variable of contingencies and influence of strategies toward success.

H18 can evaluate whether any of the variables related to construction project characteristics and the influence of strategies toward critical success factors could have influence towards the five dependent variables used in the mathematical modelling. As shown in Figure 3.13, there is no interrelationship considered between the two kinds of independent variables under H18. Figure 3.13 represents the complete conceptual model of the research study, which has been systematically developed through a step-by-step process.

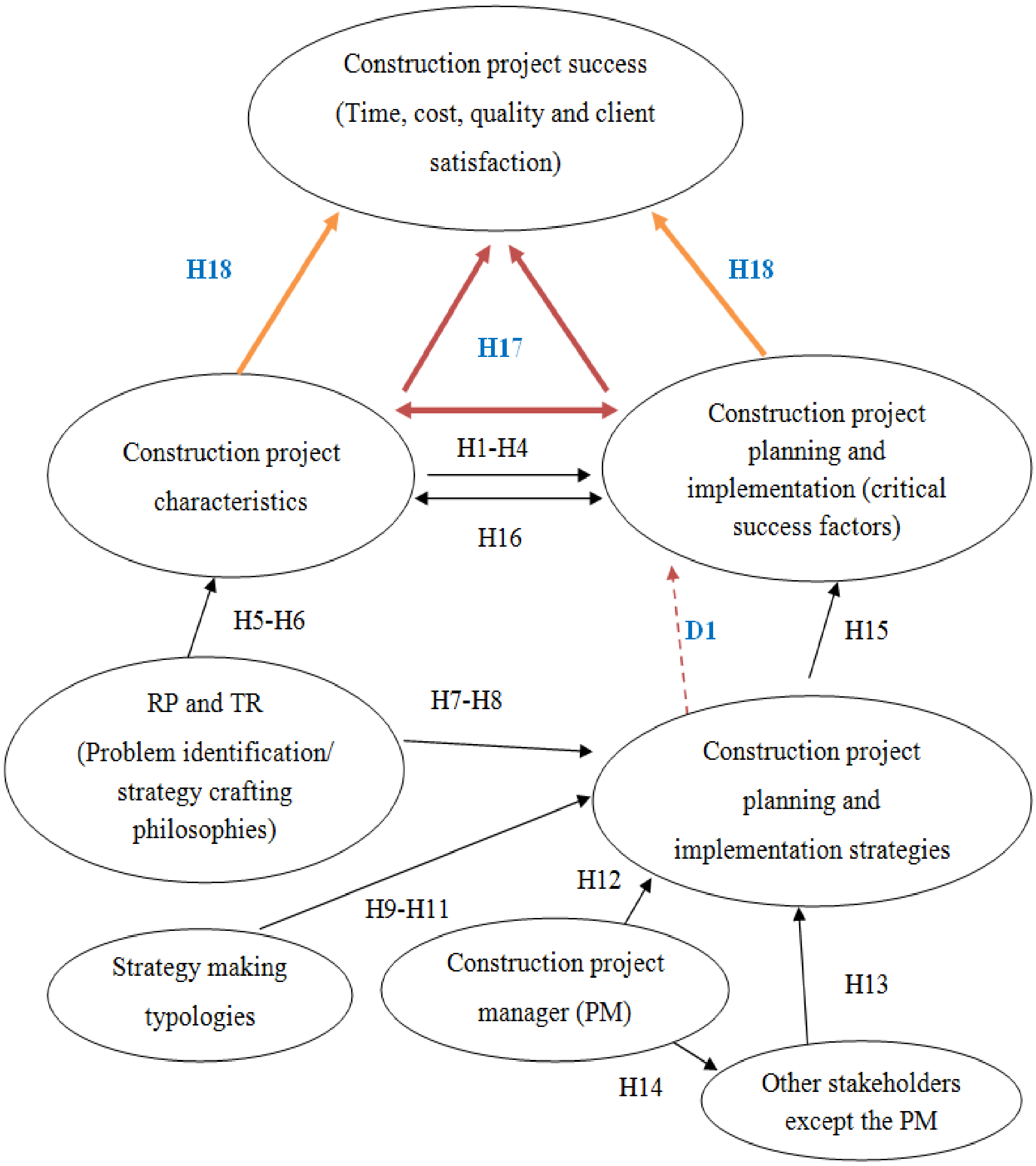


Figure 3.13: Modified conceptual model incorporating hypotheses H17 and H18

3.12 Conclusion

This chapter provided a comprehensive description of the variables and interrelationships that the study investigates. The chapter rationalized why the study selects cost, time, quality, client satisfaction and overall success as measures for success, and further described how the selected variables could be measured. Then, the chapter described construction project characteristics and set hypotheses related to them so that the knowledge gaps in the area of construction project characteristics are addressed. Hypothetical constructs were described according to TR and RP natures. Further, it was articulated how TR and RP natures would be measured under problem identification as well as crafting construction project strategies.

After all the variables were described separately, the study considered inter-relationships between the variables. Since critical success factors are used to evaluate the influence of strategies on construction project planning and implementation, a hypothesis was set in section 3.9 to determine the relationship between critical success factors and strategies. The chapter then progressed into conceptualizing the relationship between construction project characteristics and critical success factors while construction project strategies were integrated into the hypothesis through a dummy relationship which existed between construction project strategies and critical success factors. Finally, the chapter constructed hypotheses to evaluate how construction project success varies according to project characteristics if the project is planned and implemented employing strategies.

Table 3.3: Summary of the hypotheses related to the current study

Hypothesis	Description
H1	Construction project environments are complex to 'high' extent
H2	Construction project environments are dynamic to 'high' extent
H3	Construction project environments are uncertain to 'high' extent
H4	Construction project environments are unique in nature to 'high' extent
H5	Reflective interaction is more important than engineering theories to identify issues related to construction project planning and implementation
H6	Problems related are characterised more towards holism than reductionism
H7	The strategy-led approach is a practitioner dependent planning methodology
H8	The strategy-led approach is a context dependent planning methodology
H9	Generative typology is more common in construction project implementation strategies over rational typology
H10	Deliberate typology is more common in construction project implementation strategies over spontaneous typology
H11	Transformational typology is more common in construction project implementation strategies over revolutionary typology
H12	Individual strategy making is the dominant strategy making methodology in construction project implementation strategies
H13	The construction project manager's contribution is more important than other stakeholders toward construction project planning and implementation strategies
H14	Construction project managers use vision/mission/transact/ learn and improve/ experiment and risk taking/ assign responsibility to integrate other stakeholders into strategy contexts so as to achieve performance benchmarks
H15	The overall influence of strategies is high toward construction project planning and implementation.
H16	When the extent of the characteristics of a construction project increase, the influence of strategies on project planning and implementation increase.
H17-H18	There is a significant impact from influence of strategies toward the achievements of cost, time, quality, client satisfaction and overall success.

While making these hypothetical constructions, the study progressively developed the conceptual framework used for the research investigation from Figure 3.1 to Figure 3.13. Under the progression of the conceptual model, some hypotheses were set to investigate strategy process, content and context. Table 3.3 summarizes all the hypotheses that are relevant to the current study.

Chapter 4. Design of the Study

4.1 Introduction to Design of the Study

This chapter describes the development process of the current study from inception to completion. Research design is an important part of any scientific inquiry involved in an objective verification of hypothesis by using appropriate methodologies: this systematic approach distinguishes scientific knowledge from non-scientific knowledge which is based on religious and cultural aspects. In non-scientific knowledge assumptions and beliefs are usually accepted on faith without verification (Taylor, 2005). The rationale behind selecting particular methods for this research study is described throughout the chapter.

The chapter begins by describing the study's philosophical position (research paradigm). This philosophical consideration is followed by the selection process of a suitable research strategy for this particular study. Having decided these two key considerations, the chapter articulates how a mixed-method research approach could facilitate the current investigation. The chapter continues with a description of how the study was conducted in terms of data collection, analysis and synthesis related to this research inquiry.

This chapter concludes with the ethical considerations taken under this research study to comply with Auckland University of Technology Ethics Committee (AUTEC) requirements.

4.2 Research Paradigms

In any research design, it is essential to think of suitable paradigms comprehensively at the inception: "questions of method are secondary to questions of paradigm" (Guba and Lincoln, 1994, p. 106). Reviewing some definitions of the term 'paradigm' can provide clearer understanding of this statement.

Fellows and Liu (2003) articulate paradigms as theoretical frameworks as well as systems that are used to view events. Further broadening the purpose of paradigms, these are not only about views adopted, but include paths for questioning and determining (Fellows & Liu, 2003). Grant and Giddings (2002) conclude that any particular paradigm provides positive force for commitment. Paradigms can help researchers to focus their attention toward problems in certain ways. A paradigm can raise all sorts of specific problems for a researcher, which will not be present in another paradigm (Grant & Giddings, 2002). Therefore, selection of the right paradigm is crucial to any scientific inquiry.

Guba and Lincoln (1994) describe the importance of paradigms through internal (intra-paradigm) and external (extra-paradigm) critiques. Internal critiques can be eliminated within a selected paradigm as discussed later in section 4.4, but the only way to minimize extra-paradigm critiques (such as subjectivity and objectivity) is to select the best philosophical position according to the nature of the inquiry(Guba & Lincoln, 2005; Saliya, 2009).Therefore, philosophical issues play a vital role in any kind of research (Fellows & Liu, 2003; Grant & Giddings, 2002). Guba (1990) further articulates the importance of paradigms by saying that "the judgmental paradigms that guide selection of Olympic winners, the religious paradigms that guide spiritual and moral life" (p. 19).

Some other authors differentiate paradigms by using common criteria called metaphysics. Metaphysics include three basic beliefs which are ontology, epistemology and methodology. These metaphysics together guide researchers in scientific investigation (Grant & Giddings, 2002; Saliya, 2009) .

Ontology represents the nature of knowledge to be discovered (Grant & Giddings, 2002; Kuhn, n.d; Saliya, 2009). Guba (1994) explains that if the knowledge is about the 'real world' then ontology is about 'how things really are' and 'how things really work'.

Epistemology describes relationship between the researcher and knowledge disciplines (Guba & Lincoln, 2005; Kuhn, n.d). The level of influence from the researcher toward an inquiry is usually described as the amount of objectivity or subjectivity introduced to the study (Saliya, 2009). Finally, methodology describes the required researchers' approach to investigating knowledge (Fellows & Liu, 2003; Grant & Giddings, 2002).

The common practice in literature seems to discuss the three metaphysics together under one paradigm. Indeed, the current study considered all the paradigms under each metaphysical aspect and investigated the most appropriate paradigms separately. Finally, results found under the three metaphysics were merged to evaluate the consistency among them. There were four paradigms described in the current study. These are: positivism, post-positivism, interpretivism and critical theory.

This section describes the four paradigms that this research study considers under the three metaphysics in general.

4.2.1 Ontology: The Nature of Knowledge to be Discovered

Ontology describes the nature of knowledge that is to be discovered. There are four kinds of ontological positions identified, which are naïve realism, critical realism, relativism and historical relativism.

The positivist paradigm can be used to investigate facts associated with naive realism: in other words, these are facts driven by natural laws (Golafshani, 2003; E. G. Guba & Lincoln, 2005). Further, Guba (1994) as well as Saliya (2009) opine that positivist knowledge has no artificial nature. As example, consider gravitational acceleration: gravitational acceleration is unique everywhere and hence considered as a universal reality. However, are these two characteristics, being unique and natural, related to the ontological position of the current inquiry?

Conversely, the other three paradigms contradict the positivist's view of 'naïve realism'. Post-positivism argues that there is no universal truth, but there are multiple realities and hence competing views of science. It introduces 'critical realism' into research disciplines as opposed to naïve realism (Bailey, 2007; Grant & Giddings, 2002). Interpretivism believes that knowledge is local and specifically constructed realities; interpretivism is hence known as relativism. Critical theory recognizes that knowledge is virtually shaped by social, cultural and ethnic values over time; that kind of knowledge is known as historical realism (Guba & Lincoln, 1994).

Abbott (2010) differentiates knowledge associated between positivism and interpretivism by articulating nature of criminal investigation: a positivist considers simply measuring crime using quantitative methods, and consequently, the researcher aims at finding patterns and correlations among causes and effects. The interpretivist argues against a positivist approach to knowledge about crimes and considers meaning, such as what actions people categorize as crimes and who becomes a criminal in a society (Abbott, 2010).

According to Guba and Lincoln's (2005) articulation, the positivist believes that everything is tangible; the interpretivist on the other hand believes that knowledge is in the form of intangible mental constructions. The critical theory paradigm also holds the same belief as interpretivism that social constructs are intangible (Bailey, 2007; Saliya, 2009). Post-positivism provides much flexibility in terms of tangibility (Abbott, 2010).

Post-positivism argues that abstract measures, which interpretivism recognizes as intangible, can be quantified (Abbott, 2010; Grant & Giddings, 2002). However, post-positivists believes that reality cannot be known perfectly due to flawed intellectual mechanism and intractable nature of phenomena (Guba & Lincoln, 1994). Thus, post-positivism becomes different from positivism. Researchers can still move toward 'the perfect reality' related to abstract measures in post-positivism by using accumulated efforts (Bailey, 2007; Saliya, 2009). Similarly, Letourneau and Allen (1999) opine that inquiries must be critically examined to capture reality as close as possible.

Considering these ontological positions of post-positivism, knowledge associated with post-positivism is considered critical realism existing in between naïve positivism and post-structuralism which are two extremist ontological positions of positivism and interpretivism (or critical theory), respectively (Guba & Lincoln, 2005).

Advantages and disadvantages associated with these ontological positions were considered with respect to the nature of this research enquiry as described under section 4.2.4.

4.2.2 Epistemology: Relationship between the Researcher and the Knowledge to be Discovered

Epistemology describes the philosophical positions related to the relationship between the researcher and the knowledge to be discovered. There are three kinds of states related to epistemology: pure objectivity, pure subjectivity and modified or ideal objectivity (Guba & Lincoln, 1994).

As discussed previously, positivism takes the position that there is truth, which is real and natural: therefore, it argues that the investigator should not influence reality or should not be influenced by reality (Fellows & Liu, 2003; Golafshani, 2003; Saliya, 2009). Therefore, positivism demands pure objectivity. However, can pure objectivity exist? This is highly contested at philosophical level by authors like Grant and Giddings (2002).

Grant and Giddings(2002) articulate that there are influences from investigators even in physical experiments according to the way that relevant variables are selected. Further, machinery errors and human errors of observations can hinder pure objectivity.

Interpretivism and critical theory behave together related to their epistemological positions. Both paradigms emphasize the researcher's subjectivity under an investigation and can be considered as the other extreme of positivism (Guba, 1990). In these two paradigms that are interpretivism and critical theory, the researchers act both as a listeners and an interpreter, and consequently, the researcher is considered as bigger than the participants (Grant & Giddings, 2002).

Post-positivist belief on epistemology is an in-between position of pure objectivity and pure subjectivity, which is called 'ideal objectivity' (Fellows & Liu, 2003; Grant & Giddings, 2002). Guba and Lincoln (2005) articulates that post-positivism is more flexible due to ideal objectivity, while the epistemological belief of post-positivism is considered as an opportunity to take advantage of both subjectivity and objectivity in a research inquiry by Grant and Giddings (2002).

These three epistemological positions were considered with the current study's requirements to select the most appropriate paradigm with respect to the second metaphysics, epistemology. The selection procedure is described in section 4.2.4.

4.2.3 Methodology: How can an Inquirer gain Knowledge?

Methodology is the last metaphysics of research paradigms that this research study considered. Methodology describes approaches that the researcher can investigate knowledge.

The positivist approach of an inquiry is to verify a theory. The verification process seems to be a controlled process: Guba and Lincoln (1994) articulate that potentially confounding conditions must be carefully controlled to gain validity for an inquiry. For example, to observe pressure-volume relationship, the researcher controls other parameters such as temperature, on which the pressure-volume relationship depends. Letourneau and Allen (1999) articulate that this methodological position is possible where universal laws are to be found. Although not necessarily (Golafshani, 2003), Guba and Lincoln (1994) describe that verification of theory under post-positivist methodology involves intense use of quantitative methods.

Letourneau and Allen (1999), as well as Fellow and Liu (2003), do not believe that scientific knowledge can be verified by using the methodology of positivism. Fellow and Liu (2003) describe that scientific knowledge can be only corroborated or falsified, but cannot be verified. Further, they explain that there are many facts that should be used to corroborate a theory, but only one fact is enough to falsify that theory. For inquiries related to scientific knowledge, Shadish (1993) articulates that post-positivism is the right methodology where use of multiple approaches are recommended to investigate reality as close as possible. Post-positivists get validity to a proposition when it is warranted through an on-going self-correcting process of an inquiry (Oxford Dictionary of Philosophy). This paradigm does not seek to fully control intractable conditions as in the case of positivism: rather, post-positivism tries to gain validity by choosing multiple methods between value-laden/qualitative and value-free/quantitative approaches which is known as 'critical multiplism' (Letourneau & Allen, 1999).

Both interpretivism and critical theory encourages using mainly qualitative methodologies under research inquires. In interpretivism, Denzin and Lincoln (2005) emphasize how quantitative analyses are used inductively to investigate an inquiry. This methodology is named as hermeneutical/dialectical methodology in Denzin and Lincoln's (2005) articulation on interpretivism. Critical theory uses dialectical methodology, in which qualitative information of conversations is analysed in a logical manner to determine negative implications of constructs (Bailey, 2007).

According to the methodological positions described above for the four paradigms selected, the suitability of each position was compared according to the scope of this current study to determine the most appropriate philosophy in terms of methodological position as described in the next section.

4.2.4 Selecting the Most Appropriate Paradigm for the Current Study

Under this section, doctrines of positivism, post-positivism, interpretivism and critical theory are compared with the scope of this research investigation to determine the most appropriate paradigm.

Ontological Position

In section 4.2.1, ontological positions of each paradigm were described. This section relates each paradigm to the nature of knowledge that this research inquiry is associated with.

Knowledge associated with positivism is unique everywhere and hence considered as a universal reality. Are these characteristics related to the knowledge investigated in this research study?

As discussed throughout the literature review, strategies as well as traditional project planning practices are man-made and artificial in nature. Successful outcomes of construction projects are highly affected by behaviours and inputs of project stakeholders. Review of perception in literature finds that there seems to be no unique way or unified theoretical construct to plan construction projects. Further, in construction project planning, reality (what has happened) depends on respondents' diverse views. Therefore, the ontological position of positivism, which is naïve realism, is somewhat controversial in the current inquiry.

As discussed in section 3.11, in this research investigation, one of the objectives is to investigate the influence of strategies toward success measures, having the purpose to recommend the strategy-led approach as a viable solution. In this objective, causes and effects should be measurable (tangible) related to both concrete (cost, time) and abstract measures (complexity, quality and influence of strategies on critical success factors). Due to these requirements, interpretivism and critical theory are considered for this research investigation. These two paradigms believe abstract knowledge as an intangible mental construct.

According to section 4.2.1, post-positivism is based on critical realism which can give much flexibility to this research investigation due to the scope of this study. Post-positivism believes both concrete and abstract measures are tangible. Since construction project contexts are shaped by thoughts of human beings and their interpretations, tacit knowledge associates with this research study in addition to engineering knowledge and mathematical formulations. Denmark et al. (2002) articulate that critical realism is a suitable position to investigate knowledge that is socially constructed.

Selecting critical realism as the ideal ontological position in this study encourages to use multiple approaches to investigate reality as close as possible. The procedure will be described later in this section under methodological concerns.

Epistemology

According to section 4.2.2, there are three epistemological positions: pure objectivity, pure subjectivity and ideal objectivity.

Related to the current study, there could be variables such as procurement type, project type and payment type. It would become a subjective procedure to select potential variables to the study by fiat. Further, errors in responses could be possible as similar to machinery errors in a physical experiment even towards concrete measures such as achievements on cost and time. For example, the researcher may or may not consider the influence of variations on end achievements under cost consideration. How could the influence of strategies be measured for construction projects? Which scale should be used? These abstract measures may have subjective considerations. Thus, pure objectivity, that positivism is based on, is not suitable to this research investigation.

In interpretivism and critical theory, the researcher is bigger than the participants of a research inquiry which is a different condition to this research investigation. This study focuses on evaluating successful planning approaches and their impact by using the perceptions of industry experts. Therefore, the participants can be considered bigger than the researcher within this investigation, and hence, interpretivism and critical theory that demand pure subjectivity are considered as irrelevant to this research investigation.

By considering these criticisms, this study selected an in-between position of pure objectivity and pure subjectivity, which is the epistemological position of post-positivism. Thus, both under ontological and epistemological concerns, post-positivism is the most appropriate paradigm.

Methodology

Due to the ontological position of this research study, it is recommended to use multiple approaches for this research inquiry.

The confounding conditions that are relevant to the nature of knowledge in this research study cannot be fully controlled as in an experiment. Therefore, the applicability of the positivist approach is questionable. For example, for the characteristics of construction projects, the study articulated that there would not be exact boundaries between complexity, dynamism, uncertainty and uniqueness. It is somewhat difficult to measure complexity by separating dynamism or others characteristics in a project environment. Further, it could not be expected from participants to quantify these abstract measures 100% accurately. In these situations, Shadish (1993) articulates that post-positivism is the right methodology and hence recommends multiple approaches to be used for revealing reality as much as possible. Thus, this study uses both quantitative and qualitative methods to investigate knowledge associated with this research investigation as accurately as possible. According to this methodological position, this study could use methodological concerns related to positivism, interpretivism and critical theory appropriately.

As example, in addition to quantitative methodologies that this research study uses to quantify influences of construction project strategies, the researcher reviewed existing planning tools for their negative consequences as similar to critical theory methodology that uses dialectical conversations to find out negative implications of a construct (Bailey, 2007). Further, this research investigation uses inductive analyses as one method for corroborating facts from the quantitative analyses, which is an application of interpretivist methodology within the context of post-positivist methodology.

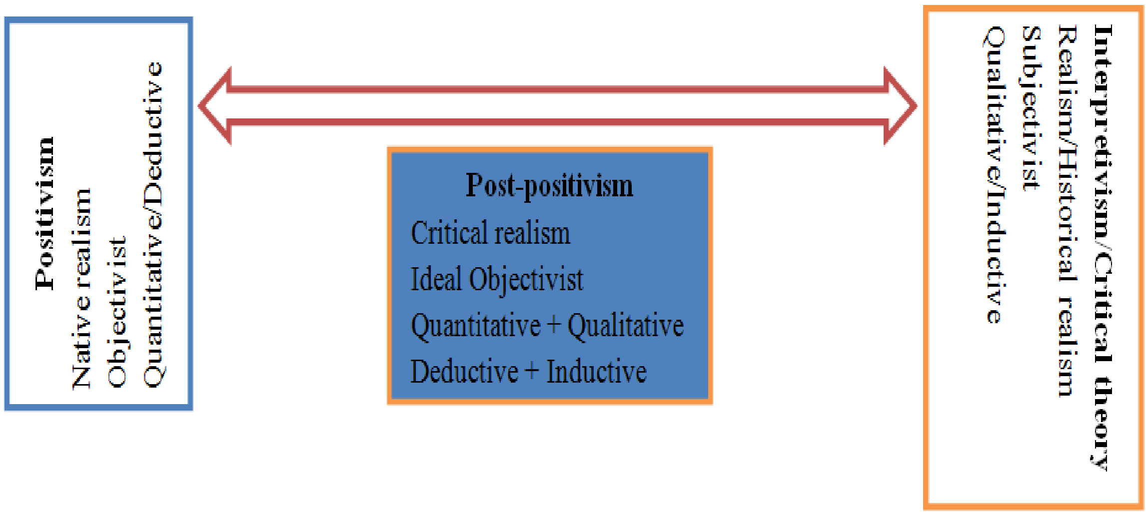


Figure 4.1: Post positivism varies between two extremes: positivism and interpretivism/critical theory

In this section, post-positivism is selected as the most appropriate philosophical position with respect to the three metaphysics: ontology, epistemology and methodology.

Related to ontological position, knowledge associated with this research inquiry could not be considered as universal laws, and consequently, this scientific inquiry includes multiple realities and competing views about construction project success and planning approaches. Ideal objectivity, which is an intermediate position between the two extremes of pure subjectivity and pure objectivity, brings more flexibility to achieve the objectives of this study by using both quantitative and qualitative methodologies appropriately. Therefore, this study considers post-positivism as a philosophical position, which varies in a spectrum as depicted in Figure 4.1. In this spectrum, positivism is considered as one extreme, whereas interpretivism and critical theory together reside at the other extreme. This post-positivistic research study can reside anywhere on this spectrum according to the nature of research questions, including the two extreme positions of the spectrum. This flexibility inherent in post-positivism is admired by several studies in literature.

Agreeing to Greetz's prophecy, Denzin and Lincoln (2005) opine that research philosophies cannot be considered as universally acceptable rules or abstraction anymore. They articulate that new paradigms are emerging from the nature of disciplines (where sociology and psychology are some examples) and also from perspectives (such as Marxism and queer theory). As a result, paradigms that have been considered as contradictory in the past, nowadays interbreed under new theoretical rubrics (Denzin & Lincoln, 2005).

After defining the most appropriate paradigm for the design of this research study, the next consideration is to select the best research strategy for the investigation.

4.3 Research Strategy

Some of the research strategies used commonly in research investigation are action research, ethnography, survey, experiments and case study (Saliya, 2009). To select the most appropriate research strategy, there are two categorization systems which are extensively used in research investigation: Bell's categorization (as cited in Fellow & Liu, 2003) and Yin's categorization (Yin, 2003). This section discusses both categorizations separately and finally merges them to find the most appropriate research strategy. In this way, it was possible to evaluate research strategies described in both categorization and evaluate the most appropriate research strategies independently for each categorization. Thus, the decision on the most appropriate research strategy comes from each categorization with a justification in relation to the remaining categorizations.

Bell's Categorization of Different Research Strategies

Bell identifies five research strategies: action research, ethnography, survey, case study and experiments (Fellows & Liu, 2003). Among them, action research, ethnography and experiments could be eliminated from the beginning by considering the nature of this research inquiry. Further insight was given to select the most appropriate research strategy between survey and case study. These considerations are described in detail below.

Eliminating Action Research, Ethnography and Experiments for Research Inquiry

Action research is introduced to identify problems as well as to provide solutions through researchers' participation (Fellows & Liu, 2003). In this research investigation, the aim is developing a strategy-led approach from perceptions given on successful project deliveries and practices by industrial experts. Thus, construction project stakeholders were bigger than the researcher in this inquiry as described in 4.2.4. Therefore, the position of action research was not applicable to this research investigation. As a supportive fact, strategies are identified in literature as trials and hence risk of failure is associated with strategic solutions. This risk can become more severe in the realm of construction project implementation due to lack of past investigation regarding construction project strategies.

The next research strategy, experiments, is done under bounded conditions when variables are well-known (Fellows & Liu, 2003). In this research investigation, there were no clear variables or certain conditions that could be controlled as described under the ontological position of this study. Therefore, experiment research strategy is not suitable.

Ethnographic approach is related to scientific studies of races and cultures where behaviour of subjects is observed by being part of that subjects' group (Fellows & Liu, 2003). The characteristics of the current study do not indicate it was in this position. Therefore, from the research strategies mentioned in Bell's categorization, only survey and case study were selected for further considerations.

Survey versus Case study for Research Inquiry

Survey research strategy can use questionnaire or interviews for data collection whereas case studies can employ several methods including interviews with key players and searches in archives (Fellows & Liu, 2003). Thus, due to the nature of this research study both methods seem suitable to collect data. Both methods can employ interviews to gather necessary qualitative information; for quantitative data collection, the survey method can employ a questionnaire whereas the case study method can utilize archives.

In this research study, optimization among breadth and depth was considered as the criteria to find the most appropriate research method among the two strategies (Figure 4.2).

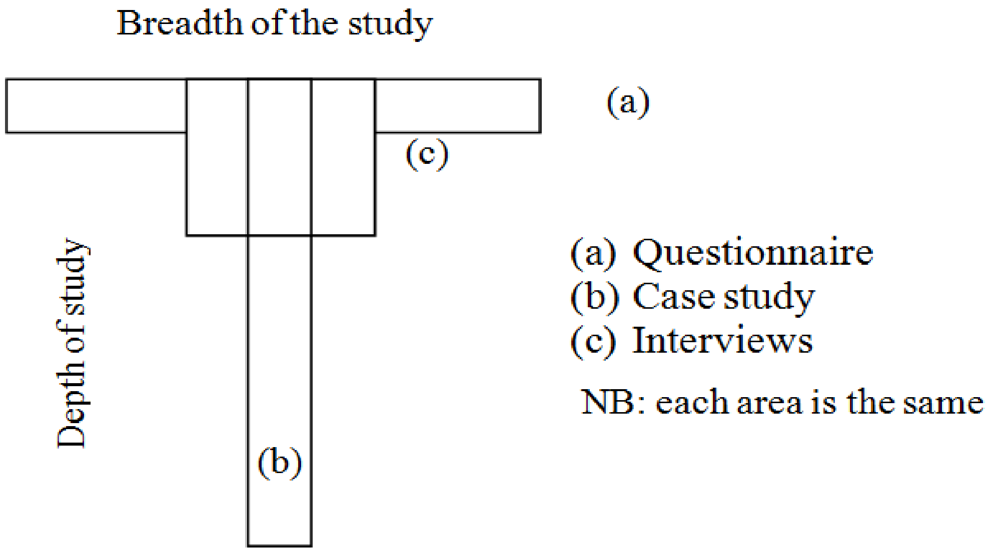


Figure 4.2: Depth and breadth of study related to questionnaire, interviews and case studies (Fellows & Liu, 2003)

Breadth can be related to the amount of data or number of projects to be studied. Likewise, depth means how deep researchers can go related to particular aspects or number of projects. In Figure 4.2, the three research methods are compared graphically and it should be noted that each of the boxes has the same area. Questionnaires have widest breadth and most shallow depth among the three strategies (Fellows & Liu, 2003). Case studies, on the other hand, are the deepest but are the narrowest related to width. Interviews hold an intermediate position.

Figure 4.3 illustrates the optimization process between the breadth and depth related to the scope of the current research study. The figure depicts the framework of the strategy-led approach under the three dimensions recognized in literature. Three hierarchical levels can be identified in this framework. The 1st level of the hierarchy considers strategy-led approach as a whole and the 2nd level breaks down the whole process into three dimensions. The 3rd level consists of several entities that make the framework meaningful in terms of 'what', 'who', 'when' and 'where'. The three hierarchy levels together represent the breadth of study. The 3rd level, which consists of the actual entities of the investigation, represents the depth of an inquiry. The current study considered two things at this stage: 'all entities of the strategy-led approach to be investigated (breadth dominated)' or 'a few entities of the strategy-led approach to be investigated (depth dominated)'.

Breadth versus Depth: Amount of Data Required

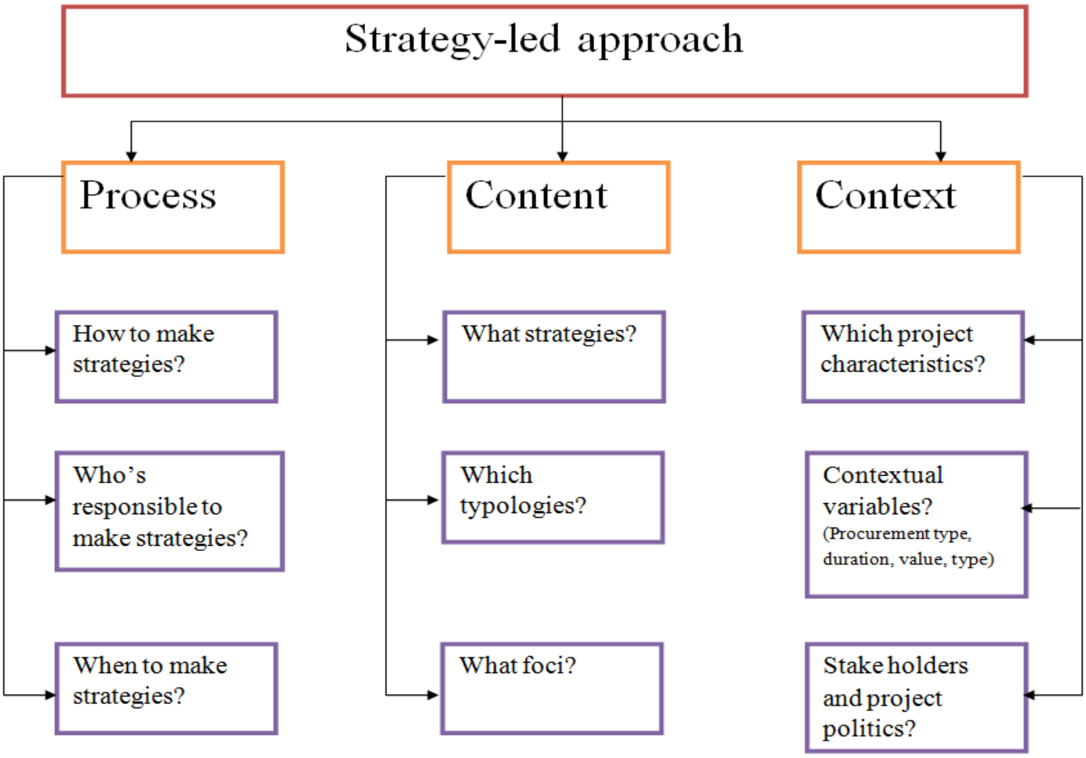


Figure 4.3: Investigation of strategy-led approach related to the three dimensions

For most of the entities of Figure 4.3, this study finds gaps in reviews of literature as described throughout Chapter 2. Adequate amount of information could be found in literature only for one entity, which is 'who makes strategies'. Therefore, this research study chose to investigate all entities of the framework shown in Figure 4.3 to achieve the fourth objective of the study, which is to investigate what the strategy-led approach is. Thus, breadth was considered as more important than depth in this particular case. Therefore, content-wise, a questionnaire strategy was preferred over case study strategy.

Another criterion to select the most appropriate research strategy is the ability to generalize findings. Both survey and case study can be used in inquiries which need generalization, but procedures of generalization are different (Beck, Coene, Hertog, & Lommelen, 2010). Findings can be generalized by using theoretical generalization in case studies similar to experiments (Rodríguez et al., 2010), where generalization can be done by using software packages or substantial theoretical arguments with empirical relations (Fellows & Liu, 2003). However, because of the nature of this research investigation, formation of such theoretical formulations to generalize findings was not possible to make.

Survey research strategy involves in statistical generalization using quantitative analysis (Fellows & Liu, 2003). Generality made about a population is based on data taken from a sample in that population (Beck et al., 2010). It seemed that preceding statistical generalization is possible under the current study. Therefore, according to the possibility to generalize, the survey research strategy became the only suitable method for the current research.

By considering the nature and scope of this research investigation coupled with the requirements for generalization, survey strategy was considered as the most appropriate method of investigation to this inquiry. Having concluded that, Yin's (2003) categorization was considered.

Yin's (2003) Classification on Research Strategies

Yin's (2003) categorization provides an independent evaluation to the Bell's categorization on the most appropriate research strategy to the current inquiry. Yin (2003) mentions five different research strategies which are experiment, survey, archival analysis, history and case study. Yin (2003) describes that the most suitable research strategy must be selected by considering three concerns which are:

- Types of questions posed,
- The extent of control that the researcher has on events, and
- Whether the focus is contemporary or historical events

Table 4.1: Different research strategies according to the context of an inquiry (Yin, 2003, p. 5)

Strategy	Form of research question	Requires control of 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

Table 4.1 describes the suitability of the five research strategies according to the three considerations. According to the information given in Table 4.1, experiments, can be used when the forms of questions posed within the study are 'how' or 'why'. Experiments need to be controlled by the researcher, but history and case study do not need any control. However, related to the time frame of inquiry, case study and experiments focus on contemporary events whereas history can be used to investigate past events.

The remaining two strategies, survey and archival analysis, can be used to investigate other forms of questions: ‘who’, ‘what’, ‘where’, ‘how many’ and ‘how much’. They cannot be used to investigate ‘how’ and ‘why’. Both strategies do not demand any control from the researcher. Therefore, the key factor to differentiate between two strategies becomes the time frame: past or contemporary. Survey strategy can be only used to investigate contemporary events, but archival strategy can be used to investigate both past and contemporary events. In Yin’s (2003) clarification, the nature of an event is decided as contemporary or past based on the ability to collect data from sources, but the time frame of actual events is in progress. In this research inquiry, required data can be collected by participating project stakeholders in data gathering although construction projects used were past. Therefore, the events were considered as contemporary. Having recognized these considerations, inquires related to this research studies were considered in-detail with Yin’s (2003) classification. Table 4.2 illustrates a few of inquiries that are related to this research study.

Table 4.2: Yin's (2003) research strategies versus the current inquiry

Research questions and description	Question form		Researcher's control		Time frame		Suitable research strategy according to the three criteria
	Form of questions	**Suitable strategy**	**Researcher's control**	**Suitable strategy**	**Contemporary / past**	**Research strategy**	
How much influence can project implementation strategies assert on successful project planning and execution?	How much/ how many impact toward success?	Survey	No	Any strategy except experiment	Contemporary	Any strategy except history	Survey
What are the successful project implementation strategies (3 dimensions)? What are the strategies? Who performs strategies? When to create strategies?	What/ who/when	Survey/ archive	No	Any strategy except experiment	Contemporary	Any strategy except history	Survey/ archive
What are the reasons to use strategies?	What/where/when/ why	Survey/ archive	No	Any strategy except experiment	Contemporary	Any strategy except history	Survey/ archive
How much do technical rationality (TR) and reflective practice (RP) contribute to strategies?	How much/how many	Survey	No	Any strategy except experiment	Contemporary	Any strategy except history	Survey

The first column of the table, describes some research questions of the primary data investigation. The next six columns describe the three considerations of Yin's (2003) classification and suitable research strategies separately to each concern. The last column illustrates the strategy suitable for each research question according to the three concerns.

In the form of the research question, some questions could be considered under several forms. For example, the third research question determines reasons to use construction project strategies. The question can be asked in many forms, including 'why strategies were used', 'what reasons influenced to select these strategies', 'where strategies could apply' or 'in which situations (when) strategies applied '. Each form can answer the question. Therefore, when multiple forms of question was possible, this study considered two dimensions of questions: breadth and depth of the research question similar to Bell's classification. The study considered 'what', 'when' and 'where' strategies are used to gather reasons as facts only: no in depth reasons are required related to the way something has happened. However, if the question is asked in the form of 'why' that investigation focuses on in-depth data gathering to add more meaning to the inquiry. For example: why does that happen; who is responsible; how are potential consequences mitigated through strategies; subsequently asked question can add more meaning to the inquiry. In the current study, reasons were taken as facts only.

The first and fourth research questions had the question form of 'how much'/ 'how many'. Yin's (2003) classification says that either survey or archival analysis could be used to answer this form of questions. However, in these particular cases, it was difficult to find out required data by using archives. For example, the study needed to find the extent that a strategy could enhance decision making capacity. The answer was difficult to find through archival analysis since this measure is an abstract concept. Therefore, although archival analysis was theoretically possible according to Yin's (2003) classification, a survey strategy for the first and fourth research questions was only selected after practical issues were considered.

The second and third criteria mentioned in the next four columns of the table refer to the amount of control and time frame, respectively. These two criteria were straightforward concerns under the current inquiry. Since no control was needed from the researcher, the study could employ any research strategy except experiments. Similarly, any research strategy except history could be used since inquiries were on contemporary events.

According to the last column, survey research was the only strategy that is realized for all the research questions mentioned in Table 4.2. Therefore, both Bell's and Yin's (2003) classifications showed similar results related to the most appropriate research strategy for the current study. After the paradigm and survey strategy were selected, potential research approaches ware considered.

4.4 Research Method: Mixed Research Approach

The methodological positioning of this research study encourages using multiple approaches to investigate the reality as closely as possible (section 4.2.4). This section discusses the applicability of quantitative and qualitative approaches within the context of the current inquiry.

Sometimes, quantitative approaches and qualitative approaches have been used as synonyms for positivism and interpretivism, respectively (Blaxter, Hughes, & Tight, 2001). Grant and Giddings (2002) criticize that the qualitative and quantitative difference can marginalize a research, but this difference is not adequate to compare doctrines of philosophy. Indeed, scholars articulate that both qualitative and quantitative approaches can be facilitated under any paradigm (Johnson & Onwuegbuzie, 2004). Guba and Lincoln (1994) articulate that even quantitative dominated positivist inquiries cannot be considered as purely quantitative because the researcher has authority to control possible contextual variables which are qualitative.

Further, Sandelowski (2000) articulates that there is linkage between data collection, analysis methods and paradigms. She says that both positivist and critical theory paradigms can conduct interviews by using same standardized measures, but the ways in which the two paradigms treat data are different. Positivist researchers use data in a deductive manner, but critical theorists treat data in an inductive way to interpret the transcripts (Sandelowski, 2000). The selected paradigm of the current inquiry, post-positivism, offers the greatest opportunity among all paradigms to use both qualitative and quantitative methods by encouraging practitioners to use multiple methods to reveal reality as much as possible (Denzin & Lincoln, 2005). Therefore, the current study was conducted in a mixed method approach to investigate the research questions.

This research study could receive several benefits from use of mixed method approach which are: ability to comprehend the research, possibility to construct reliability and validly, as well as potential to minimize intra-paradigm issues.

Related to the current study, cause and effect between project strategies and success can be found through quantitative data and analysis tools such as regressions and correlations. Further, findings can be generalized through using inferential statistics as described in section 4.7.1. However, McDonald and Schneberger (2006) emphasize that there is no meaning of finding such relations without adding meanings such as why such correlation exist. For example, if a qualitative question is asked on 'why strategies are used' this research investigation can compare those reasons with the drawbacks of traditional planning tools, which are mentioned in literature. Both quantitative and qualitative approaches together can give more meaning to the strategy-led approach as a complementary planning method to eliminate the drawbacks of traditional planning algorithms.

Further, by gathering qualitative information, the participants can be actively integrated in the study to uncover their views about strategy-led approaches, which are not found through the reviews of literature. Active participation of respondents is encouraged through gathering qualitative information by Denzin and Lincoln (2005). Active participation by gathering qualitative data is emphasized by several authors as a method to construct validity of the findings, on which interpretations are based of quantitative data that participants' experience and perspectives, which are fit into limited number of predetermined responses (Fellows & Liu, 2003; Golafshani, 2003; Kirk & Miller, 1986).

In addition to these advantages, the ability of minimizing intra-paradigm issues were considered as benefits of mixed method approach for this research investigation.

Removing Intra-paradigm Issues through Mixed Method Approach

Guba (1990) explains that extra-paradigm issues (such as the amount of objectivity) are minimized in research investigation by selecting the most suitable paradigm for an inquiry, but there are issues within the selected paradigm called intra-paradigm issues where use of mixed method approach is required to minimize the drawbacks.

In conventional quantitative methodologies, verification of a hypothesis depends on the sources of that hypothesis, and hence a scientific theory derived from quantitative analysis largely depends on the insights and creativity of the theorists (Guba & Lincoln, 1994). Guba and Lincoln (1994) recommends to use qualitative methods along with quantitative methods to minimize influence of the researcher in a theory. In this investigation, to quantify the relationship between construction strategies and success, critical success factors are used as variables to measure influence of strategies on project planning and implementation (section 3.11). Thus, the resulting relationship at the end of an analysis depends on how the researcher selected critical success factors. To minimize the influence of the theorists, this investigation used qualitative data provided by the Chartered Institute of Building, UK, to determine the suitability of the critical success factors found in literature to use as the strategy focus under the subsequent phases of the study. By using this qualitative information, this research investigation can address foci of construction project strategies which are not found through the reviews of literature. Thus, use of qualitative information can comprehend the quantitative findings by minimizing the influence of researcher in the way that variables are set.

Context stripping is one of the intra-paradigm issues that Guba (1990) explains. This issue articulates that quantitative data alone loses its relevance or generalizability because findings based on quantitative data can be applied only under similar contexts (Guba & Lincoln, 1994). In this research investigation, correlations between influence of construction project strategies and success may vary according to procurement type, type of construction and characteristics of projects (extent of complexity, dynamism, uncertainty and uniqueness). If qualitative data related to the projects are taken, practitioners know under which circumstances those correlations are applicable. Thus, through mixed method approach, this study can minimize context stripping.

In addition to issues related to generalization, this research study considered the applicability of generalized findings to a new condition. Guba (1990) explains that the suitability of quantitative findings cannot be evaluated without using qualitative information. In this research investigation, one of the research questions relates to evaluation of how construction project managers use integration methods (such as vision, mission and transaction with stakeholders) to incorporate other stakeholders into the strategy-led approach. Since these integration methods can be influenced through procurement methods, these findings will not be applicable to a procurement method which is established in future based on different principles. In such circumstances, Guba (1990) explains that qualitative information (in this case the procurement types that the findings of the study are based on) taken during data collection allows meaningful interpretation by the practitioner.

By considering these arguments, this research investigation was carried out under mixed method approach. Amarathunga, et al. (2007) articulate that built environment research uses either strong quantitative or qualitative methodologies. However, Amarathunga et al. (2007) suggest that mixed method approach is the most appropriate approach to counteract with weakness of each extreme method and hence to enhance accuracy of phenomena related to build environment research which includes cognitive, affective and behavioural components. The following section describes how the three matrix levels of the mixed method approach are used.

4.5 Investigation of the Inquiries using Different Methods

Having the flexibility to use both qualitative and qualitative methods effectively under post-positivist philosophical positions, this section describes how methods were selected for this research investigation through criteria given by Walliman (2005). He identifies four major criteria to consider when suitable data collection and analysis techniques are selected:

1. What is to be found out,
2. Particular characteristics of research problem,
3. Specific sources of information, and
4. Type of analysis (if quantitative or qualitative)

The selection procedure is clarified in Table 4.3 related to four research inquiries of the current study by following Walliman's (2005) procedure. In this way, the applicability and advantages of the mixed method approach to the current study is understood.

The first inquiry of Table 4.3 was to find out ambiguous natures that make construction project planning and implementation challengeable. This query was used to shape the actual problem. Therefore, the inquiry was exploratory, and consequently qualitative data was preferred. Interview transcripts as well as archival information were considered as potential sources of data. From the literature review, it was identified that complexity, dynamism, uncertainty and uniqueness are the key words that make construction projects ambiguous. Therefore, from an analytical point of view, this inquiry required to identify to which extent the four keywords were mentioned in the data used for the investigation. Therefore, a frequency analysis was preferred. Considering these facts, both interviews and archive analysis were possible tools, but archival analysis was preferred over interviews because the data was available as web documents.

The second and third inquiries were all related to the primary data collection. The second query aimed at identifying the contribution from 6 typologies to strategy crafting and implementation. This explanatory inquiry required quantitative data. Dialectical information such as interviews and archival information was not suitable to effectively provide quantitative measures on these abstract measures. Therefore, closed-ended survey questions were preferred. Statistical analyses such as the comparison of central tendencies were used to analyse data obtained from the questionnaire. To determine the validity of the findings, the study uses subject matter expert (SME) interviews as a follow-up technique and analysed the data using thematic analysis.

The third inquiry was related to identifying construction project strategies. In this exploratory inquiry, the study preferred to use as many projects as possible to investigate if there were common concepts of strategies (such as rate and rhythm suggested by Abeysekara (2007)) that construction project managers used. The only subsequent question that is required to investigate was why those strategies were used in construction project implementation. Therefore, no in-depth information was needed. Due to this nature, interview transcripts were absolutely possible, but archive analysis as well as open-ended questions were satisfactory. Considering these criteria, the investigation was done using three stages; an archival analysis followed by open-ended questionnaires and finally validation through interviews. Each stage refined the focus of the inquiry for the succeeding phase and hence this step-wise investigation could enhance the accuracy of the findings, effectively. Further, it allowed the use of a large number of projects in the inquiry. Thematic analysis was possible to use under the three stages. Having recognized the applicability of the mixed method approach through some sample explanations, the next section outlines different methods used in the study.

According to the procedure explained through the use of the above samples, different research methods were used within mixed method approach to investigate the research questions mentioned in section 1.3. A summary is depicted in section 4.10 to explain the use of different research methods.

The preliminary data collection stage		The secondary data collection stage	
Criteria	**Inquiry 1**	**Inquiry 2**	**Inquiry 3**
What is to be found?	Ambiguous nature of construction projects, discover industry's perception about project success and, determine approaches that offer a bridge between ambiguous project natures and unambiguous success	Which typologies contribute to strategies?	What are successful project delivery strategies that project managers could use to deliver construction projects?
Characteristics of the problem	The questions were to identify the actual problem in the industry and hence an exploratory inquiry. Therefore, qualitative data was required.	Inquiry aimed to identify contribution from 6 typologies to strategy crafting. The explanatory inquiry required quantitative data on abstract measures.	The inquiry was exploratory. The width of the inquiry was considered as prominent over the depth of the question, consequently open-ended question was possible.
Sources of information	Interview transcripts or archives (websites, company records, newspaper articles, library archives).	Dialectical information such as interviews and archives were not suitable. A closed-ended questionnaire was preferred.	Archives, open-ended questions and interview transcripts.
Analysis	Themes identification was required, and hence thematic analysis was preferred. Frequency count (quantitative) was used.	Statistical analysis such as comparison of means	Thematic analysis
Result	An archival analysis was preferred.	A questionnaire survey (closed-ended) with statistical analysis and follow up interviews to construct validity.	An archive analysis followed by an open-ended question succeeded by validating interviews. Each stage refined the preceding stage.

Table 4.3: Selection of innovative strategies of the current inquiry according to Walliman (2005)

4.6 Outline of the Research Method Used

This section describes the major stages of the current study in detail including the problem identification, the preliminary data collection and analysis, the primary data collection and analysis, and the validation of the findings of the current study.

4.6.1 Approach to 'Problem Identification'

The approach used for 'problem identification' is depicted in Figure 4.4 . This stage was carried out as an iterative process in line with Dias and Blockley's (1995) reflective practice (RP) loop consisting of four entities: world, perception, reflection and action.

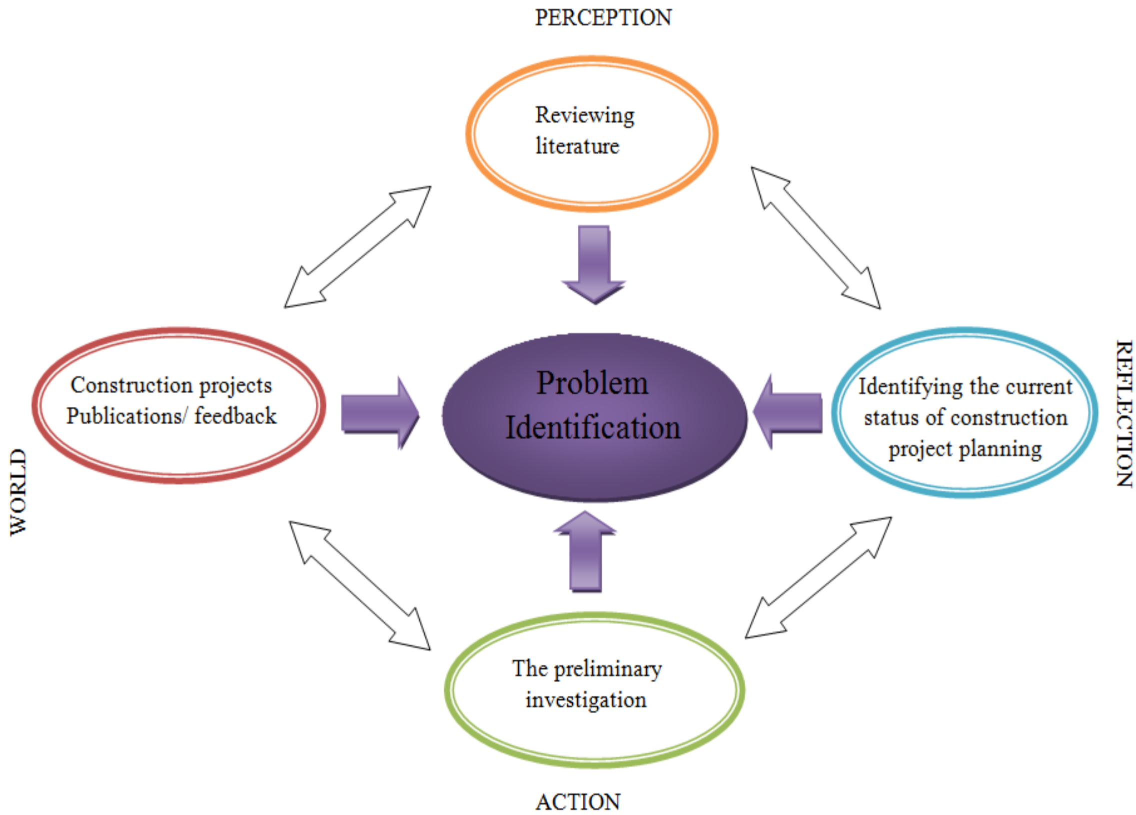


Figure 4.4: The stage 1 of the research process: the problem identification

For the current research process, the "world' refers to construction projects, which are the starting point of the problem identification stage. Past literature was perceived and the researcher reflected on several opinions stated by scholars, including controversies associated with them. Based on these reflections, the research study identified existing research gaps to be filled by the current study's aim, objectives, research questions as well as hypotheses.

However, the researcher identified a major issue at the problem identification stage: there are many knowledge areas associated in this research investigation, which are abstract concepts. For example, natures of strategies as well as construction project natures such as complexity and uncertainty are all abstract measures consequently these concepts cannot be quantified through measurements or performance records as similar concrete measures, like cost and time. Popper (2002) identifies that knowledge associated with such non-concrete objects is usually influenced by investigators' subjectivity. Therefore, to eliminate subjective conclusions and potential misinterpretations, the researcher needed to review many studies from past literature and reflect on rival opinions.

Although there was a necessity to review many scholars, there is no significant volume of studies available focusing on the study's major areas like construction project strategies and reflective practice. In addition to subjective influences, Taylor (2005) identifies that lack of literature can weaken an overall research framework. Therefore, as a remedial action, a preliminary study is carried out to refine the aim, objectives, research questions and hypotheses identified after reflecting on past literature. The preliminary research investigation can be taken as the 'action' of the RP loop (Figure 4.4) whose focus is to identify the problems of this research study comprehensively.

Getting feedback from peer reviews was another step in the problem identification of this research study. Three conference papers were written based on both, the literature survey and preliminary findings. The first conference attendance, the 27th ARCOM, was made based on a paper written about literature review reflections. The conference paper mentioned strategies related to the construction industry and the potential contributions from the TR and RP paradigms for them. The second and third papers focused on strategies and the two paradigms (the TR and RP), respectively, in order to fertilize identified gaps through document analysis findings. The key ideas discussed in each paper are summarized further in Appendix A1 with these three publications.

Taking feedback did not become the last step of the problem identification loop. Based on feedback, new areas that could be important were identified and literature review was continued through several iterations by using the concept of RP loop. The aim, objectives and questions of this research investigation mentioned in section 1.3 are the final outcome of the problem identification, which is refined through several iterations by using the procedure mentioned in this section. After the problem is identified, several data collection and analysis techniques were used to achieve the research objectives as discussed in the following sections.

4.6.2 Preliminary Investigation: Analysis of Archival Information

There were five objectives set under the preliminary investigation as mentioned below.

- To identify what makes construction project implementation challenging. The current study reviewed literature to identify construction project characteristics, which influence planning and implementation activities, and the reliance on contemporary planning tools. It would seem that construction project performance falls short of expectations especially in situations where the reflective abilities of project managers are not harnessed. Based on these, the need for a contemporary planning approach was suggested. Analysis of archival information helped to corroborate facts toward this argument before the study proceeded toward the primary data collection.
- To identify the industry perception about project success. Having recognized that there are a multitude of parameters to measure success, the study used only cost, time, quality and client satisfaction for as the measurements. In addition, this research investigation uses overall success which is a combination of the above success parameters. Are they rational? The preliminary investigation aimed to investigate success measures that the industry demands.
- To identify approaches that could help to overcome these challenges and achieve ultimate success. The study identified several approaches from literature as remedies to existing failures. By reviewing these suggestions in literature, this research study conceptualized strategies over other inventions as a suitable project delivery method in construction. Are strategies actually used in practice and which ones? The preliminary investigation provided an opportunity to collect facts about this question.
- To identify construction project managers' roles in achieving success. The study reviewed past literature and found construction project managers as the most important person for achieving project success. Therefore, the study decided to use construction project managers as the most appropriate person to provide information on project planning and implementation in the primary investigation. The preliminary investigation was used to check the validity of using construction project managers as the most suitable stakeholder to provide information in the primary investigation.
- To identify which factors can govern construction project success. From literature, the study identified 32 critical success factors, which a reliable planning approach

should influence effectively. Is there anything else to be considered as critical success factors which did not emerge in the review of literature?

According to Yin's (2003) classification mentioned previously in section 4.3, an archival analysis, a way of sorting and analysing publicly available past data , was a suitable research strategy to investigate the objectives mentioned above.

Apart from Yin's (2003) classification, archival analysis seemed to be economical as well as adequate as a form of preliminary research strategies. Using archival analysis, it was possible for the researcher to study a larger number of projects (66) which could be somewhat difficult to achieve if interviews were used. Further, no ethical approval was required for the archival analysis used in this preliminary investigation.

Since the archival information used in this preliminary investigation was not in an orderly format, the analysis procedure took more time and effort than analysing interview transcripts which would have been systematically focused only on relevant research questions. Use of NVivo 9 software, which is a qualitative research tool for data sorting and analysis, minimized the effects due to non-orderly organized information in the archival information compared to the preliminary inquiries. The use of NVivo 9 is discussed in detail in section 4.6.5

The preliminary study involved an analysis of archival information provided by the Chartered Institute of Building (CIOB), UK, on Construction Manager of the Year Award (CMYA) winners. The information on the award winners were collected for the period of 2009-2011. This resulted in information collected for a total of 66 construction managers and 66 projects within the period considered. The CIOB information was selected among other archives after systematically considering many facts.

Firstly, the award statements described each and every project from their inception to completion. This feature facilitated the researcher to understand overall construction implementation process and associated barriers in a holistic manner.

Further, the information provided under the award statements was relevant to the scope of the current study. The award statements provided information on project complexities and uncertainties that project managers faced in real projects, as well as the mitigation actions they implemented, which were recognized as strategies in the current study,.

The reliability of the information was considered. The data on past successful projects was provided by a third party and evaluation was essentially done by members from a third party (CIOB, 2010). The third party was consisted by corporate members of the CIOB, including management specialists, clients, design teams, construction project managers etc. (CIOB, 2010), and hence the evaluation could be assumed as an overall representation of the industry. Therefore, by using the archival information provided by CIOB, the preliminary investigation could review the overall industry's perception on project implementation and success. The approach to the analysis of information obtained from the award statements is described later in section 4.7.2, while the results are presented in Chapter 5.

4.6.3 The Questionnaire Survey

Questionnaires were used under the primary investigation to achieve the objectives of this research study. The following sub-objectives were set in the primary investigation in line with the objectives of the current study:

- To quantify the volume of the characteristics of construction projects within the scope of planning and implementation. The literature survey, as well as the preliminary stage, identified the existence of complexities, dynamisms, uncertainties and uniqueness in construction project planning and implementation. However, what is the impact of these challenges? The primary investigation intended to quantify these four challenges related to their impacts toward construction project planning and implementation.
- To reckon the amount of success achieved by the construction projects used under the primary data collection. Literature and the preliminary investigation showed that cost, time, quality and client satisfaction are the main expectations by project success. To which extent the industry demands successful outcomes on these measures? To find this out, the primary investigation focused on quantification. Further, the findings of this objective could help one to understand the amount of success achieved by the construction projects used in the primary investigation by planning through the strategy-led approach.
- To identify the three dimensions of strategies. In this way, someone can get an understanding about strategy crafting and implementation process in terms of 'what', 'why', 'who' 'when', 'where' and 'why'.

- To quantify influences from strategies toward critical success factors. This quantification would allow the study to identify areas that strategy can influence more effectively. Further, it could indicate if strategies can influence construction project planning in a holistic manner.
- To determine the relationships between influences of strategies, project contingencies and project success. The study posited that project contingencies could negatively affect success while strategies would be able to positively influence success. Combining the influence of strategies and contingencies together toward project success could indicate the overall effect of them.

To investigate these inquiries, the majority of the questions were set as closed-ended questions. A few open-ended questions were also set to gather information on strategies. Therefore, the primary investigation can be regarded as quantitative dominated. The nature of variables and their scales were previously described in chapter 3: Conceptual Framework. The following sections describe considerations for the design of the questionnaire, selection of participants as well as the way the questionnaire survey was conducted.

4.6.3.1 Design of the Questionnaire

To design an effective questionnaire, Malhotra et al. (2002) articulates three major considerations: to provide questions such that respondent can and will answer, to vary the format of questions to motivate respondents, and to increase clarity to minimize response errors.

Following Malhotra et al.'s (2002) recommendation, the first step toward the questionnaire design was to review the objectives to determine the information needed to be gathered. Thereafter, the study was in position to consider availability and accessibility to the data required. In this questionnaire survey, construction project managers were selected as respondents. In the questionnaire design, it was considered that there was potential for the participants to provide answers to the questions of the primary investigation. After considering the possibility of gathering required information, the length of the questionnaire was considered.

The length of the questionnaire was considered to balance between the amount of information and the response rate. To secure a good response rate, Saunders, Lewis and Thronhill (2007) recommend to use 6-8 pages in a postal questionnaire. Further, Malhotra et al. (2002) articulate that the response rate can become inadequate when the length is increased.

To optimize the length, the importance of each question, which are initially selected to investigate under the primary investigation, was rated using a Likert scale of 1-5 (from 1 = very low to 5 = very high). The level of importance was considered based on importance toward strategy dimensions and unavailability of past literature. The questions that are rated with ‘low importance’ were removed from the questionnaire. ‘Moderately important questions’ were selected, but the depth of information required for them was limited in the questionnaire. The questions rated as high and very high importance to propose the strategy-led approach as a suitable planning approach to plan and implement construction projects were selected to gather in-depth information. In this way, this research study could minimize the consequences of limiting the length of the questionnaire toward the richness of data gathered. After the length of the questionnaire was optimized, considerations were given to increase clarity and willingness to answer the questions.

Any potential confusion from double-barrelled questions was considered in addition to biased questions. Thereafter, brief, but adequate, descriptions were added for each question to increase clarity. Although the potential respondents were professionals, technical words were avoided as much as possible and words were kept to the simplest. Ambiguous things such as how to dedifferentiate complexity and dynamism were defined and sometimes examples were provided. It caused everything to be explicit throughout the questionnaire.

The questionnaire was anonymous and the anonymity would make it easier for the respondents to answer the questionnaire. To increase their willingness, randomized techniques (ticking and graphical methods) were used to answer. The study used short easy-to-respond questions most of which require the respondent to tick, circle or give brief explanation, too.

Finally, the layout of the questionnaire was decided. A few open-ended questions were put at the beginning as a right of entry to the questionnaire. The questionnaire included six major sections putting the most important once at the beginning. Finally, the question design reached the final stage: pre-testing.

Pre-testing the Questionnaire

Barribeau et al. (2012) mention that designing the perfect questionnaire is impossible, but an effective one can be prepared through pre-testing. There are two kinds of pre-testing mentioned: general application and pre-testing for reliability and validity (Barribeau et al., 2012). General pre-testing includes checking for layout, difficulty to answer, adequacy of information, content, wording, sequence and statistical significance (Barribeau et al., 2012). Reliability and validity considers accuracy through test and pre-test (Barribeau et al., 2012). For general pre-testing, the researcher used participating pre-tests (protocol analysis) where respondents were informed that they were participating in a pilot survey: the reliability and validity pre-test used de-briefing to test the questionnaire. Thus, the respondents were not informed that their response was a pilot step (Malhotra et al., 2002). Table 4.4 describes how pre-testing was done for the questionnaire survey of this study.

Table 4.4: Participation for the pilot surveys of the questionnaire

Participant	No	Types of tests	True participants of the questionnaire
		General pre-testing	
Production engineer and lean experts	1	Layout, difficulty, adequacy of information	No
Construction managers	3	Content, wording, sequence, form, layout, difficulty, adequacy of information	2-Yes 1-No
Civil engineers	1	Layout, difficulty, adequacy of information	No
Mechanical engineers	1	Layout, difficulty, adequacy of information	No
Architects	1	Layout, difficulty, adequacy of information	No
Quantity surveyors	1	Layout, difficulty, adequacy of information	
Statisticians	1	Adequacy of information, statistical significance	No
Construction Management Lecturers	4	Content, wording, sequence, form layout, difficulty, adequacy of information, statistical significance	No
		Reliability and validity pre-test	
Construction managers	2	Reliability and validity	Yes

The first column describes background information of the respondents of the pilot survey. There were 13 respondents under the general pre-testing. In the general pre-testing, the participants were advised to give their feedback on specific themes as mentioned in the third column. The themes were specified according to their background. For example, for statistical significance, only the lecturers were asked to give their feedback.

For the general pre-testing, as well as for the reliability and validity pre-testing, there were only two participants who are NZIOB awardees which would participate in the questionnaire survey at the data collection of the primary investigation. Under the reliability and validity pre-testing, the researcher was concerned about the consistency among responses which the participants gave at two different times.

The participants of the pilot survey were recruited in a systematic manner. Initially, the general pre-testing was done and followed by the reliability and validity pre-testing. For the participants of general pre-testing, the draft questionnaire was sent out one after another so that someone's feedback could work as refinements for the next one's draft. Finally, the true participants (the two NZIOB awardees) were recruited for the general pilot survey. After that, the statistician was used to get feedback on statistical significance and the adequacy of information to perform rigorous statistical analyses. After, the general pre-testing was done, the reliability and validity pre-testing was conducted, having a one-week gap between the two responses taken.

4.6.3.2 Selecting the Participants for the Questionnaire Survey

This section describes two major considerations for selecting the population and eventually selecting the sample of the respondents for the questionnaire survey.

The study aimed at developing a reliable planning approach based on planning and implementation techniques used in past successful projects. Therefore, the population was construction projects that had been completed successfully. Since different stakeholders have different perceptions about project success, the current study preferred to use projects recognized as successful by a third party. The New Zealand Institute of Technology (NZIOB) was selected as the third party in the selection procedure of the population.

NZIOB conducts an award ceremony annually for which construction professionals are evaluated on individual basis for their excellence based on their performance shown in their construction projects. The awardees are evaluated under several categories which include construction work related to commercial, industrial, residential, refurbishment fit-out, institutional, civil projects or any other aspect of building (New Zealand Institute of Building, 2011a). Therefore, selecting the NZIOB awardees as representatives of the population to the questionnaire survey could facilitate the study to have construction projects successfully completed from various disciplines.

The projects that the awardees were nominated for should undergo challenges apart from normal issues common to any construction project (New Zealand Institute of Building, 2011b), and therefore the criterion harmonizes with the requirements of the current study. The entry requirements of the NZIOB award emphasize clear identification of specific challenges because issues of program, logistics, quality, design and cost are common to most construction projects.

The judging process includes two rounds, which are preliminary and final. The preliminary round is judged by three judges, who are generally NZIOB members and award sponsors, per each category. These NZIOB members include managerial, technical and administrative professionals of construction, installation, designs, survey as well as teaching and building research (New Zealand Institute of Building, 2011a). The panel interviews all entrants as well as at least one referee to decide the finalists. Having notes from preliminary judges, three new judges in addition to only some of the preliminary judges evaluate the finalists through face-to-face interviews. The final judges that are representatives from industry professional bodies including New Zealand Institute of Architects (NZIA), The Institute of Professional Engineers New Zealand (IPENZ), The Registered Master Builders Federation (RMBF), New Zealand Institute of Quantity Surveyors (NZIQS) as well as Property Council and award sponsors may speak to the nominator and referees. After all evaluations, each panel comes together and decides winners through a challenging process. No judges who worked on a project closely with an entrant as well as from the same company are permitted for evaluation (New Zealand Institute of Building, 2011b). Therefore, NZIOB awardees are evaluated unbiased through an overall representation of the industry.

The awardees are not restricted to construction project managers. However, the current study was in a position that only construction project managers are able to provide information related to the overall processes of strategy crafting and implementation for construction projects. Therefore, only construction project managers were selected as the population by evaluating the award statements given in the ‘Progressive Building’ magazine, which is the official magazine of the NZIOB. The awardees were selected from 2001 to 2011 only by considering practicality to find out their contact details. NZIOB provided the awardees names and company details only. For this time period, there were 160 construction project managers selected to represent the population for this study. From that population, the sampling of the questionnaire survey was done.

Malhotra et al. (2002) recommend the use of sampling when a population is large. However, they do not provide any clue to separate samples as either large or small. Implicitly, it seems that the size of a population depends on the possibility to recruit a whole population. Recruiting each member of the population of the current study seemed to be somewhat impossible due to potential inaccuracies of some contact details and their possible non-participation. Therefore, the current study used a sample as opposed to census. The required sample size was selected by using Cochran's (1977) formula.

Since the primary variables such as influence of strategies were measured in the questionnaire by using a 10-point scale, this study used this scale to be used in Cochran's (1977) formula. Thereafter, the margin of error was determined according to Chadwick's (2007) recommendation, which is to use 3% as the margin of error for continuous variables. The study used a level of significance of α=0.05. Since the degree of freedom was unknown at this stage, the t value ($t_{0.05}$= 1.196) was taken as the equivalent Z value. The variance was calculated by dividing the scale points by number of standard deviations. The study assumed that 98% of the data values are within 3 standard deviations from the mean. Therefore, there were six standard deviations considered to the both sides and hence the variance was equal to 1.67 (10/6). Required return sample size according to Cochran's (1977) formula was 119 according to these values described above. Since the sample size is greater than 5% of the population, the correction was applied for the return sample size and hence the required sample size calculated from a population of 160 award recipients was 69.

4.6.3.3 Selection of Survey Techniques for the Questionnaire Survey

Questionnaires can be classified as mail surveys, mail panels, e-mails and internet surveys (Malhotra et al., 2002). Among the four techniques, three alternatives were initially selected; mail panels were discarded. To select the best technique among these three, the researcher considered 14 criteria suggested by Malhotra et al. (2002).

The second and third columns of Table 4.5 describe the meaning of each criterion and its importance for this survey, respectively. The last five columns describe the efficiency of the selected strategies toward the 14 criteria according to Malhotra et al. (2002). They describes five different qualitative measures and the current study assigned numerical values (4-very high; 3-high; 2-moderate; 1-low; 0-none or not applicable) to facilitate the comparison. Further intermediate values were given fractional numbers, for example medium-to-high is equivalent to 2.5.

The current study's input for Table 4.5 was to assign the importance of each factor related to the current research inquiry. These qualitative measures were decided based on a 5-point scale which ranges between 0 and 4 (4-very high; 3-high; 2-moderate; 1-low; 0-none or not applicable). Stevens (2009) recommends to keep transparency of these subjective decisions because it can ultimately assist to make the process understandable and justifiable. Therefore, the following paragraphs provide the rationale behind the assigning of importance toward the 14 criteria.

The first factor, the flexibility of data collection, considers the possibility to clarify inquiries by using different strategies such as visual, verbal and textual. Regarding the questionnaire, there were some questions that needed clarification (such as to contingency themes: complexity, dynamism, uncertainty and uniqueness). However, in the three survey methods selected (mail survey, e-mail and internet/web), the researcher could address this issue by using textual explanations. Therefore, the first factor could not work as a variable to select the best technique consequently the factor was given zero significance to become a selective criterion.

The 13th factor is 'speed'. Since the questionnaire could allocate adequate time for data collection and entry, this factor was not taken into consideration. Likewise, 2nd, 3rd, 5th, 6th, 10th and 11th factors were considered unrelated to the questionnaire. The 14th factor, cost, was given low significance in the questionnaire, but this factor could not work as a selection criterion because the three techniques have the same efficiency for that factor. Since the post-positivist-paradigm was adapted for the study, the 12th factor that related to objectivity was given very high importance, but the selected three techniques are rated similar under this criterion.

Perceived anonymity was the ninth factor and required consideration under the questionnaire administration due to the AUTEC requirements. As a result, the 9th criterion was considered as very important. The 8th factor (response rate) was considered as a very high important consideration.

Table 4.5: selection of survey techniques for the study by considering the importance of each criterion versus efficiency of each strategy

	Criteria (Malhotra et al., 2002)	**Meaning**	**Importance to study (*i*)****	**Capability/efficiency of Survey methods(*j*)****		
				Mail survey	**Email**	**Internet /web**
1	Flexibility of data collection	Interaction needed between the researcher and respondents to clarify complex questions	0	1	1	2.5
2	Diversity of questions	Different kind of questions to be asked	0	2	2	2.5
3	Use of physical stimuli	Necessity use physical stimulation (such as products to test)	0	2	1	2
4	Sample control	Ability to reach units effectively and efficiently	2	1	1	1.5
5	Control of data collection env.	Providing an environment to make answering easier	0	1	1	1
6	Control of field force	Controlling interviewers and supervisors	0	3	3	3
7	Quantity of data	Amount of data to be collected	4	2	2	2
8	Response rate	Percentage of completed among attempted respondents	4	1	1	0.5
9	Perceived anonymity	Identify is not revealed	4	3	2	3
10	Social desirability	Giving socially acceptable answers	0	1	2	1
11	Sensitive information	Taking sensitive information	0	2.5	2	3
12	Interviewer bias	Interviewer's influence through selection of respondents, omitting questions and misleading recordings	4	0	0	0
13	Speed	Speed of the survey	0	1	3	3.5
14	Cost	Cost involved in the survey	1	(1)*	(1)*	(1)*
**** 4-very high 3-high 2-moderate 1-low 0-none or not applicable * – values inside brackets indicate disadvantages and considered as minus values for ∑(*ij*) calculations**			∑(*ij*)	25	21	24

Finally, the most suitable survey method was selected based on ∑(*ij*) values where *i* is the importance rating according to the researcher's perception and *j* denotes the efficiency rating according to Malhotra et al. (2002). However, the difference between the highest and the second highest rated questionnaire strategies was marginal (25 and 24 for mail and internet surveys respectively). Finally, based on the potential response rate, this research study decided that mail survey as the most appropriate method to conduct the questionnaire within the context of the current study. Then, the questionnaire survey was conducted as described below. Conducting the mail questionnaire survey is described in the following section.

4.6.3.4 Conducting the Questionnaire

The plan of the questionnaire is given in Table 4.6. The questionnaire was dispatched to the participant by using their company addresses on 7 July 2012, with at least 69 responses expected back. To receive the required sample size, 130 questionnires were distributed.

The respondents were required (within the participant's information sheet) to complete the questionnaire within two weeks. During this given time, 18 responses were received representing 26% of response rate only. The first reminder letter was sent out on 22 July 2012, which resulted in another 14 responses within two weeks. A second reminder was sent on 6 August 2012. Finally, on 13 August 2012, the last reminder was sent. A total of 40 questionnaire responses were received throughout the data collection period. The response rate became 58% related to the required sample which represents 25% of the population. At this point, the adequacy was decided by considering analytical and practical points of views.

Table 4.6: Plan to conduct the questionnaire survey

Stage	Duration given	Response given		
		Number	% to the sample size	% to the population
Launching the questionnaire	2 weeks	18	26	11.3
1st follow-up reminder	2 week	14	20	8.8
2nd follow-up reminder	1 week	7	10	4.4
Final follow-up reminder	1 week	1	1	0.6
	Total	40	58	25

Since the response rate depends on the professional background of the participants (Baruch, 1999; Rogelberg & Stanton, 2007), to determine the typical response rate related to this research study, the relevant literature reviewed in the ambit of management and behavioural research disciplines. Baruch (1999) evaluates 175 cases from six international journals including Academy of Management Journal and Organizational Behaviour and Human Decision Process and has found that for top management level, the average response rate is about 17% to 94% at 95% confidence interval. Fenton O'Creevy (1996) has found that 28% respondents do not complete the questionnaire since they are busy (Baruch, 1999). Further, a postal questionnaire is recommended to be conducted within 4-8 weeks (Saunders et al., 2007) and the study had already spent 6 weeks. From an analytical point of view most statistical analyses need more than 30 responses (Malhotra et al., 2002). Thus, it was considered that the current study's response rate was reasonable with respect to practical and analytical consideration. In addition, the final reminder returned back only one response. Therefore, the study stopped the questionnaire survey at this point.

In the next section, the procedure followed for the validation interviews is described.

4.6.4 Conducting Validation Interviews with Subject Matter Experts (SMEs)

According to the post-positivist philosophical position of this research investigation, multiple approaches are required to investigate the inquiries to the highest accuracy. The findings of the preliminary and primary investigation were finally validated by the interviews with the participating subject matter experts (SMEs).

Sugar and Schwen (2009b) describe SMEs as individuals who become experts in their field and can be used to evaluate the feasibility of research findings in practice. In this study, the SMEs were construction project managers who are the recipients of the NZIOB awards. There were three SMEs and their demographic information is given in section 6.2 with the rationale of using only three of them.

The interviews with the SMEs was semi-structured so that the SMEs could offer their opinions freely as opposed to strict question layouts of structured questionnaires (Malhotra et al., 2002). The potential questions were selected by considering the findings emerging from literature and the research investigations (preliminary and primary). The validation interviews were designed in terms of time as shown in Figure 4.5.

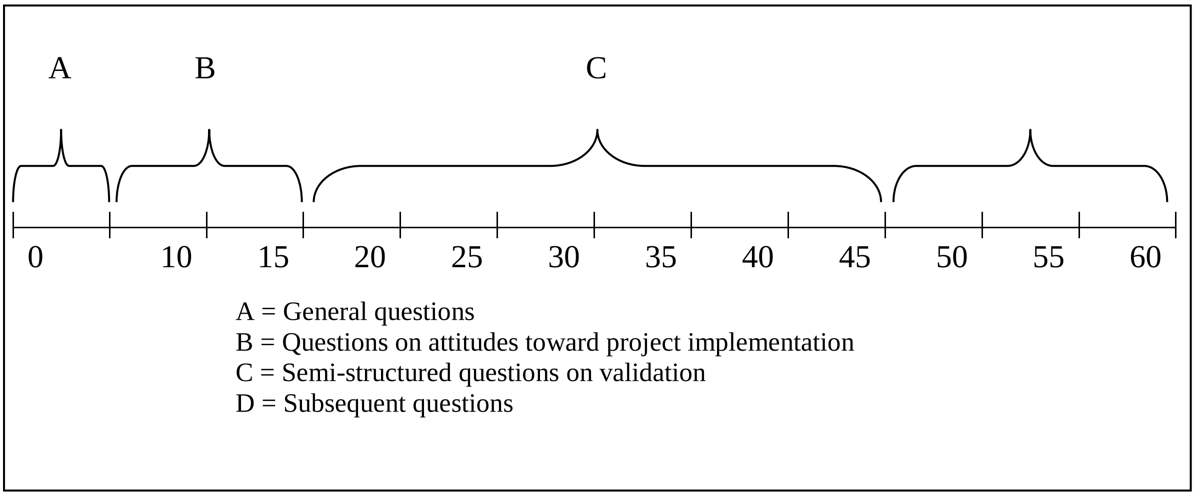


Figure 4.5: The design of the semi-structured interviews in-terms of time

The total time for one interview was fixed at one hour. First, general questions were asked to familiarize with the respondents and to allow them to opine about nature of construction projects and planning methods. For example, ‘what are challenges in construction project implementation?’ and ‘do you think that current planning tools are capable to handle these situations?’ In addition, these questions were not followed with many subsequent questions because more important questions remained to be answered. The second type of questions focused on attitudes toward construction project implementation. Under this stage the participants were asked about themselves and other stakeholders in the context of strategy.

The third stage of interviews was considered as the most important part, the purpose of which was validation. These questions were related to the use of the strategy-led approach and the complementary role to improve traditional planning algorithms. In addition, to achieve the objectives of this study, there were questions investigating the dimensions of construction project strategies. The answers of these validation inquiries were usually followed by subsequent questions to probe situations: these following questions usually included ‘why do you think such’, ‘can you please explain it more’ and ‘do you want to add something to this’. This arrangement was used as a guidance only to complete interviews in-time and effectively.

Since estimate for the validate interview was about 60 minutes, face-to-face interviews were preferred over telephone interviews. Malhotra et al. (2002) have found that social interaction and home environment motivate respondents to spend more time (up to 75 minutes) in personal interviews, but respondents have their own caution to stop telephone conversation at any time, which may lead to limit the length of a telephone interview only up to 15 minutes.

4.6.5 Data Management under the Research

Different methods were used to manage the data of the current study. The preliminary investigation used NVivo 9, which is a software package containing qualitative data sorting and analysis method, with text files. The archival information downloaded from the CIOB official website was imported to the software package as internal text files. Thereafter, different parent nodes and child nodes were created based on the objectives of the preliminary analysis. A snap-shot view of nodes developed using NVivo 9 is given in Figure 4.6.

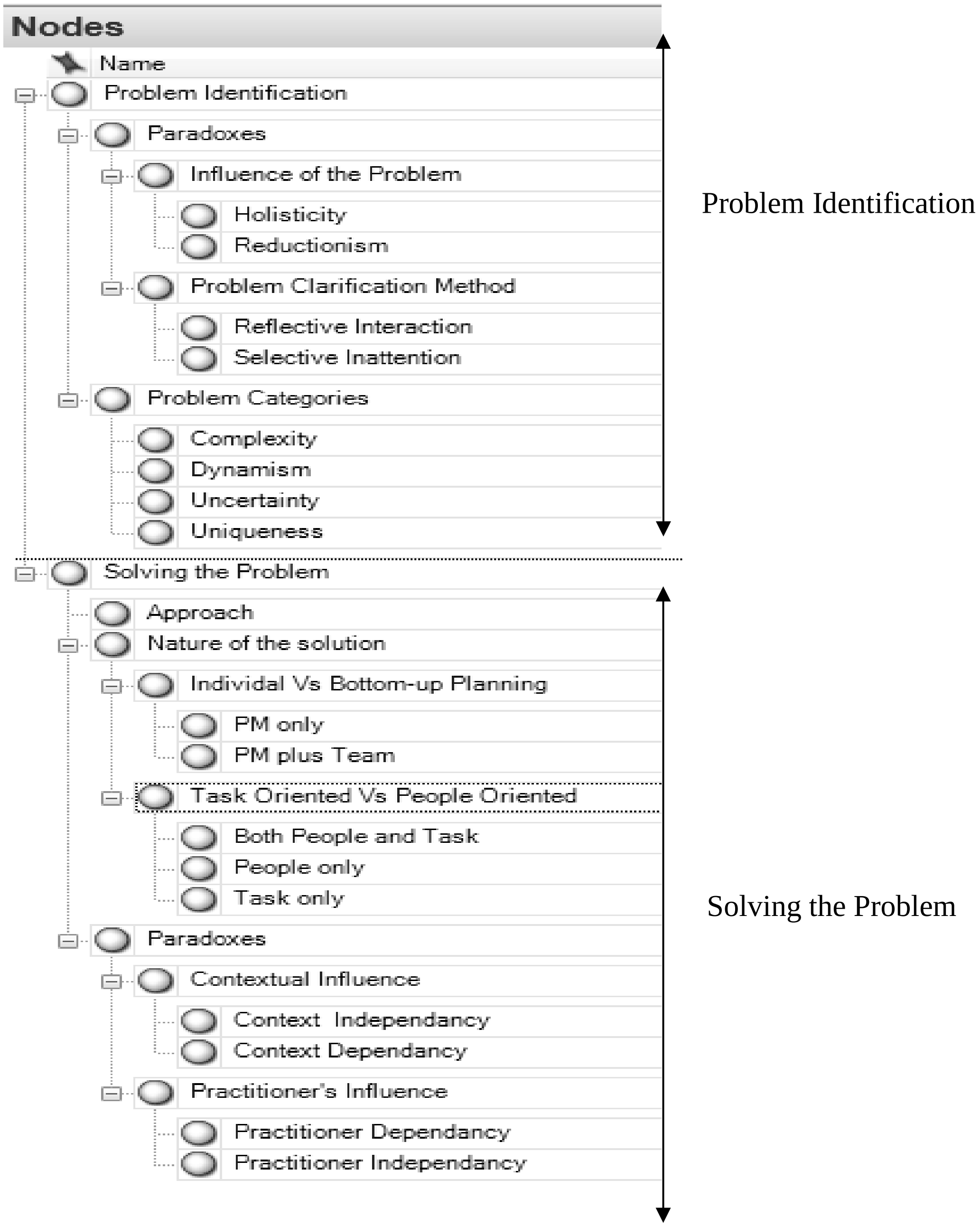


Figure 4.6: Arrangement of nodes in NVivo 9

For the primary investigation, all closed-ended questions were entered in SPSS version 18. Ratio and interval data were entered as given by the respondents. Categorical data was coded and entered in numerical format. Data cleaning was considered as a necessary step before proceeding with the required statistical analyses. For each data set, frequency distribution was checked to identify outliers and normality. Based on that, data cleaning and suitable adjustments were done and these considerations are discussed in Chapter 5 accordingly. Further, it was noticed that there were missing data for some variables. Sekaran (2009a) mentions three options to missing data replacement: to assign the mid-point to interval variables, to use mean value of other responses or to exclude missing values from the analysis. The study therefore excluded all missing data values from the analysis because it was not rational to use mean values to replace missing data as many data distributions were non-normal. The missing data analysis is described in Chapter 5 under the suitability of data. The qualitative data given to the open-ended responses were entered in Excel spreadsheet to analyse the content.

The remaining data were the qualitative data taken from the SME interviews under the validation exercise. The data was imported to NVivo 9 as audio files. Nodes and sub-nodes were created similar to the preliminary investigation. NVivo 9 had the facility to select and drag required voice phrases similar to textual data. Using SPSS 18 and NVivo 9 made both quantitative and qualitative analyses easy and more convenient.

Next analysis techniques are described. The data collected through the preliminary and primary investigation, and validation interviews were analysed by using both quantitative and qualitative methods.

4.7 Data Analysis Techniques

Within the selected post-positivist methodological positions, both quantitative and qualitative data can be analysed by using either quantitative or qualitative analysis methods. In this research study, statistical methods were used for quantitative analysis whereas content analysis was used as the qualitative technique.

4.7.1 Using Statistical Analyses for Quantitative Data

Statistical analysis is very important to avoid misleading interpretation in research investigation. It is a branch of mathematics, but the difference between mathematics and statistics is that “mathematics shows the naked truth; statistics dresses it and relates it to the realities of experience” (Taylor, 2005, p. 08) by accumulating, describing, classifying and evaluating experiences in an objective manner. The statistical analysis techniques used in this study are described in detail below. Under the statistical analysis of this study, $\alpha=0.05$ was used as the acceptable confidence level.

Suitability of Data

The suitability of the quantitative data, which were gathered through the primary investigation, was tested before the statistical analyses were performed. Outliers were checked parallel to other statistical analyses by observing histograms. Only reliability checks and missing data analysis were done to the quantitative data before other statistical analyses were carried out.

Since this study had several abstract measures, reliability check was important. Response given on a Likert scale for abstract measures like the characteristics of construction projects actually measure how generally the participants ‘feel’ about that abstract measure, but not exactly the variable. Walliman (2005) emphasizes to perform reliable checks for these kinds of measures to assess if the questions could accurately quantify what was intended to be measured.

In this study, SPSS 18 was used to check the reliability and Cronbach's alpha value was used as the parameter. If the Cronbach's alpha value is above 0.7, data set is considered as internally consistent (Walliman, 2005).

To evaluate missing data entities, SPSS 18 was used. The variables with missing data entities were reviewed further to determined possible causes of missing entries. Possibility of having non-random errors were statistically tested through Little’s missing completely at random (MCAR) test at $\alpha=0.05$ significance level by using the null hypothesis that ‘data is missing randomly’ (Schlomer, Bauman, & Card, 2010). Non-random errors occur due to participants’ inability to understand the question clearly (University of Maryland, 2012) and hence indicate the reliability of the quantitative data gathered in the primary investigation. When the missing data is random, those missing entities were deleted list-wise. It is safe to delete missing data list-wise when missing entities are random(Amanda & Enders, 2010).

Normality Checks

The normality of data was checked to select the most appropriate statistical test for both descriptive and inferential statistics to avoid misleading interpretations (Smith, 2012). Actual deviations from normality were determined by using three types of tests, which are graphical, numeric methods and formal tests. None of these methods are definite. Thus, Razali & Wah (2011) recommends to use multiple tests to verify normality in a data set.

Under the graphical methods, histograms and normality Q-Q plots were reviewed where numeric methods comprised observation of mean, medium, mode, skewness and kurtosis. In the perfect normal distribution, kurtosis and skewness should be zero, but as a rule of thumb, values between ±1 are acceptable as approximate normal distributions in a study (Razali & Wah, 2011).

There are four formal tests used in literature related to normality assessment: Shapiro-Wilk test (SW), Kolmogorov-Smirnov test (KS), Lilliefors (LF) and Anderson Darling (AD) test (Razali & Wah, 2011). By using Monte Carlo procedures, Razali and Wah (2011) find the most suitable techniques among them. According to their recommendations, for the sample size of the quantitative information, SW test is the most accurate formal test at α=0.05 significance level. In the current study, SPSS 18 was used to test the null hypothesis of SW test which is 'data distribution is normal'.

After normality was determined for the data distributions of the primary investigation, the most suitable statistical tests could be chosen between parametric and non-parametric techniques.

Compare Means

Both descriptive and inferential statistical tests were done to evaluate the characteristics of construction projects, project success and dimensions of the strategy-led approach. Descriptive statics comprised of evaluating central tendencies and variances whereas inferential statistics were used to compare means.

In descriptive statistics, mean and standard deviation were used to describe the properties of the sample if the data distributions are normal. When the data sets were non-normally distributed, median and mode values were used as the most appropriate central tendency. To calculate the variances of non-normal distributions, quartiles were used. To investigate the population parameters, these sample statics were used. To compare means under parametric test and non-parametric tests, mean and median values of the sample were used correspondingly.

To calculate population central tendency by using the sample central tendency, this study used one sample test for normally distributed variables. For non-normal distributions, alternative non-parametric one sample t-test, Wilcoxon signed rank test was used.

There were situations where two central tendencies were compared in the population. Under those situations, the study used paired t-test and alternative non-parametric Wilcoxon signed rank test according to the nature of data distributions.

When there were more than two means to be compared, ANOVA test was used for normally distributed variables. When data distributions were non-normal, this research study used the non-parametric alternative of ANOVA, the Friedman test. When Friedman test was used, a Wilcoxon signed rank test was done as a post-hoc test to evaluate where the difference of central tendency occurred. For the post- hoc test, since, the test involved 8 comparisons, Bonferroni correction was applies to the accepted levels of significance (α=0.05) to eliminate type I error. This was done by dividing α=0.05 with the number of comparisons to calculate the $\alpha_{modified}$ value for the relevant tests.

Regression and Correlation

In correlation analysis both parametric and non-paramtric tests were done according to the nature of the distribuiton in analyses. For nomal distributions, Pearson correaltion was used to test the null hypothesis that ‘there is no significant linear correlation between the varibles (r = 0)’ at α=0significnce level. For non-parametric distributions, Spearman correlation was used.

In regression, both normality and multi-collinearity were considered as the requiremtns to carry out the analysis. Whenever these two conditions were not met, those variables were subjected to several transformation techniques. These transformations are described in Chapter 5 under the regresison modling. To check for multi-collinearity, the collinearity statistics tolerance and VIF were calculated by using SPSS 18. If the tolerance values were higher than 0.1 and the VIF values were less than 10 there was no multi-collinearity issue (Malhotra et al., 2002).

The significance of the regression models were checked through verification of hypotheses at α=0 significnce level. In addition to the significance of the overall model, each dependent variable in the model was checked for the significance by using SPSS 18.

To test the assumption of normality under the hypothesis testing of the regression analysis, the normal probability plot was examined. If the plot between (0, 0) and (1, 1) represented a nearly a straight line, the asuuption of normality under hypothesis testing was considered as satisfied. The residual plot was examined for each regression model to check the assumption of constant varaince under regression analysis.

Factor Analysis

Factor analysis was used in some situations to integrate individual factors into component factors. SPSS 18 was used to carry out factor analysis by using Varimax rotation. Varimax rotation was used according to Field's (2005) recommendations since this study needed independent component solutions to use new variables given through the analysis in regression analysis at the later stage. The Kaiser-Meyer-Olkin test (KMO) was used to accept the solutions of factor analysis by measuring sampling adequacy. If KMO values were greater than 0.5, the factor solution was considered as acceptable (Williams, Onsman, & Brown, 2010). Bartlett's test of sphericity was used to test the null hypothesis that 'variables were uncorrelated in the population'. If the level of significance is below $\alpha=0.05$, the factor analysis was regarded as suitable (Tobias & Calson, 1969). Items of the factor solutions were considered as significant if the Eigen values were grater than 0.5 (Field, 2005).

4.7.2 Analysing Qualitative Data

Thematic analysis was used to analyse open-ended questions as well as the transcripts of the validation interviews. Thematic analysis involved reviewing open-ended questions of the questionnaire and audio transcripts of the interviews back and forth to identify themes within the content of the qualitative information. Further, it was used to analyse textual data under the preliminary investigation stage. As described in section 4.6.5, NVivo 9 was used for data sorting under the thematic analyses for the preliminary investigation and the validation interviews. Although NVivo 9 facilitates finding themes by using software, manual interpretation was used for the analysis.

The above sections described how the quantitative and qualitative data were analysed by using statistical analysis and content analysis. Using both quantitative and qualitative methods could ensure reliability and validity to the findings of this research study as described in the next section.

4.8 Reliability and Validity Checks in the Findings

Both qualitative and quantitative approaches share the common feature that reliability and validity checks of findings are necessary (Taylor, 2005).

Reliability and validity of research questions is an important consideration in any research (Malhotra et al., 2002). To check the validity and reliability of the questions in the primary investigation, this study conducted pilot surveys and reviewed the feedback given by the participants. In this way, this research could minimize drawbacks in the questionnaire (Taylor, 2005) and hence improve the reliability and validity of the questions that were asked from the participants in the questionnaire survey. Further, in the primary investigation, the reliability of the responses was evaluated through statistical methods (Cronbach's Alpha values) to determine whether the responses could indeed measure what those questions intended to measure.

In addition to the reliability and validity checks done to the questions, statistical generalization was used to construct validity of the findings. In the primary investigation, the findings of the inferential statistics are valid at 95% confidence level. In addition to statistical generalization, this study used triangulation to construct reliability and validity of the findings.

Within the mixed-method approach of this study, both quantitative and qualitative methods were used at the data collection and analysing levels. Through triangulation of the results that are found from multiple approaches, a study can construct reliability and validity (Guba, 1990). Golafshani(2003) stresses the power of triangulation over other methods to construct reliability and validity toward findings of a research. For example, some researchers use the test-retest method to evaluate the reliability of responses by searching for repeatability (Golafshani, 2003). In this research study, test-retest was considered as not reliable to measure reliability, because the respondents could become familiar with the question when they are repeatedly answer for the same questionnaire (Golafshani, 2003; Wainer & Braun, 1988).

Therefore, this research study used three techniques to check reliability and construct validity of the findings, which are review of the pilot survey, statistical generalization and triangulation exercise.

4.9 Ethical Considerations of the Research Study

Research ethics of the current study was set in line with the Auckland University of Technology Ethic Committee (AUTEC). The relationships between the researcher and other participants were in accordance with each of the three principles of the Treaty of Waitangi throughout the design and practice of the current research study.

This study was considered as an opportunity for industrial experts to share their innovative knowledge, which would be beneficial to both researcher and practitioners within the ambit of construction management. The participant's role was limited only to answer the survey and had no other role with the research outputs apart from answering the questionnaire survey and interviews. Their participation in the study was voluntary. Further, the participants were informed that the full report would be available as a thesis accessible at AUT library at the end of the study.

The participant's privacy was protected by keeping the participant's information anonymous. The data collected was accessible only to the researcher, and primary and secondary supervisors. The data was stored in a locked cabinet in AUT premises to satisfy the requirements of the AUTEC conditions. The output of this research did not include any personal information of the participants, and consequently, there were no issues, which could have been directly impacting on the Treaty of Waitangi. All information collected will be permanently destroyed after six years from the completion of the study.

Information was given to the participants in writing. The participant's information sheets are attached in Appendix B. A self-addressed envelope was provided to return the completed questionnaire to secure anonymity. Completing the questionnaire was the consent for the participation under the questionnaire survey. For SME interviews, the responses were presented in a coded system. In addition, the participants were kept informed that they could skip or stop the questionnaire survey or interviews at any time.

The participants were required to inform any of the supervisors, if they had any concerns about the research. Alternatively, concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTEC. For further information about the study, they were informed to contact the researcher. In addition, the participants were informed that the research is approved under the AUTEC reference of 11/198 Appendix B. In accordance with these ethical concerns, the current study was carried out.

4.10 Conclusion

The chapter discussed philosophical positions in research investigations in relation to the nature of the current study. According to the scope of this study, post-positivism was selected as the most appropriate philosophical position so that this study could be carried out with more flexibility. The use of multiple approaches under post-positivism could be used to construct reliability and validity of the findings of this research investigation.

Under the design of this study, the survey research strategy was selected by using Yin's (2003) classification and Bell's classification, which are widely used approaches to evaluate the most appropriate strategy for research including disciplines of construction management research. For, the preliminary investigation, an archival analysis was selected by considering the nature of inquires and the adequacy of information provided by the database that the archives are based on.

For this research study, a mixed method approach was selected so that disadvantages of both quantitative and qualitative methods could be mitigated. By adapting the mixed method approach, this study could comprehend the findings. Considering qualitative information with quantitative analyses provided an opportunity to present the output within the context for that those findings are applicable. In addition, mixed method approach could help to construct reliability and validity to the findings.

Under the research methods, this chapter described how the problem identification was done in accordance with Dias and Blockley's (1995) RP loop. The problem identification thorough the reviews of literature coupled with the preliminary investigation on the web-based archives provided by the CIOB, UK, provided an opportunity to refine the aim, objectives and research questions of this study. Under the primary investigation of this study, a questionnaire survey was administered by using a sample from the population of the NZIOB award recipients between 2001 and 2011. A postal survey over web-based and online questionnaire distribution was preferred for this research investigation by considering the 14 criteria given by Walliman (2005). As the validation method, the study used qualitative data gathered by using semi-structured interviews where the NZIOB award recipients could provide their insights towards construction project planning as well as the strategy-led approach.

The data analyses of this study comprised of both, quantitative and qualitative, analysis. For the quantitative data, the study used both parametric and non-parametric statistical operations appropriately. Content analysis was used to analyse the qualitative data. Using both quantitative and qualitative techniques under the data collection and analysis allowed the study to check the reliability and construct validity of the findings. The chapter finally concluded how this research investigation was carried out in line with the requirements of the AUTEC requirements. Figure 4.7 is depicted to summarize the use of different research methods under the mixed method research methodology to investigate the research questions of this study.

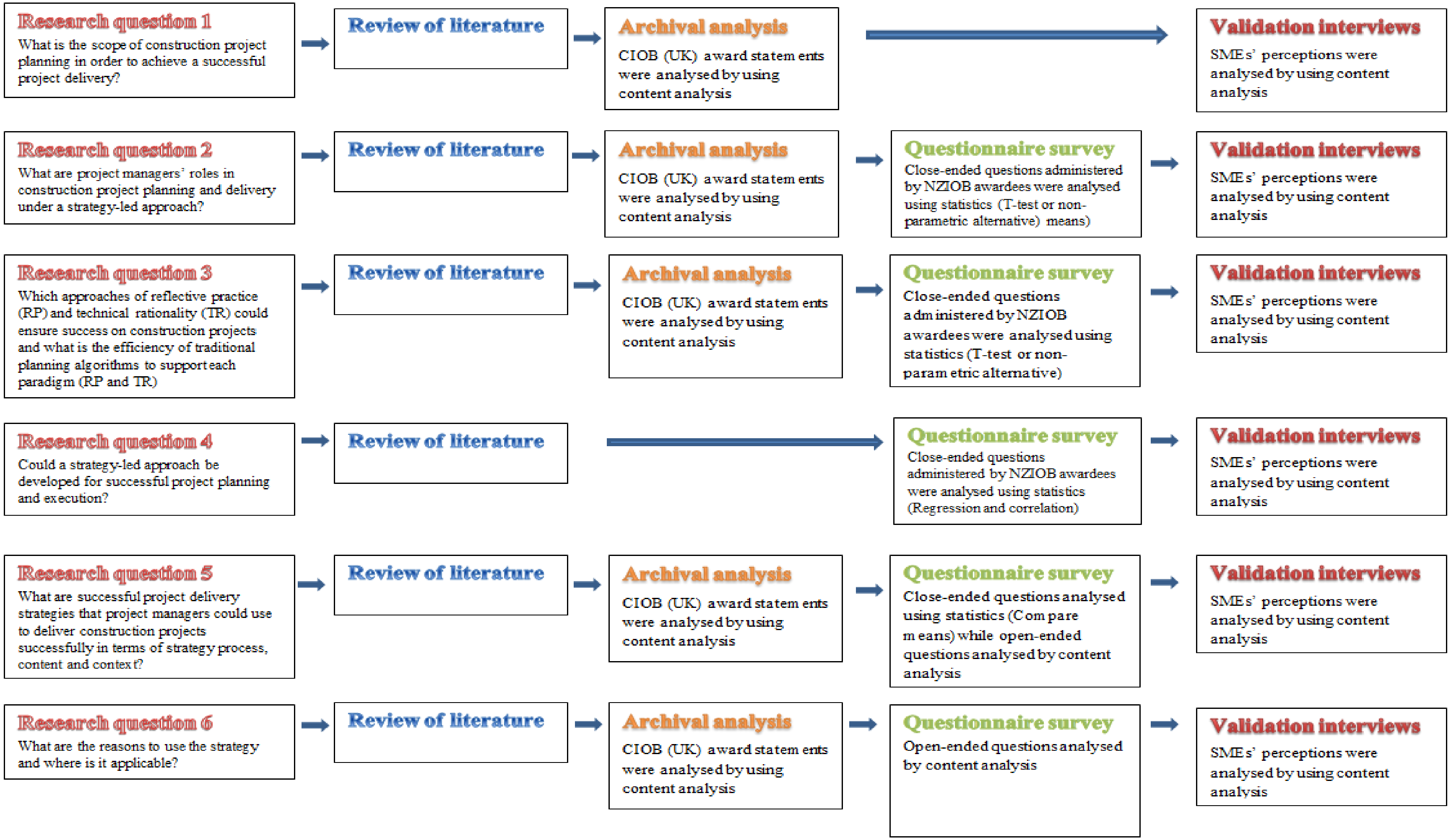


Figure 4.7: Use of mixed method research methodology in the current study

Chapter 5. Results & Presentation of Findings

5.1 Introduction to Data, Results & Presentation

This chapter includes data, results and the presentation of this research study under both preliminary and primary investigations. These two investigations are discussed in line with the research objectives of this study. Throughout this chapter, the main theme of this research investigation, which are project success, the characteristics of construction projects and project implementation strategies, are discussed.

The preliminary investigation described in this chapter is an introductory step toward the subsequent primary investigation. The achievements and limitations of the preliminary investigation, together with the reviews of literature, constitute the enquiries of the primary investigation. A brief introduction is added separately to clarify the objectives under each investigation to achieve the aim and objectives of this research study. Therefore, this chapter is in pursuant of the objective five of this study which is:

> ***Proposing a strategy-led approach for adoption by project managers in the form of a suitable practice to deliver construction projects with successful outcomes.***

This chapter presents both qualitative and quantitative research methodologies, and hence is in line with the mixed-methods approach selected under post-positivist paradigm. The chapter starts with describing the preliminary investigation and then proceeds to explain the primary investigation stage of this study.

5.2 The preliminary investigation

As described in the methodology chapter, the preliminary investigation was done by using archival information provided about the recipients of the Construction Manager of the Year Award (CMYA). The purpose of the archival analysis of the current research study was to act as a comprehensive piece of work toward the problem identification together with the literature review. In addition, the findings of the archival analysis are used to validate the research findings through triangulation as described throughout Chapter 7.

Under the archival analysis, challenges toward construction project implementation were identified in line with the first objective of this research study with the focus to identify the constitution of construction project success/failure. What the industry expects as successful outcomes was identified. In addition, this preliminary investigation looked into the suitability of construction project managers to be the most responsible stakeholder to craft and implement construction project strategies. This evaluation helps to corroborate facts to achieve the second objective of this research study.

In addition, the archival analysis investigated if strategies were used in the past successful projects to minimize challenges and ultimately to achieve successful outcomes. This investigation is one of the steps used to achieve the fifth objective of this research study, which is to propose a strategy-led approach for adoption by construction project managers in the form of a suitable practice to deliver construction projects with successful outcomes. To achieve these objectives, the preliminary investigation of this research study investigated the following research questions:

1. What makes construction project implementation challenging?
2. What is the nature of construction project implementation issues?
3. What is the industrial perception of a successful construction project delivery?
4. What are the approaches and their focus to ensure a construction project success?
5. Who is the most responsible person to ensure project success?

5.2.1 Demographic data of the projects/participants

Awardees profiles were collected for the period of 2009 to 2011 which resulted in a total of 66 construction managers and 66 projects that are used for the analysis. The demographic information is given in Table 5.1. The table gives a breakdown of type of projects, year of award, type of award and form of contract.

For each year, 22 awards are given out to projects within three categories: new refurbishment, housing and accommodation, and private finance initiative (PFI). The breakdown on Table 5.1 shows that 76% (50 projects) of awards were made to persons under the new/refurbishment category. There were 18% (12 projects) of housing and accommodation projects while PFI projects counted for 6% (4 projects).

There were no demographic information provided on the awardees such as experience levels and educational qualifications. From the awardees, 33 of them were awarded under the 'Gold' category and the rest 33 were 'Silver' awardees.

Information on the contract types was only available on 46 (70%) projects. From those, 27 (59%) project were procured under Joint Contracts Tribunal (JCT). In addition, there were six (13%) project partnering contracts (PPC) projects awarded. New engineering contracts (NEC) and PFI types had four (9%) projects in each category. There were five (11%) other contract types mentioned in the CMYA award statements.

Table 5.1: Demographic information of the projects/participants of the preliminary analysis

Description		Number of projects	In per cent
Type of projects			
New/refurbishment		50	76
Housing and accommodation		12	18
PFI		4	6
	Total	*66*	*100*
Year awarded			
2009		22	33
2010		22	33
2011		22	33
	Total	*66*	*100*
Award type			
Gold		33	50
Silver		33	50
	Total	*66*	*100*
Contract form			
JCT		27	59
PPC		6	13
NEC		4	9
PFI		4	9
Other		5	11
	Total	*46*	*100*

These 66 projects were sorted through NVivo 9 to assess the research questions of the preliminary investigation.

5.2.2 Challenges toward Construction Project Implementation

The first aspect of the analysis was aimed at determining what made construction project implementation challenging during those projects for which the recipients were awarded. The analysis is hence in line with the first research question of the preliminary investigation.

The archival information provided on the award winners was sorted by creating parent and child nodes in NVivo. The parent node created was ‘problem identification’ and there were two child nodes which were ‘problem categories’ and ‘paradoxes’. The ‘problem categories’ child node was to identify kinds of challenges that were encountered during construction project implementation. The ‘problem category’ was divided further into four sub-nodes representing complexity, dynamism, uncertainty and uniqueness. Each of the nodes and sub-nodes are included in Figure 5.1.

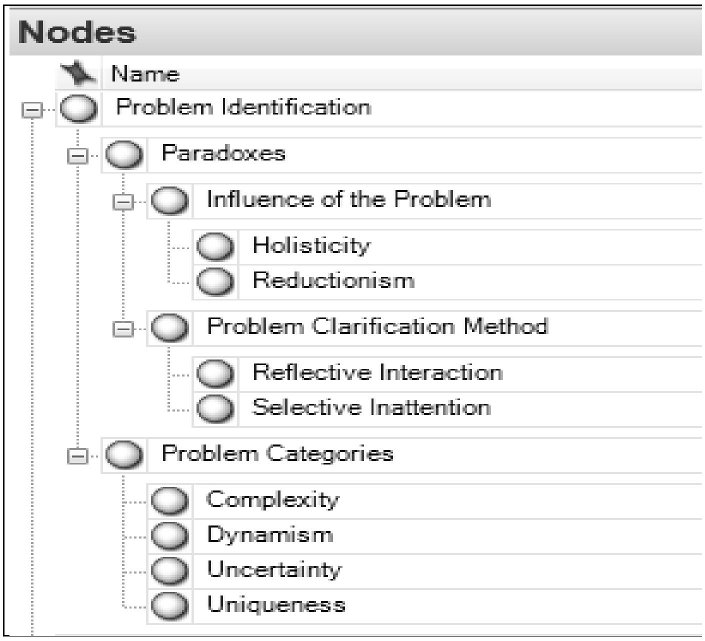


Figure 5.1: Arrangement of the nodes and sub-nodes in NVivo for ‘problem identification’

Each problem identified while screening through information provided in the award statements was sorted into one of the four sub-nodes. Although it was difficult to distinguish problems between some child nodes, the four operational definitions mentioned in section 3.3 could help to minimize conflicts that occurred during problem identification. Following the determination of the nature of construction projects, it was necessary to determine the frequency of occurrence of these themes within the award statements. In this way, the ranking of the four problem characteristics were determined. Table 5.2 summarises the result of the frequency counts generated, first by sorting the information using NVivo software and then counting manually. The table is split into separate columns for each year. The last column of Table 5.2 shows the total frequency count for the three years with the percentage of occurrence.

For the projects awarded in 2009, in 20 projects (91%), at least one issue related to the four contingencies was mentioned. Having an average about 2.5 issues per project, 82% of projects mentioned issues related to uncertainties. The second highest frequency was for complexities with 68%. These two frequencies were followed by dynamism and uniqueness as 64% and 23%, respectively.

In 2010, both complexity and uncertainty showed the highest frequencies such that 68% of projects mentioned their occurrence as a challenge. Compared to 2009, dynamism was mentioned rarely in 2010 and the frequency was 27%. The least occurrence was for uniqueness whose frequency was 14%. Similar to 2009, 91% of projects mentioned at least one issue related to the four contingency terms.

The least number of issues was recorded for 2011. In 2009, descriptions of the award statements were the longest comparatively and hence more detailed explanations were available compared to 2011. This may be the reason for the low number of issues in 2011. The highest frequency was recorded for complexity and it was almost twice as frequent as that for uncertainty (32%). Dynamism and uniqueness were mentioned in 18% and 14% of projects, respectively.

The last columns showed that both complexity and uncertainty generated the highest frequencies of occurrences (67% and 61%, respectively) for the 66 projects analysed. This is followed by dynamism (36%) and uniqueness (17%), respectively. There were 8% of projects without mentioning any issue related to complexity, dynamism, uncertainty and uniqueness.

From this result, it could be deduced that the awards (CMYA) were made on the basis of these four construction project characteristics. Thus one could safely assume that success on construction projects with these characteristics is the ability of the construction project managers to manage and control.

In this analysis, it was possible to investigate the occurrence of the four construction project characteristics which were recognized through past literature. As a limitation of this investigation, the archival analysis could not discover the amount severity; i.e. high, moderate or low. All projects may have some amount of complexity, dynamism, uncertainty and uniqueness. Inability to quantify the extent of these four project characteristics was a limitation of the preliminary analysis and hence it became one focus of the subsequent preliminary investigation. The next consideration was to find out reasons that made construction projects complicated.

Table 5.2: Characteristics of CMYA award winners' projects (Ramanayaka & Rotimi, 2012)

Characteristics	2009 (n=22)	2010 (n=22)	2011 (n=22)	Total (%) (n=66)
Complexity	15 (68%)	15(68%)	14(64%)	44 (67%)
Dynamism	14(64%)	6(27%)	4(18%)	24 (36%)
Uncertainty	18(82%)	15(68%)	7(32%)	40 (61%)
Uniqueness	5(23%)	3(14%)	3(14%)	11 (17%)
None of the above	2(9%)	2(9%)	1(5%)	5 (8%)

5.2.3 What Makes Construction Project Implementation Challenging

To identify the nature of construction project implementation issues is the second research question of the preliminary investigation. To investigate this research question, the second child node of the 'problem identification', 'paradoxes', was used. The child node was further divided into two sub-nodes named 'influence of the problem' (reductionism (R) versus holism (H)) and 'problem clarification method' (selective inattention (SI) versus reflective interaction (RI)). To distinguish four natures, the operational definitions given in section 3.4 were used. Each of the nodes and sub-nodes are included in Figure 5.1.

Following the creation of nodes and sub-nodes, it was possible to determine the frequency of occurrence of each nodal theme within the archival information provided in the award statements. The scope of NVivo software usage was limited to data sorting, hence requiring manual interpretation to categorize issues under the different nodes and sub-nodes mentioned above. In all 66 projects analysed, the study identified 136 issues and solutions provided by the CMYA awardees. The summary of this analysis is presented in Table 5.3.

The first paradox (reductionism versus holism) helps practitioners to identify whether it is important to see issues as a whole and in parts. Regarding this first paradox, 28% issues appeared likely to have been solved as separate problems without considering their consequences on other activities. As an example, in the Square Project, North Hampshire Hospital, the most critical instance was when 96 ensuite bedrooms were ready for occupation.

"The most critical instance was when 96 ensuite bedrooms were ready for occupation but BT could not install the infrastructure to allow the offsite monitoring of the fire alarms. John averted a three-month delay in occupancy by having a security guard, equipped with a mobile phone to provide the link to outside, monitor the fire alarm panel overnight"(Charted Institute of Building, 2009c, p. 1).

However, the majority of problems (72%) appeared to interrelate with succeeding and parallel activities. For example, when unexpected ground conditions were discovered, alterative construction methods were used, but those alternative construction methods influenced the desired outcomes such as the speed of construction.

"Even more impressive was the way he tackled the piling risk. The unexpected finding that the Glasgow underground train line was only 5m below the site meant that vibration from the piling for the seven storey block had to be restricted to less than 1mm of movement per second" (Charted Institute of Building, 2011a, p. 1).

The second paradox (selective inattention versus reflective interaction) would indicate the importance of problem clarification by using either theoretical concepts or reflection in and on action. It seemed that major issues encountered could not be described through engineering theoretical formulations. Out of 136 issues contained in the award statements, 132 issues (97%) seemed to be understood through reflective interaction (Table 5.3). For example, the following quotation is extracted from the CMYA award statements and it describes that construction methods were challenged due to the site conditions of the UK Supreme Court project, London; delivery and craneage impeded by the risk of damaging the building fit-out. Making the situation worse, the client's urgency made alternative and slower construction alternatives unsuitable and hence the solution was to patiently negotiate.

"The remedial works would take 14 weeks to carry out, would need scaffolding around the entire building perimeter, and had associated delivery and craneage requirements that risked jeopardising the fit-out. Given the prestigious nature of the project the client would entertain no extension of the programme. Having first persuaded the client of the urgency of the remedial works, Steve then patiently negotiated a programme with the design team and the masonry subcontractor"(Charted Institute of Building, 2010b, p. 1).

Only 3% (Table 5.3) of issues mentioned in the CMYA award statements appeared to be clarified predominantly through engineering science. There were situations mentioned in the award statements where inefficient structural design solutions as well as structural variations were clarified and resolved through extensive use of engineering theoretical knowledge such as structural analysis and design. For example, in the Sport Park project of Loughborough University, a post-tensioned structure was used as an alternative to a traditional reinforced concrete frame design to reduce slab thickness and hence to raise the access floor void such that the requirement of an above-ground service box could be eliminated.

> And his early decision to change the traditional reinforced concrete frame to a post-tensioned structure generated major benefits. It reduced slab thickness by 50mm, saving concrete, labour and carbon emissions. It increased the size of the raised access floor void, eliminating above-ground service boxing. And it cut the foundation size and load (Charted Institute of Building, 2011c, p. 1).

The content analysis done through NVivo and subsequent frequency count showed that natures of the reflective practice (RP) and technical rationality (TR) paradigms contained in construction project implementation issues while the RP paradigm was dominant. However, natures of issues may be characterized with some contributions from both RP and TR paradigms. The preliminary investigation could not provide information to determine these contributions separately and hence another focus emerged, which will be investigated further in the primary investigation of the current study. Having evaluated the nature of problems in construction project implementation, the preliminary investigation progressed to consider what project success is.

Table 5.3: Project evaluation according to problem identification

Year	SI*	RI*	R*	H*
2011 (n=33)	0	33	6	27
2010 (n=56)	3	53	17	39
2009 (n=47)	1	46	15	32
Total (n=136)	4	132	38	98
As a % (n=136)	3	97	28	72

*** SI-Selective inattention RI-Reflective interaction R-Reductionism H-Holism**

5.2.4 What is 'Success' in Construction Projects?

To investigate the third research question, success measures were identified in the CMYA award statements and frequencies of their occurrence were counted. In this way, it was possible to get an indication about what the industry perceives as 'success'.

Thematic analysis was done to identify the themes that made the awarded project successful. As mentioned in the chapter 3, time extensions or budgetary overruns due to out-scope variations were not considered as failures. Achievements on cost, time, quality, client satisfaction were considered as distinct themes for success criteria.

Sustainability, environmental and corporate responsibilities have been considered in the analysis as one theme. Concerns to minimize disturbance to third parties due to construction implementation was considered under corporate responsibility. In addition, health, safety and wellbeing were considered as another theme. It could be noticed that there were some projects considered successful, but none of the success criteria mentioned above were stated specifically. Those projects were considered under the theme: overall success. If any of these success themes were mentioned as an achievement or requirement of the projects to be achieved, the theme was considered as a measure of project success.

Table 5.4: Successful outcomes of CMYA winners' projects

Success measure	2011 (n=22)	2010 (n=22)	2009 (n=22)	Total (n=66)	Total % (P)
Cost	17	18	15	50	76
Time	16	17	16	49	74
Quality	12	15	15	42	64
Client satisfaction	9	9	12	30	45
Sustainability, environment and corporate responsibility	1	2	1	4	6
Health, safety and welfare	1	2	2	5	8
Overall success only	3	0	0	3	5

The first column of Table 5.4 indicates the success measures used in the projects for which CMYA awards were made. Further, it summarizes the result of the frequency count for each year and the last two columns indicate the total counts of the success measures. It can be observed from the table that for the 66 projects analysed, time and cost were the top-most measures (76 and 74% respectively) in selecting the awardees. However, it did not mean that the rest of projects had failed to achieve success in time and cost. Indeed, this preliminary investigation assumed that only remarkable achievements were mentioned in the CMYA award statements analysed.

Quality (64%) and client satisfaction (45%) were mentioned next to them. Table 5.4 shows some other criteria that were used to select the awardees. They include: sustainability, environment and corporate responsibility, health and safety etc., but none of these measures were mentioned significantly within the award statements compared to the top four measures. The result depicted in Table 5.4 implies that the industry considers cost, time, quality and client satisfaction as key deliverables for project success and are measures by which project success is determined. This could be treated as an overall trend of the industry because the award evaluations were based on the input of a variety of project stakeholders. The judges involved in the determination of awards were representatives of the whole industry. In the next section, the archival analysis considered approaches which were used to achieve success.

5.2.5 What are the Approaches that Ensure 'Success' in Construction Projects?

To find out successful approaches and their focus is the fourth research question of the preliminary investigation. This will identify key areas to focus on to achieve project success. NVivo 9 software was used to deduce the types of strategies that awardees had implemented to cope with project issues and hence to achieve successful outcomes. The study recognizes strategies in the CMYA award statements by using the operational definition of:

> *"Strategy is that which will assist the construction planners in decision making and problem solving within the complexities, dynamisms, uncertainties and uniqueness of the construction process"*

After strategies were identified, the archival analysis investigated what the strategies' focus was. This was done by using both inductive and deductive techniques. The deductive technique involved frequency count for the existence of predetermined critical success factors which had been already identified from literature, while the inductive technique was to read the award statements back and forth to determine critical success factors which were not mentioned in literature. After some new critical success factors were identified inductively, their frequencies were determined similarly to the deductive method.

Identification of critical success factors that had not emerged in literature was important to conduct the subsequent primary investigation in the next chapter. Therefore, findings from the inductive analysis were given more priority than those of the deductive analysis.

There would not be any critical success factor removed from the study due to the zero frequency of occurrence under the deductive analysis, but if any strategy focus was found under the inductive analysis that critical criterion would be essentially added to the primary investigation. The summary of both analyses are given in Table 5.5.

There were three important critical success factors that emerged from the preliminary investigation. These are 'effective use of technology', 'coping with site conditions' and 'smoothly working with sub-contractors'. Among the three inductive factors, 'effective use of technology' was mentioned, the highest number of times. This factor was cut across all three years accounting for 67% of all projects. Further, 'effective use of technology' had the highest frequency among the 35 factors. 'Coping with site conditions’ was another factor identified from the preliminary investigation. It occurred in 38% of projects. The remaining factor was ‘smoothly working with sub-contractors’ and mentioned in 33% of projects. It was observed that this factor was mentioned similarly throughout the years considered.

From the factors identified through literature, project related factors showed the highest average frequency among other categories. ‘Improving project schedules and plans’ was mentioned around half (52%) of the projects per each year. This factor had the highest frequency among the 32 factors identified from literature and the second highest frequency among the all factors. The information provided showed that the merging of programmes (contractors and sub-contractors), segmental and independent programming, engaging supply chain into programmes and scheduling around identified critical elements were construction managers’ strategy focus. ‘Improving communication’, ‘better handling of design complexities’ and ‘setting clear objectives’ were mentioned in project statements on about 25% of the projects. ‘Coping with estimation errors’ was not mentioned in any project statement, but all other factors of the project related category were mentioned in more than 10% of the projects reviewed.

The second most mentioned factors belong to the organizational category. It contained the factor that had the second highest frequency among the 32 critical success factors mentioned in literature. The factor related to ‘dealing with client’s characteristics’ was mentioned in 42% of the project statements. ‘Improving site management and supervision’ was mentioned in nearly 40% of the projects. Nearly 25% of the project statements had facts related to ‘minimizing delays and errors in design documents’. ‘Improving client cash flow’ was mentioned considerably (20%) in the statements. ‘Ensuring contractor’s cash flow’ was not mentioned in any project statement.

Among the 10 ‘resource related’ factors, only four factors mentioned in the award statements. ‘Minimizing material changes’ and ‘deciding off-site prefabrication’ was the highest mentioned critical success factors and respectively mentioned in 21% and 15% of the projects. ‘Coping with material changes’ was mentioned in 9% of the statements. Labour shortages were focused only in 3% of the awarded projects.

Further, it could be seen that the external related factors were least mentioned in the project statements. The only identified focus was to ‘minimize social issues’, which was mentioned in 25% of the projects under consideration.

From the analysis, it should be noted that some strategies were multi-focused. For example, some strategies strived to minimize variations through effective use of technologies. Essentially, that kind of a situation was considered under both critical success factors: ‘minimizing variations’ and ‘effective use of technologies’. In this situation, minimizing variations become one of the reasons to use technology effectively. ‘Minimizing social issues’ and ‘coping with site conditions’ can be given as a similar case. In this case, ‘minimizing social issues’ may become within the context of the second critical success factors.

In addition to the resource related factors, ‘coping with estimation errors’, ‘ensuring contractor’s cash flow’, ‘getting top management support’ and ‘developing project organization structure’ were the least mentioned factors in the CMYA award statements. These factors are primarily related to the contractor and hence confidentiality may be one of the reasons to hinder these factors as project implementation issues in the award statements. After the frequency count, the statements were reviewed to find out natures of the solutions.

Table 5.5: Focus of construction strategy in CMYA awardees and their frequencies of occurrence

Strategy focus	**2009 (n=22)**	**2010 (n=22)**	**2011 (n=22)**	**Total (n=66)**	**%**
Emerging critical success factors					
Effective use of technology	15	14	15	44	67
Coping with site conditions	10	12	3	25	38
Smoothly working with sub-contractors	7	8	7	22	33
Project related					
Setting clear objectives	5	6	4	15	23
Coping with necessary variations	9	12	6	27	41
Improving communication	8	6	4	18	27
Speeding up decision making	3	0	6	9	14
Handling unforeseen ground conditions	2	3	1	6	9
Improving project schedules and plans	12	12	10	34	52
Coping with legal/statutory requirements	3	1	5	9	14
Ensuring monitoring and feedback system	1	2	4	7	11
Better handling of design complexities	7	8	2	17	26
Coping with estimation errors	0	0	0	0	0
Organization related					
Dealing with client’s characteristics	10	8	10	28	42
Improving project financing from client	7	4	2	13	20
Ensuring contractors cash flow	0	0	0	0	0
Minimizing delays & errors in design documents	8	5	4	17	26
Improving site management and supervision	10	8	8	26	39
Getting top management support	0	2	1	3	5
Developing project organizational structure	2	0	1	3	5
Getting lower cadres’ support	5	3	4	12	18
Resource related					
Minimizing material shortages	7	5	2	14	21
Coping with material changes	2	3	1	6	9
Deciding on off-site prefabrication	5	4	1	10	15
Handling labour shortages	2	0	0	2	3
Coping with low skill levels	0	0	0	0	0
Handling plant shortages	0	0	0	0	0
Coping with low efficiency of plants	0	0	0	0	0
Coping with plant breakdowns	0	0	0	0	0
Avoiding wrong selections of plants	0	0	0	0	0
External related					
Helping to minimize political issues	0	0	0	0	0
Helping to minimize economic issues	0	0	0	0	0
Helping to minimize social issues	8	4	5	17	26
Helping to minimize weather uncertainties	0	0	0	0	0

5.2.6 The Nature of Solutions

For the identified 136 issues, strategies provided were reviewed and sorted under the ‘approach’ node. The approach node had two child nodes: context independency (CI) versus context dependency (CD) and practitioner independency (PI) versus practitioner dependency (PD). To identify these four natures, the archival analysis used the operational definitions given in section 3.6.

To differentiate context dependency and independency, it was necessary to determine what contextual variables should be considered. The study considered project value, duration, type, design, scope, procurement type and site conditions as contextual variables. Any solution that was crafted specific to these contextual variables was considered as context-dependent. Otherwise, solutions were considered as context-independent.

The resulting frequency count is shown in the second and third columns of Table 5.6. On observation of the result, one could see that 97% of the total solutions were crafted by considering contextual variables. As illustration, in the Winterflood Theatre Project, London, due to site condition, there was no space for storage and that led to a contextually dependent material deliveries schedule.

> "Gemma placed material orders very early in the programme. The steelwork, in particular, had to be ordered and fabricated from day one. With the theatre a windowless room in the middle of a live school, there was no space for storage, so deliveries had to be precisely co-ordinated for the consecutive trades on a just-in-time basis. And as the manufacturer needed several weeks lead-in, she ordered the lifts before" (Charted Institute of Building, 2009b).

A similar situation was mentioned in the Henderson Centre Project of St George's College where examinations and classroom works could be highly influenced due to project implementation. The construction project manager of this project had to re-sequence some construction activities such as demolition of a teaching block to minimize disruptions as mentioned in the quote below. Further, disruptions were minimized by adapting alternative construction technologies: use of augur piling over driven piling to minimize disturbances for examination procedures can be given as one example.

"Andrew went out of his way to help the school. Examples include his selection of augur piling over driven piling, so works could take place without disrupting exams, creating a covered walkway for students through part of the site, and postponing the demolition of one teaching block so the school could use its classrooms longer. The client's confidence was reflected in awarding Leadbitter an additional £350k refurb contract while he was still onsite – and which Andrew incorporated within the original contract programme" (Charted Institute of Building, 2010d).

As another example of context dependency of construction project strategies, some construction project managers of CMYA awardees used integration strategies to avoid public protest in different ways: in urban areas, noisy construction was scheduled for off-peak hours while neighbours were given advantages (such as using local labours and suppliers) from the projects in rural areas.

There were some solutions which could be used to advantage any construction project despite the context. In the Project Slam, Vimy Barracks, Yorks, lightweight reinforced plastic shutters were used instead of traditional PERI systems. This value adding strategy can be used in any construction project to speed-up construction. In the same project, the use of preformed composite plastic over clay pipes and manholes saved money. This strategy can be used in any construction project to get the desired benefits of reduced cost. Therefore, if this kind of solutions were mentioned, those were considered as characterized by context independency. There were 3% of such solutions which could be recognized as context-independent. A part of the award statement of Project Slam, Vimy Barracks, is quoted in the following:

"He planned works out of sequence to maximize multi-use of scaffolds and plant and off hire them early. To form the ground beams he used Pecafil, a lightweight reinforced plastic shutter which could be installed far faster than traditional PERI systems. He also exchanged clay pipes and manholes for preformed composite plastic, with a notable cost saving" (Charted Institute of Building, 2010c).

From this investigation, strategies that are commonly associated with a particular context are context-dependent. Thus, nomothetic rules would not be suitable for construction project strategies. Further, through context dependency, strategies could contribute to improvements in construction project implementation by eliminating ineffectiveness (context independency) of traditional planning tools.

Table 5.6: Nature of solutions by relation to the context and to the practitioner

Year	CI*	CD*	PI*	PD*
2011 (n=33)	0(0%)	33 (100%)	0(0%)	33(100%)
2010 (n=56)	3(5%)	53(95)	1(2%)	55(98%)
2009 (n=47)	1(2%)	46(98%)	1(2%)	46(98%)
Total (n=136)	4(3%)	132(97%)	2(1.5%)	134(98.5%)

*** CI-Context independency CD-Context dependency PI-Practitioner independency PD-Practitioner dependency**

To differentiate practitioner dependency and independency, the mention of education, experience and qualities was used. If a solution was created by using extensive engineering theoretical formations, that solution would be considered as practitioner independent (PI). Extensive use of structural analyses and design alternatives to change the initial design of the Carnegie Pavilion Project of Headingly Stadium, Leeds can be given as one example:

> "His innovations brought the clients considerable savings. He took an integrated programme approach. He changed the piling and frame methodologies. He used prefabricated steel framing for roof trusses and designed cast-in plates for interfaces between the concrete and steel frames. And he changed the brick and block construction to metsec and cement board" (Charted Institute of Building, 2011b).

Implications toward use of experience and personal qualities extensively were considered as practitioner dependent (PD) solutions. From the frequency count, it could be found that 98.5% solutions were created by using experience and qualities or at least being combined with them. The quotation given below is from the award statement of the Kittiwake House Project, Slough, where the site was surrounded by a busy road, a railway, a university and two office blocks. The potential complaints of disturbances were completely handled by the construction project manager using his extensive negotiation skills.

> "Bordered by a busy road, a railway, a university and two office blocks, the building filled the entire site footprint. Garry demonstrated excellent personal skills to make the access and logistics work. He minimized disruption to the neighbors by allocating and policing strict delivery times. He regularly invited them onto site for construction updates over tea and biscuits. He programmed works thoroughly and well in advance, and constantly developed rapport. There were no complaints as a result" (Charted Institute of Building, 2009a).

The award statement of the Rockliffe Hall project of Hurworth on Tees, Darlington, provided credence to use of experience to create strategies where resolutions were not straightforward to be crafted by using engineering theories. When the construction team discovered a brick vault of a hall, digging works of an external tunnel became risky. The construction project manager set up his own plan based on his experience and skills such that the alternative construction procedure could become effective as well as economical.

> "…..a tunnel to link the separate basements at either end of the old hall. Once the discovery of a brick vault under part of the derelict hall piled up the risk involved in digging an external tunnel, Neil set out his own proposal: to prop up the superstructure with scaffold while open-excavating a tunnel through the building, using small plant to excavate and conveyors to remove the spoil. The enthusiastic development of the idea by the team turned it into an effective and economical solution" (Charted Institute of Building, 2010a).

Therefore, practitioner dependency, which is a characteristic of the RP paradigm, appeared to be the dominant nature over context independency (CI; a TR nature) according to the CMYA award statements. Thus, strategies could be used in construction project planning and implementations to encourage use of experience and qualities, in addition to theoretical knowledge.

However, every solution may contain some contribution from education, experience and qualities. In addition to context-dependent solutions, projects may use context-independent techniques such as probabilistic solutions under planning. It was not possible to identify these contributions of different natures from the preliminary investigation and hence the primary investigation focus was required. The next section considers the stakeholder contribution

5.2.7 Stakeholder Contribution towards Strategy Crafting

The purpose of this investigation of the preliminary analysis is to assess the last research question of the archival analysis: to evaluate whether the construction project manager is the best person to collect data on construction project strategies.

First, strategies were categorized under two opposing categories. The first category is the controversy of 'individual decision making', in which case the construction project manager is assumed to decide on project implementation alone. The second category is named 'bottom-up planning' to refer to situations where the construction project manager decided on project implementation collectively with other project stakeholders. Other stakeholders are client, design team, sub-contractors, the own team and specialists. ‘Bottom-up planning’ is not to be confused with the stakeholders’ positions, but describes the nature of problem solving by the construction project manager: getting strategic directions from the team and developing them.

There were 136 strategies identified within the award statements. It was found that the project managers seemed to craft strategies on their own in 71 (52%) situations. In 65 situations (48%), the project managers incorporated other stakeholders into strategy crafting.

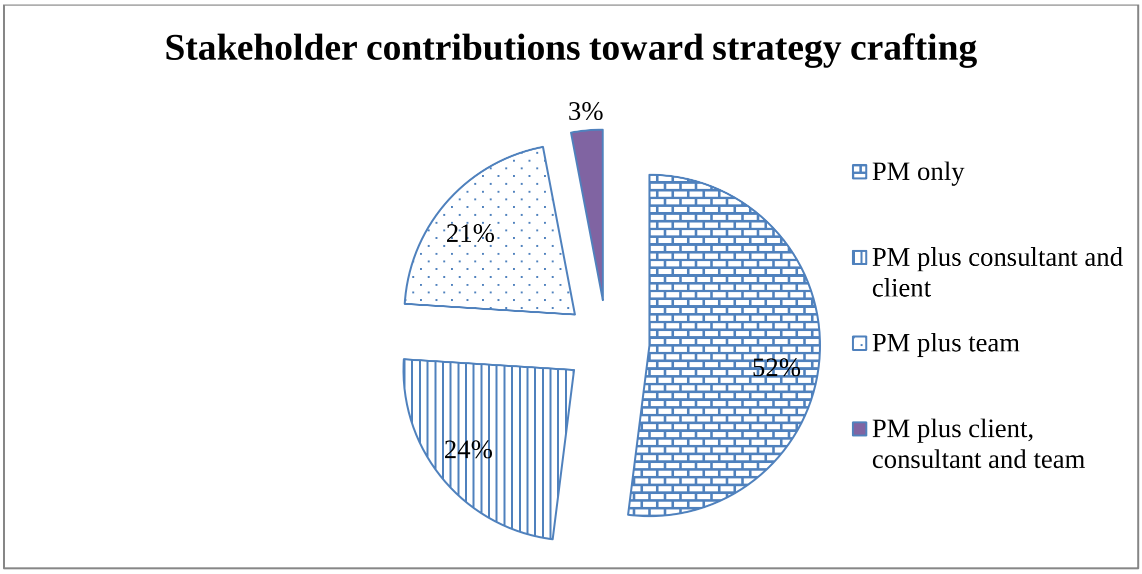


Figure 5.2: Stakeholder contributions toward strategy crafting

Figure 5.2 depicts stakeholder contributions in more detail. Having noticed that slightly more than 50% of strategies were crafted by the project managers by themselves, 24% of strategies were crafted by the project managers by including clients and consultants. Further, 21% of strategies were made by the project managers with their functional teams. For 3% of strategies, all stakeholders were involved.

For strategies crafted by the construction project manager using functional team (i.e. 21%), the teams included: top management, site managers and engineers, labour, sub-contractors and suppliers. A breakdown of the contributions of each of the team members is shown in Figure 5.3. For a team, the highest contribution was mentioned to be sub-contractors, thus a total 59% of contributions were related to them. This was followed by functional managers and labour having the correspondent contributions of 18% and 15%, respectively. Suppliers contributed 8%. Surprisingly, no project statement mentioned top-managers’ involvement toward strategy crafting at the project implementation level.

From the analysis on the stakeholder contributions, the preliminary study could confirm that construction project managers are the stakeholder for primary responsibilities to craft construction project strategies. Other stakeholders who are within or outside the same organization as the construction manager would contribute to craft project implementation strategies considerably.

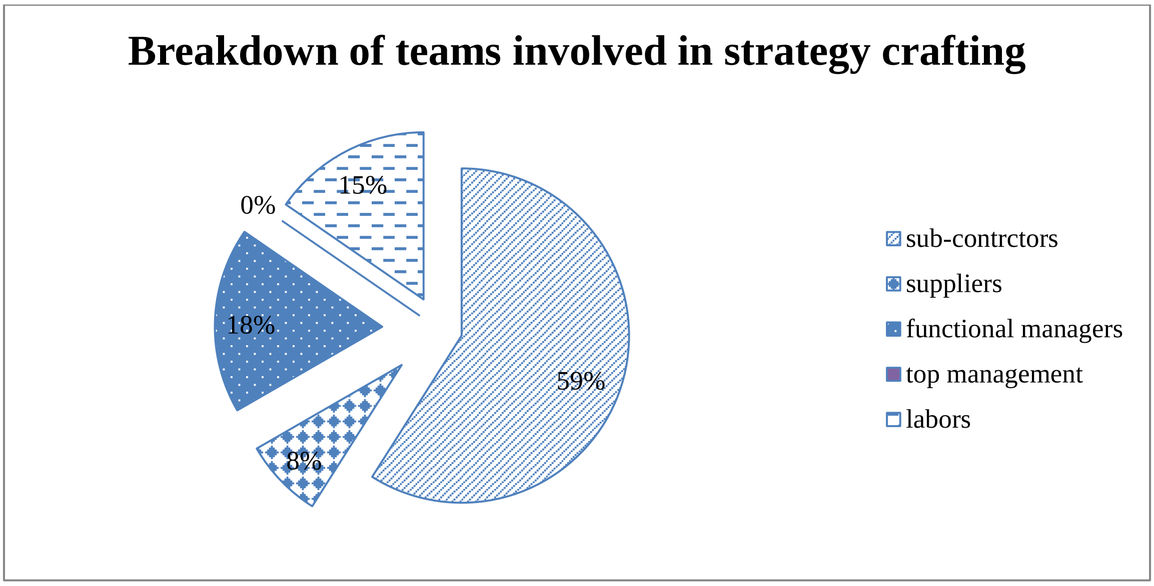


Figure 5.3: Breakdown of teams involved in strategy crafting

5.2.8 Conclusion of the Preliminary Analysis

The above presented findings of the preliminary investigation helped to develop ideas about the research enquiry in the next stage of the research. As would be seen later, the primary investigation is based on inputs from this preliminary investigation.

Although quantification was not possible, the frequency count shows that complexity, dynamism, uncertainties and uniqueness usually challenged construction project planning and implementation. Further, the analysis shows that real world problems are usually interconnected with each other and hence cannot be treated using a reductionist approach. The importance of holism is not limited to activities but also to stakeholder responsibilities. For example, some construction project managers used value-adding strategies to minimize the consequences of variations outside of the project scope, although variations could be claimed. While delivering advantages to the client, those value-adding techniques cutting the cost of out-of-scope variations ensured client satisfaction and smooth cash flow of projects, which is beneficial to the contractor.

Further, the problem cannot always be clarified with theoretical formulations. These findings can be used to strengthen the arguments made in literature that RP is required to clarify real world scenarios. Regardless of existing challenges, construction projects seemed to achieve successful outcomes.

According to the findings of the preliminary investigations, time, cost, quality and client satisfaction were identified as primary measures of success. These measures are in line with literature findings. There are other measures of project success that were not as prominent in the analysis of the award statements. These include: sustainability, corporate responsibility, health and safety.

To cope with challenges and hence to ultimately achieve successful outcomes, strategies were used widely.

The inductive analysis done on the focus of strategy helped to identify three critical success factors which would be used in the primary investigation. This is in addition to the 32 critical success factors found in literature to measure the influence of construction project strategies. It could be seen that more than 50% of CMYA projects focus on improving planning and schedules. This observation can support to some extent the existing trend that project success can be ensured by improving project scheduling and planning. However, contemporary research focal points for strategies such as probabilistic developments and adding buffers were not mentioned. Rather information showed that the merging of programs (contractors and sub-contractors), segmental and independent programming, engaging supply chain into programs, and scheduling around identified critical elements were the focus of construction project implementation strategies.

Then, the analysis focused on natures of strategies. From this analysis, one can understand that most of the solutions were created by considering the particular context of a project. Therefore, the strategies mentioned are in line with RP natures which are not available in current planning tools. This observation strengthens the fact that complementary planning methods are needed to handle construction projects effectively. Further, the strategists used their experience and skills more than education to create strategies, but it was not possible to quantify contributions from these attributes through the project statements.

The next consideration was to identify the strategist of construction project implementation strategies. Sometimes, the project managers crafted strategies on their own and, with similar frequency, attempts were made to incorporate other stakeholders into strategy crafting. As the top-most additionally involved stakeholders, client, consultant and sub-contractors were mentioned. However, even in bottom-up strategies, construction project managers played a key role to shape them. Therefore, the primary investigation helped to safely assume that construction project managers are the best stakeholder to provide information related to the whole strategy crafting and implementation process.

Having achieved the objectives of the preliminary investigation, the study proceeds to the subsequent primary investigation stage.

5.3 The Primary Investigation

This chapter consists of two kinds of data, which are quantitative and qualitative. Responses of the quantitative questions were analysed through statistical methods under this chapter. Further, the qualitative questions were analysed through thematic analysis. Both quantitative and qualitative parts together provided facts and meaning toward achievements of the research objectives which were ultimately aimed at finding a strategy-led approach as a suitable planning method and to investigate its three dimensions, i.e. process, content and context. As described previously, the preliminary investigation served as an initial step toward the primary investigation. To achieve the objectives of this research study, the primary investigation focused on the following enquiries:

- To determine the amount of success achieved by the construction projects used under the primary data collection.
- To evaluate the characteristics of construction project implementation.
- To investigate the nature of construction project issues
- To identify the three dimensions of strategies (so as to get an understanding about the strategy crafting and implementation processes in terms of ‘what’, ‘why’, ‘who’ ‘when’ and ‘where’ and ‘why’).
- To quantify influences from strategies toward critical success factors.
- To make relationships between influences of strategies, project characteristics and project success.

The chapter starts by explaining demographic information of the participants as well as the projects. Thence, it continues to explain the analyses according to a systematic order in line with the conceptual framework exhibited in chapter 3.

5.3.1 Demographic Data of the Participants and Projects

The Participants

As described in chapter 4, Methodology, the questionnaire survey was conducted over six weeks with three follow up reminders sent. The participants were the awardees of NZIOB from 2001 to 2011. There were 130 questionnaires distributed among the population to receive the required sample size. Although 69 responses were required from the sample size calculations, only 40 usable responses could be received. This gives a response rate of 58%. The demographic information obtained from the research participants is given in Table 5.7. This demographic information acts as an indirect measure of the quality and reliability of the data used for the analyses.

Table 5.7: Demographic information of the participants of the primary investigation

Demographic information		**Number**	**% value**
Type of education	Post graduate	5	12.5
	Degree or equivalent	21	52.5
	Diploma/certificate	12	30.0
	On the job training	2	5.0
	Total	40	100.0
Amount of experience in the industry	11-15	7	17.5
	16-20	13	32.5
	>20	20	50.0
	Total	40	100.0
Amount of experience as a project manager	0-5	2	5.0
	5-10	12	30.0
	10-15	12	30.0
	15-20	10	25.0
	>20	4	10.0
	Total	40	100.0

Regarding the education of the research participants, the highest percentage (52.5%), had degree or equivalent level educational qualifications: 12.5% participants completed their post graduate qualifications, 30% of the participants were diploma/certificate holders and 5% rose through the ranks through on-the-job training. Based on this information, it would seem that the participants have above average qualification. The participants could represent all the educational categories. Therefore, the study could discover unique views of each educational category related to construction project planning and implementation, consequently, non-biased response could be considered as minimum.

Concerning their experience in the construction industry, all the participants had worked for at least 11 years: of all the participants, 32.5% of the research participants have had between 16-20 years of experience, while 50% had worked for over 20 years.

In the same light, the research participants were required to indicate for how long they had been involved in construction projects as construction project managers. Most of them had worked as construction project managers around 5-10 years and 10-15 years: Both categories accounted for 60% of the research participants, while 25% of the participants had around 15-20 years of experience as project managers. Among the remaining, 10% had more than 20 years of experience and only 5% of the research participants had less than or equal to five years of experience as project managers.

As a summary, the participants were well experienced both in the industry and as construction project managers. These experiences coupled with their educational backgrounds, their qualification could be considered as reliable. As a result, the richness of the information seemed to be high, including textual explanations for quantitative questions, although their responses were limited for pre-determined responses. After considering the demographics of the research participants, the awarded projects were reviewed for their project type, contract type, procurement method and types of planning tools used in addition to strategies.

The Projects

Facts found through quantitative analyses are meaningful only if the context of which those facts are determined is given (Guba & Lincoln, 2005). This section focuses on explaining the demographic information of the projects that are used under the primary investigation.

To evaluate the type of projects that the primary investigation focuses on, the participants were asked to categorize their projects under predetermined categories which were residential buildings, non-residential buildings and infrastructure projects (Table 5.8). Among the 40 projects, only 39 participants mentioned their project types. The majority of the projects were ‘non-residential buildings’ which were 26 (67%) in total. There were nine (23%) infrastructure projects and four (10%) residential building projects among the questionnaire responses. The type of contract was considered next.

Only for 37 projects, the contract type was specified. In addition to the predetermined responses, the participants had opportunity to mention other contract types. There were six contract types (Table 5.8), and the maximum number of projects, 18 (49%) in total, belonged to the ‘lump sum’ category. The second highest category was the incentive contract, which had seven (19%) projects in total. This was followed by ‘cost plus fee’ contracts having four (11%) projects in the sample. There were three (8%) projects for each group related to ‘lump sum plus unit price’ and ‘percentage of contract fee’. The least number of projects were associated with ‘unit price’, only two (5%) projects belonged to this category. No response was given related to other contract types. Similar to contract type, procurement types were considered.

There were 38 projects for which the procurement type was mentioned (Table 5.8). The maximum sample with 13 (34%) was mentioned for ‘traditional’. This was followed by ‘management’ and ‘design and build’ procurement types, having eight (21%) and seven (18%) projects, respectively. ‘Traditional with trait partnering’ had four (11%) projects. There was one project that combined ‘management’ procurement and ‘design and build’ procurement types. There was another situation where ‘design and build’ procurement type was used together with ‘traditional’ procurement. There was one alliance project in the sample, too. Since the participants were allowed to mention other procurement types, there were three projects belonging to that category. Finally, planning tools used were considered.

This study found the suitability of strategies to work as a complementary approach toward current planning tools. Therefore, it was vital to find out the types of planning tools for which strategies could be used complementary. The participants were asked to categorize planning tools used in addition to strategies by using predetermined categories as well as using their own opinions.

Table 5.8: Demographic information of the projects of the primary investigation

Demographic information		Number	% value
Type of project	Non-residential	26	67
	Residential	4	10
	Infrastructure	9	23
	Total	39	100
Type of contract	Lump sum	18	49
	Incentive	7	19
	Cost plus fee	4	11
	Lump sum plus unit price	3	8
	Percentage of contract fee	3	8
	Unit price	2	5
	Total	37	100
Method of procurement	Traditional	13	34
	Management contracts	8	21
	Design and build	7	18
	Traditional with trait partnering	4	11
	Traditional plus design and build	1	3
	Management contract plus design and build	1	3
	Alliances	1	3
	Other	3	8
	Total	38	100
Planning tools used	CPM plus PERT	10	26
	CPM plus EVM	7	18
	CPM only	6	16
	CCPM only	5	13
	CPM plus CCPM	4	11
	PERT only	2	5
	PERT plus CCPM	2	5
	CPM, PERT plus CCPM	1	3
	Other	1	3
	Total	38	100

It can be noticed in Table 5.8 that CPM was the predominant planning tool used among the participants. Out of 38 projects that mentioned the planning tools used, six projects (16%) were implemented by using CPM only. However, it was used with other planning tools in 22 (58%) projects. CPM was mostly used with PERT (10 projects, equivalent to 26%), but there were two (5%) and seven (18%) projects that combined CPM with CCPM and EVM, respectively. It could be seen that EVM was used only along with CPM in the sample. The second highest planning tool that could work alone in scheduling was CCPM which had five (13%) projects in total. There were two (5%) projects that were implemented through PERT only. There was one project for which a proprietary company tool was used for scheduling. From the assessment of planning tools, the primary investigation could find that traditional planning tools are widely used for construction project implementation, despite the critiques among past scholars about their applicability.

With this, the primary investigation next determines the suitability of data before employing it for analyses.

5.3.2 Suitability of Data

The primary investigation included both qualitative and quantitative data. This study heavily used statistical analyses to analyse quantitative data gathered through the questionnaire. As described in section 4.7.1, suitability of data should be checked before statistical tests are performed to make accurate interpretations. Under the suitability of data, the primary investigation considered the reliability and missing data contained in the responses given by the NZIOB awardees.

Reliability of the Data

Reliability is an important criterion especially when abstract concepts are measured by using interval scales (Walliman, 2005). In the reliability analysis of the current study, the original variables were sorted under six categories: measures of project characteristics, influence of strategies, success factors, stakeholder contribution, project manager's attributes and project politics. These categories are based on the original variables to be measured. The second column of Table 5.9 listed out the original variables considered under these six categories. Cronbach's Alpha method is used to check the reliability of data. Cronbach's Alpha values were calculated for the six themes and presented in Table 5.9. If the Cronbach's Alpha value is greater than 0.7, that data set is considered internally consistent (Walliman, 2005).

In Table 5.9, 35 critical success factors together showed the highest Cronbach's alpha value which was 0.937. The lowest Cronbach's alpha value was associated with success measures and the value was 0.712. Since the six categories showed Cronbach's alpha values greater than 0.7, it was concluded that the sets of data was internally consistent.

Table 5.9: Cronbach's Alpha (α) values for group variables

Theme	Original variables	Cronbach's alpha
Project characteristics	Complexity Dynamism Uncertainty Uniqueness	0.861
Project success	Cost Time Quality Client satisfaction	0.712
Influence of strategies toward critical success factors	35 critical factors	0.937
Stakeholder contribution	Project manager Client Consultant Top management Site manager Site engineer Foremen Sub-contractor Labour	0.824
Project manager's attributes toward strategy crafting	Education Experience Skills and characteristics	0.759
Project politics	Vision Mission Transaction Risk taking Learn and improve Responsible for performance	0.731

Further, the study considered if there was any negative influence from any project toward the overall internal reliability of the variables. For this purpose, the overall Cronbach's Alpha value of the 40 projects was compared with modified Cronbach's Alpha values when each project was removed from the data set. Table 5.10 represents the modified Cronbach's Alpha values for the group 'project characteristics' only. The original Cronbach's alpha value was 0.861 as shown in Table 5.9. Compared to the original value, only in 11 out of 40 projects, reliability could be increased if the particular project was removed. However, the values of improvement compared to the original value were considered as not significant: 5 out of the total 11 projects could contribute to less than 1% of improvements: another 5 projects could contribute only toward 1-2% of improvements: the maximum improvement, which was 2.2%, was recorded when project P19 was deleted. Therefore, the current study decided not to remove any project by reflecting on the modified Cronbach's alpha values of project characteristics.

Likewise, modified Cronbach's alpha values were checked for other five group variables. For the two categories 'project success' and 'influence of strategies toward critical success factors', the modified Cronbach's Alpha values showed that there was no negative influence from any single project toward the internal consistency. In the category of 'stakeholder contribution', there were slight improvements of less than 1% when individual projects were removed. The remaining two categories (project manager's attributes toward strategy crafting and project politics) showed improvements between 1-2% for modified Cronbach's Alpha analysis when about 10% of projects were removed. Therefore, the primary investigation did not remove any project from further analyses based on the Cronbach's Alpha value analysis.

Table 5.10: Modified Cronbach's Alpha (α) values when each projects are removed

Project	α value	Project	α value	Project	α value	Project	α value
P1	0.840	***P11***	0.849	***P21***	0.86	***P31***	0.841
P2	0.847	***P12***	0.864	***P22***	0.861	***P32***	0.861
P3	0.857	***P13***	0.844	***P23***	0.86	***P33***	0.853
P4	0.856	***P14***	0.871	***P24***	0.864	***P34***	0.854
P5	0.854	***P15***	0.859	***P25***	0.853	***P35***	0.848
P6	0.848	***P16***	0.880	***P26***	0.868	***P36***	0.858
P7	0.852	***P17***	0.838	***P27***	0.866	***P37***	0.859
P8	0.866	***P18***	0.847	***P28***	0.871	***P38***	0.853
P9	0.870	***P19***	0.876	***P29***	0.851	***P39***	0.849
P10	0.861	***P20***	0.872	***P30***	0.859	***P40***	0.859

Missing Data analysis

Missing data analysis was done by using SPSS 18 as another step of determining the suitability of the data. There were 44 variables which had zero number of missing values. More importantly, the data which were considered as the most important (the characteristics of construction project, success measures and influence of strategies on critical success factors) had no missing data. All the contingency measures and success measures except quality and client satisfaction were included while 17 out of 35 critical success factors belonged to these 44 variables. Quality and client satisfaction as well as nine critical success factors had only one missing data. The variables which had missing data entities more than or equal to three were reviewed further to find possible causes of missing entries.

There were four data entities belonging to critical success factors and which had missing data equal to three. However, since these factors (reducing waiting time for test samples, getting lower cadres' support, coping with low efficiency of plants and helping to minimize weather uncertainties) were straight-forward to understand, having non-random errors was considered as not possible. Non-random errors occur due to participants' inability to understand the question clearly (University of Maryland, 2012). Further, these critical factors could be considered as component factors in some analysis like multiple-regression. Therefore, errors due to missing data are reduced.

However, related to the use of education, experience and qualities toward strategy making process, there were 21 questions and two-third of them had between three and four missing data points. Although the questions could be considered straight-forward, due to the high frequency of missing data in the variables, the possibility of having non-random errors was statistically tested through Little's MCAR test (Schlomer, Bauman, & Card, 2010). SPSS 18 was used to test the null hypothesis that data was missing randomly. The level of significance was 0.381 for Chi-square = 61.665 and 59 degrees of freedom. Hence, the null hypothesis could not be rejected and data was considered as missing randomly.

The missing data was not replaced. Rather, these data entities were deleted list-wise or pair-wise accordingly. Since there were no non-random errors, it was safe to delete missing data 'list-wise' (Amanda & Enders, 2010). After suitability of data was checked for reliability and missing data, several analyses were done as described under the following headings.

5.3.3 Deciphering Construction Project Success

The aim of this study is to develop a reliable planning approach to achieve construction project success. The study decided to use construction projects, which are considered successful by the NZIOB for the purpose of selecting award recipients based on awardees' performance in a construction project practically completed within NZ. By considering these facts, the study considered in which amount the projects have achieved successful outcomes.

Five success measures are considered: time, cost, quality, client satisfaction and overall success. Calculations of these parameters were done according to the equations given in chapter 3.2. For the five parameters, the numerator and denominator were set such that larger values could reflect better performances. For example, it was expected that the parameters would have values fluctuating around one which would indicate 100% achievement of initial expectations. A summary of responses given by the participants of the primary investigation for success measures are given in Table 5.11. Since the types of analyses for both descriptive and inferential analyses depended on the nature of the distributions, Normality checks were carried out at the beginning.

Table 5.11: Summary of responses for success measures: cost, time, quality, client satisfaction and overall success

Success Parameter	Cost		Time		Quality		Client satisfaction		Overall success	
	No.	%	No.	%	No.	%	No.	%	No.	%
0.80-0.85	-	-	-	-	1	*2.5*	-	-	-	-
0.86-0.90	-	-	1	*2.5*	7	*17.5*	-	-	-	-
0.91-0.95	1	*2.5*	-	-	1	*2.5*	-	-	-	-
0.96-1.00	6	*15*	8	*20*	12	*30*	8	*20*	4	*10*
1.01-1.05	4	*10*	6	*15*	-	-	9	*22.5*	13	*32.5*
1.06-1.10	2	*5*	10	*25*	6	*15*	16	*40*	9	*22.5*
1.11-1.15	16	*40*	4	*10*	8	*20*	4	*10*	2	*5*
1.16-1.20	2	*5*	2	*5*	1	*2.5*	3	*7.5*	6	*15*
1.21-1.25	0	*0*	3	*7.5*	0	*0*	-	-	5	*12.5*
1.26-1.30	6	*15*	1	*2.5*	1	*2.5*	-	-	1	*2.5*
1.31-1.35	0	*0*	1	*2.5*	-	-	-	-	-	-
1.36-1.40	2	*5*	4	*10*	-	-	-	-	-	-
1.41-1.45	1	*2.5*	-	-	1	*2.5*	-	-	-	-
1.46-1.50	-	-	-	-	1	*2.5*	-	-	-	-
1.51-1.55	-	-	-	-	-	-	-	-	-	-
1.56-1.60	-	-	-	-	1	*2.5*	-	-	-	-
Total	**40**	***100***	**40**	***100***	**40**	***100***	**40**	***100***	**40**	***100***

5.3.3.1 Checks for Normality of Data: 'Success Measures'

Normality was checked by following the procedure mentioned in the methodology, section 4.7.1. Three kinds of tests for normality were used: formal test (Shapiro-Wilk (SW) test), graphical methods (histograms and Q-Q plots) and numeric methods (central tendencies, skewness and kurtosis).

To check the type of distribution through SW test, the null and alternative hypotheses were set as follow:

H_0: The data distribution is normal.
H_1: The data distribution is non-normal.

Table 5.12 shows SW test statistics for the five data distributions. The level of significances becomes more than 0.05 in case of 'overall success' (α=0.156) as well as 'client satisfaction' (0.232). Therefore, the null hypothesis of SW test could not be rejected for these two cases. Other three variables had their level of significances lower than 0.05 consequently the null hypotheses on normality could be rejected. According to the SW test, only the measures 'overall success' and 'client satisfaction' showed normal distributions. To corroborate observations to these observations of the SW test, graphical tests were done.

Table 5.12: The SW statistics of the five success measures

Success measure	Shapiro-Wilk Statistic	Degrees of freedom	Significance
Initial cost : final cost	.908	40	.003
Initial duration : final duration	.903	40	.002
Achieved : intended quality	.667	40	.000
Achieved : intended client satisfaction	.963	40	.232
Overall success	.958	40	.156

Under the graphical tests, histograms and Q-Q plots were checked (Appendix E). The histograms of cost, time and quality showed significant deviations from normality. Only client satisfaction and overall success showed normal approximations. The histograms provided similar observations toward the results of the SW test. Thus, only overall success and client satisfaction were considered as normal. Supporting to the normal distributions of overall success and client satisfaction, the Q-Q plots showed that the distances between the snake like data distributions and straight lines were not significant (Appendix E). Numeric tests were performed on the two variables 'overall success' and 'client satisfaction' as the final step to confirm the normality.

For 'overall success', the central tendencies (mean, median and mode) showed that they were close to each other, having difference of 1% only between the median and mean (Appendix E). In addition, the calculated values for skewness and kurtosis were 0.773 and 0.340, respectively, and hence both within the acceptable limit of less than 1. Therefore, all numeric methods accepted that the data of overall success was normally distributed. In the case of 'client satisfaction', the three central tendencies were almost the same, within a 1%-range between each value (Appendix E). Both skewness and kurtosis values were less than 1 (-0.011 and -0.595, respectively).

Therefore, considering all the all tests carried out for normality, only overall success and client satisfaction were considered as approximate normal distributions. Cost, time and quality were considered non-normally distributed. The most appropriate descriptive and inferential statistical analyses were selected according to the normality/non-normality to conclude reliable interpretations.

5.3.3.2 Descriptive Statistics of Success Measures

Since the two variables 'client satisfaction' and 'overall success' are normally distributed, mean and standard deviation were used as the most appropriate descriptive statistics to measure central tendency and variation respectively (Table 5.13).

Only three projects out of 40 achieved overall success below 1 (100% success). These three projects achieved 98% of success overall. The projects were considered successful projects for to two reasons: firstly, there was no exact margin used in literature to divide the project into success or failure. Secondly, the projects were perceived as success by a third party, the NZIOB. Regardless of the three projects, overall success had a mean success of 1.09. The lower limit and upper limits for the sample mean were 1.06 and 1.12 at 95% confidence level. Of the construction projects in the sample, 92.5% had overall success between 1.00 and 1.26.

In the sample used for the primary investigation, the mean client satisfaction was 1.06. At 95% confidence level the lower and upper limits of the sample mean were 1.04 and 1.07, respectively. The minimum and maximum values of client satisfaction were 0.96 and 1.17, respectively. With a standard deviation of 0.50, 95% of the sample data entities were distributed between 0.96 and 1.18.

Table 5.13: Central tendencies associated with the success measures: overall success and client satisfaction

Item	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**95% confidence interval for mean**	
					Lower limit	**Upper limit**
Overall success	0.98	1.26	1.09	0.066	1.06	1.12
Achieved : intended client satisfaction	0.96	1.17	1.06	0.050	1.04	1.07

Table 5.14: Central tendencies associated with the success measures: cost, time and quality

Success factor	**Minimum**	**Maximum**	**Median**	**Mode**	**Percentiles**		
					25th	**50th**	**75th**
Final : initial cost	0.95	1.42	1.12	1.12	1.04	1.12	1.19
Final : initial duration	0.90	1.38	1.1	1.1	1.03	1.10	1.18
Achieved : intended quality	0.80	1.60	1	1	0.99	1.00	1.11

Table 5.14 shows descriptive statistics for cost, time and quality, which were each non-normally distributed. Thus, median and mode were used as the most appropriate measures of central tendencies while 25th, 50th and 75th percentiles were used to measure variances.

Among the three distributions, cost had the highest central tendencies which were 1.12 for both median and mode. Although the minimum value was 0.95, 75% of data fell above 1.04. Further, 25% of the projects achieved values above 1.19.

Timely achievement of the projects had both, median and mode values, equal to 1.1. The minimum achievement was 0.90, while 75% of projects could achieve values above 1.03. The highest achieved 25% of projects were distributed between 1.18 and 1.38.

For quality, both median and mode values were equal to 1. Having 0.80 as the minimum achievement, 50% projects could only accomplish quality achievements below 1.00. Further, 25% of projects achieved quality above 1.11 with the maximum of 1.6.

By considering the sample statistics of the success measures, one can perceive the status of the sample that this primary investigation is based on. Further, these parameters of the sample statistics are used as the preference values to make hypothesis under inferential statistics as described below.

5.3.3.3 Inferential Statistics for Success Measures

Inferential statistics of success measures can indicate the project success, which the population of this primary research investigation could achieve in terms of cost, time, quality, client satisfaction and overall success. To determine central tendencies of the five success measures, both parametric and non-parametric tests were used. ‘Overall success’ and ‘client satisfaction’ were assessed through parametric one sample t-test. For ‘time’, ‘cost’ and ‘quality’, population central tendencies were evaluated using non-parametric Wilcoxon signed rank test.

Table 5.15: Central tendencies associated with the success measures

Success factor	**Mean**	**Hypothesized mean μ**	**t value**	**Level of sig. (2–tailed)**
Overall success	1.09	1.05	3.342	0.002
Achieved : intended client satisfaction	1.05	1.00	6.473	0.000

For the parametric test, mean values were used as the relevant central tendency to investigate the parameters of the population. Based on perceptions from the descriptive statistics, the population mean values were null hypothesized as $\mu = 1.05$ and $\mu = 1.00$ for ‘overall success’ and ‘client satisfaction’, correspondingly.

Table 5.15 shows the results of the one sample t-test. The last column of Table 5.15 shows that the levels of significances were less than 0.05 consequently the related null hypotheses were rejected, and the actual mean values of the population were different from the hypothesized values. Since t-values for both, overall success and client satisfaction, were positive (3.342 and 6.473, respectively) the population means were found to be greater than the hypothesized means.

For ‘time’, ‘cost’ and ‘quality’, population central tendencies were evaluated through non-parametric Wilcoxon signed rank test and hence the most appropriate sample statistics used to make hypothesis were the median values. The hypothesized median values were tested at $\alpha = 0.05$ significance level and the results are shown in Figure 5.4. According to the test, the study could retain the null hypotheses that the medians of cost and time achievements equalled 1.1, whereas, the median of quality of the population equalled to 1.05.

	Null Hypothesis	Test	Sig.	Decision
1	The median of final cost:initial cost equals 1.1.	One-Sample Wilcoxon Signed Ranks Test	.090	Retain the null hypothesis.
2	The median of final duration:initial duration equals 1.1.	One-Sample Wilcoxon Signed Ranks Test	.727	Retain the null hypothesis.
3	The median of achieved:intended quality equals 1.1.	One-Sample Wilcoxon Signed Ranks Test	.006	Reject the null hypothesis.

	Null Hypothesis	Test	Sig.	Decision
1	The median of final cost:initial cost equals 1.05.	One-Sample Wilcoxon Signed Ranks Test	.000	Reject the null hypothesis.
2	The median of final duration:initial duration equals 1.05.	One-Sample Wilcoxon Signed Ranks Test	.005	Reject the null hypothesis.
3	The median of achieved:intended quality equals 1.05.	One-Sample Wilcoxon Signed Ranks Test	.747	Retain the null hypothesis.

Figure 5.4: One-sample Wilxocon signed ranks test results for cost, time and quality

According to the inferential statistics, quality and client satisfaction showed the least achievements for the central tendencies, which was 1.05. Thus, the lowest central tendencies evaluated for success measures are greater than 1 (100% achievements toward the initial expectation). Cost and time showed the highest achievements which were 1.10 while overall success had a mean of 1.09 in the population. Since the population are successful projects as perceived by NZIOB, these achievements can be considered as an industry’s perception about construction project success in NZ. Further, one can reflect on these interpretations to get an indication about ultimate achievements of construction projects, which the findings of this primary investigation are based on. For construction project managers, these findings can be used to recognize the scope of success in terms of ultimate outcomes and hence the findings are in line with the first objective of this research study.

5.3.4 Investigating Characteristics Associated with the Projects

The objective of this aspect of the study is to determine the challenges that construction projects are facing, which could impair planning and implementation strategies. Four key project characteristics had been confirmed during the preliminary investigation as influencing project success. These four characteristics are: complexity, dynamism, uncertainty and uniqueness. Frequencies of ratings of these four characteristic given by the NZIOB award recipient on their projects are summarized in Table 5.16. These ratings are based on a 0-100 scale, with 0-20 being very low while 80-100 represents very high.

To calculate the extent of these four characteristics associated with the projects, descriptive statistics were taken for central tendencies and variances. Thereafter, inferential statistics was used to test hypotheses related to the population. To identify the suitable tests for both descriptive and inferential statistics, the first step was to determine the nature of the distributions.

Table 5.16: extent of project characteristics: complexity, dynamism, uncertainty and uniqueness

Rating	Complexity		Dynamism		Uncertainty		Uniqueness	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
20	-	-	-	-	1	*2.5*	-	-
25	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	1	*2.5*
45	-	-	1	*2.5*	1	*2.5*	-	-
50	-	-	3	*7.5*	3	*7.5*	1	*2.5*
55	-	-	2	*5*	2	*5*	1	*2.5*
60	3	*7.5*	2	*5*	3	*7.5*	2	*5*
65	4	*10*	3	*7.5*	8	*20*	3	*7.5*
70	5	*12.5*	5	*12.5*	10	*25*	5	*12.5*
75	6	*15*	10	*25*	4	*10*	7	*17.5*
80	6	*15*	3	*7.5*	5	*12.5*	5	*12.5*
85	7	*17.5*	2	*5*	1	*2.5*	2	*5*
90	5	*12.5*	6	*15*	1	*2.5*	7	*17.5*
95	1	*2.5*	1	*2.5*	1	*2.5*	3	*7.5*
100	3	*7.5*	2	*5*	0	*0*	3	*7.5*
Total	**40**	***100***	**40**	***100***	**40**	***100***	**40**	***100***

5.3.4.1 Type of Distribution for Project Characteristics

To determine the type of distribution of project characteristics a similar procedure was followed as for the success measures explained in section 5.3.3. Table 5.17 shows the SW test statistics and significance levels for the contingency variables. It shows that the level significance was more than 0.05 for all the cases. Therefore, the null hypothesis could not be rejected for the four variables. Therefore, SW test showed that the contingency variables were normally distributed. In this analysis, it should be noted that the degree of freedom for ‘uncertainty’ was 39 while it was 40 for the other three cases. The reason was the presence of an outlier in the variable. The outlier can be observed clearly in the frequency distribution given in Table 5.16. The removal of the outlier improved the level of significance for ‘uncertainty’ drastically from 0.042 to 0.493 which was from a non-normal to a normal distribution. Normality was confirmed by further testing with numerical and graphical methods.

Table 5.17: The SW test values for project characteristics

Contingencies	SW test statistics		
	Statistic	Degrees of freedom	Sig.
Complexity	.963	40	.208
Dynamism	.960	40	.166
Uncertainty	.974	39	.493
Uniqueness	.946	40	.056

Although histograms of the four contingencies seemed to be distributed approximately along normal curves (Appendix E), it was difficult to make decisions due to presence of missing data intervals and skewness. Therefore, only normal Q-Q plots were considered as the relevant graphical test. It could be seen that data was not considerably diverging and consequently data could fairly be assumed as normally distributed (Appendix E). Having these observations in mind, the study considered numeric methods to assess the normality.

The central tendency values were not considerably different from each other for the contingency variables. The difference between the highest and lowest central tendencies was about 6% for the most extreme case, i.e. between mean and mode values of complexity. Further, the skewness and kurtosis values were observed. The four skewness and kurtosis values were all less than 1 and therefore, the variables could be considered as approximately normal. This observation coupled with the results of the SW test and graphical methods assisted to consider complexity, dynamism, uncertainty and uniqueness as normally distributed.

5.3.4.2 Descriptive Statistics of Project Characteristics

Descriptive statistics can be used to identify the characteristics of the sample data that the inferential statistics are based on. Further, the descriptive statistics were used to construct hypotheses that the subsequent inferential statistics of construction project characteristics based on. Since the contingency variables were considered as normally distributed, mean and standard deviation were considered as the suitable descriptive statistics.

Table 5.18 shows that complexity and uniqueness had the highest and the second highest mean values with 79% and 77%, respectively. These were followed by dynamism and uncertainty, having mean values of 73% and 67%, respectively. Thus, all central tendencies of the project characteristics in the sample data can be considered as high according to the scale used.

The responses related to complexity were distributed between 60% -100% and hence all the construction projects in the sample could be rated as having ‘high’ to ‘very high’ complexity. Related to uniqueness, the projects were between ‘average’ and ‘very high’ (minimum = 40%, and maximum = 95%). Dynamism was rated between 45% and 100%, having a 95% confidence interval of (47%, 98%). Therefore, related to dynamism, the projects recruited could be rated between ‘average’ and ‘very high’. Uncertainty had the minimum and maximum values of 45% and 95%, respectively, while 95% of data entities were distributed between 48% and 93%. Thus, uncertainty of the construction projects in the sample data varied between ‘average’ and ‘very high’.

Table 5.18: The descriptive statistics of the project contingencies

Item	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**95% confidence interval**	
					Lower limit	**Upper limit**
Complexity	60.00	100.00	79	10	-	-
Dynamism	45.00	100.00	73	13	47	98
Uncertainty	20.00	95.00	68	13	48	93
Uniqueness	40.00	95.00	77	11	-	-

Since the participants’ responses for complexity are above 60% for all the data entities, the construction projects in the sample had at least one project characteristic rated to be highly or very highly influenced by planning and implementation. There was no project rated as low or very low related to their characteristics, except in the case of uncertainty where an outlier was present. The frequency distributions shown in Table 5.16 indicate that only 15% of data entities belonging to dynamism and uncertainty were in the average zone, while only 7.5% data entities were in the average zone for uniqueness. Therefore, the construction projects of the sample, which the interpretations of the primary study are based on, were mostly influenced highly or very highly from the four project characteristics.

Based on these sample statistics, hypotheses were next made for inferential statistics of the project characteristics.

5.3.4.3 Inferential Statistics of Project Characteristics

Under inferential statistics, the purpose was to predict central tendencies of construction project characteristics related to the population. The hypotheses tested in this section are from H1 to H4 which are described in section 3.3 under the development of theoretical framework.

Population mean values were hypothesized for the four project characteristics by look at the sample means as shown in Table 5.19. Thus, the null hypotheses and alternative hypotheses related to the central tendencies of the population can be written as follow:

For complexity: H0: $\mu=75$; Ha: $\mu \neq 75$

For dynamism: H0: $\mu=65$; Ha: $\mu \neq 65$

For uncertainty: H0: $\mu=60$; Ha: $\mu \neq 60$

For uniqueness: H0: $\mu=70$; Ha: $\mu \neq 70$

Table 5.19: One sample t-test for the project contingencies

Contingency	**Mean**	**Hypothesized mean μ**	**t value**	**Level of sig. (2–tailed)**
Complexity	79	75	2.380	0.022
Dynamism	73	65	3.929	0.000
Uncertainty	67	60	3.439	0.001
Uniqueness	77	70	3.390	0.002

Since the data distributions of the project characteristics were normally distributed in the sample, a one sample t-test was used to test these four hypotheses. Table 5.19 provides credence that all the null hypotheses could be rejected at $\alpha=0.05$ confidence. Therefore, the study accepted the alternative hypotheses which express that the central tendencies of the four project characteristics were different from the hypothesized values for all the cases. Since the given four t-statistics were all positive, the values of the population means were greater than the hypothesized mean values.

The population had the mean value greater than 75% for 'complexity' and hence in the upper portion of the 'high' region of the scale used. The lowest value of the population means was recorded for 'uncertainty', but it was higher than 60% (the 'high' region of the scale used). Dynamism and uniqueness had population mean values larger than 65% and 70%, respectively. Therefore, all the project characteristics that challenging construction project planning and implementation were regarded as high in the population at $\alpha=0.05$ significance level.

According to the definition of this study for construction project strategies (*Strategy is that which a construction manager employs in decision making and problem solving within the complexities, uncertainties, uniqueness and dynamisms of any construction process*), the study needed to gather data on construction projects that were challenged to a high extent by the four construction project characteristics. According to the inferential statistical analyses done on the project characteristics, it could be noted that the projects in the sample used in this primary investigation had faced challenges to a high extent.

Therefore, these concluding remarks can be considered as an indication that the requirements of the current study, to use construction projects which are challenged highly, is satisfied. Table 5.20 summarizes the findings of this analysis in line with the hypotheses constructed in Chapter 3.

Table 5.20: Inference on H1, H2, H3 & H4

Hypothesis No.	Population mean μ	Inference
H1	79	Construction project environments are complex to 'high' extent
H2	73	Construction project environments are dynamic to 'high' extent
H3	67	Construction project environments are uncertain to 'high' extent
H4	77	Construction project environments are unique in nature to 'high' extent

5.3.5 Nature of Construction Project Implementation Issues: Technical Rationality (TR) versus Reflective Practice (RP)

One of the objectives of this research study is to identify the drawbacks of traditional planning approaches so as to suggest that the strategy-led approach as a complementary planning tool minimizes those drawbacks. Form literature and the preliminary investigation, the study investigated selective inattentions (SI) and reductionism that are natures of technical rationality (TR) paradigm are drawbacks of traditional planning approaches. Therefore, an alternative reflective practice (RP) paradigm is recognized to clarify problems under complex and uncertain situations for TR. This analysis of the primary investigation investigates issues of construction project implementation as a combination of these TR and RP natures in line with the hypotheses (H5 & H6) described in section 3.4.

Natures of problems that construction projects encountered were evaluated by using two opposing alternatives: 'holism versus reductionism' and 'reflective interaction versus selective inattention'. According to the operational definitions provided to the participants, they rated issues faced under the two alternatives on a scale as described in chapter 3 Conceptual Framework.

5.3.5.1 Holism versus Reductionism

Reductionism encourages practitioners to solve problems by dividing the whole into parts while holism criticizes the reductionist approach by emphasizing the need of considering interrelationships between the parts.

Table 5.21: Nature of issues in construction project implementation: holism versus reductionism

Holism versus reductionism (Total contribution equal to 100%)	Number of projects	As a %
100 : 0	1	2.5
90 : 10	6	15
80 : 20	10	25
75 : 25	1	2.5
70 : 30	3	7.5
60 : 40	4	10
50 : 50	8	20
40 : 60	3	7.5
30 : 70	3	7.5
25 : 75	1	2.5
20 : 80	-	-
10 : 90	-	-
0 : 100	-	-
Total	*40*	*100*

Table 5.21 illustrates the frequencies of the NZIOB awardees on their overall perception about construction project issues related to the first alternative of problem natures: 'holism versus reductionism'. Since the data distributions were found to be non-normal for 'holism' and 'reductionism', the median was considered as the suitable central tendency for both descriptive and inferential statistics. Quartiles were selected to evaluate variances.

In the sample data shown in Table 5.22, the central tendencies related to median were 30% (P) and 70% (100-P) for reductionism and holism, respectively. In more than 75% of projects, holism was rated as the dominant nature (larger than 50%) over reductionism in construction project issues. Further, in 25% construction projects, the participants rated that their overall perception on holism was more than or equal to 80%. By considering these descriptive statistics, this primary investigation could determine that there was a difference between the two natures in the sample used. Thus, inferential statistical tests were used to determine whether this difference is statistically significant in the population of this study.

Table 5.22: Descriptive statistics of the nature of problems: reductionism and holism

		Reductionism	Holism
Mean		35	65
Median		30	70
Mode		20	80
Percentiles	25	20	50
	50	30	70
	75	50	80

To evaluate the significance of difference between holism and reductionism related to the population, the null hypothesis was set as median values of reductionism and holism were same in the population. At α=0.05 significance level, non-parametric Wilcoxon signed rank test was used to test the null hypothesis.

The level of significance for the null hypothesis of this test was 0.000 (<0.05) and the null hypothesis was rejected. Consequently, there was a statistical significant difference between the two natures, reductionism and holism (Appendix E). The test further showed that reductionism was rated over holism in construction project issues encountered only in seven cases out of 40. On the other hand, in 25 cases, holism was the governing nature in the construction project implementation issues. There were eight cases where issues encountered were rated as 50:50 regarding reductionism and holism. Thus, Wilcoxon signed rank test showed that holism was the governing nature of issues encountered in construction project implementation. Therefore, the postulation made that ‘traditional planning tools, which are based on reductionist algorithms, cannot solve issues encountered in the realm of construction project implementation effectively’ seems valid.

Further, one sample Wilcoxon signed ranks test showed that the reductionist nature of issues encountered in the population of the primary investigation was equal to 35% at α=0.05 significance level. The median value of holism was investigated to be 65%. Therefore, issues related to construction project implementation can be clarified through a combination of TR and RP paradigms where the combination becomes 35:65 with respect to reductionism versus holism respectively.

5.3.5.2 Selective Inattention versus Reflective Interaction

Selective inattention is considered as one of the major drawbacks of traditional planning tools due to the inability of conservative planning tools to clarify problems which cannot be described through theoretical formulations. In the preliminary investigation, the content analysis could confirm that most of the construction project implementation issues are likely to be diagnosed through reflective interaction.

In this primary investigation, the participants provided information on how they identified issues encountered in the projects. The participants of the primary investigation rated use of theoretical knowledge (TR) and reflective interaction (RP) as an overall perception to construction projects they selected. The frequency count of their responses is given in Table 5.23.

Table 5.23: Nature of issues in construction project implementation: selective inattention versus reflective interaction

Theoretical knowledge versus reflective interaction (Total contribution equal to 100%)			Absolute frequency	%
30	:	70	3	8
35	:	65	4	11
40	:	60	10	27
45	:	55	10	27
50	:	50	9	24
55	:	45	1	3
		Total	*37*	*100*

Both distributions were checked for normality and found to be non-normally distributed. This means that median and quartiles are the most appropriate measures for the descriptive statistics.

Table 5.24 shows that the median value for use of theoretical education to clarify construction project implementation issues was 45%, while that of reflective interaction was 55%. Of the participants, 25% rated the use of theoretical knowledge below 40%, while the first quartile of reflective interaction was 50%. Thus, according to the sample, there was a difference between use of theoretical knowledge, which as an indication of selective inattention, and reflective interaction to clarify issues encountered in construction project implementation. As the next step, the primary investigation used inferential statistics to determine the statistical significance of this difference in the population.

Table 5.24: Descriptive statistics for nature of problems: selective inattention (use of theoretical knowledge) versus reflective interaction

		Theoretical knowledge	Reflective interaction
Mean		43	57
Median		45	55
Mode		40	60
Percentiles	25	40	50
	50	45	55
	75	50	60

The null hypothesis used for this analysis is that 'median values for use of theoretical knowledge and reflective interaction are the same'. Non-parametric Wilcoxon signed ranks test was used to check the null hypothesis at $\alpha=0.05$. The level of significance was 0.000 (<0.05) consequently, the null hypothesis was rejected. Further information provided by the Wilcoxon signed rank test revealed that there were only three situations that theoretical knowledge was rated over use of reflective interaction, but in 29 cases reflective interaction became the most important approach to diagnose issues of construction project implementation. According to this analysis, the primary investigation could conclude that reflective interaction is more important than theoretical formulations to clarify issues encountered in construction projects.

Wilcoxon signed rank test was used to calculate the median values for use of theoretical knowledge and reflective interaction in the population to be 45 and 55, respectively. Therefore, the study emphasized that both reflective interaction and theoretical knowledge should be used as a combination to solve issues related to construction project implementation. Use of reflective interaction becomes slightly more important than the use of theoretical knowledge. According to the contributions of theoretical knowledge and reflective interaction which are used to assess the nature of issues related to construction projects, the ratio of TR to RP becomes 45:55. Therefore, the findings are in agreement with the hypothetical construct made at the earlier stage of this study and which ‘reflective practice should be encouraged in construction project planning approaches in addition to theoretical constructs (such as probabilistic theories) which are prevailing in traditional planning tools. Table 5.25 summarizes these findings and inferences are given to H5 and H6 described in section 3.4.

Table 5.25: Inference on H5 & H6

Hypothesis		Inference
H5:	Experience and artistry is more important than engineering theories to identify issues related to construction project planning and implementation	**Supported**. Use of tacit knowledge: Engineering theories is 55:45
H6:	Problems related to construction planning and to implementation are interrelated with each other	**Supported**. Ratio of reductionism: holism is 35:65

After the three analyses that are focused on determining project success, characteristics of construction projects and nature of issues related to TR and RP were considered. The primary investigation evaluated construction project strategies, which the current study believes to lead to project success in terms of cost, time, quality and client satisfaction.

5.3.6 Construction Project Strategies and Reasons of using Strategies: Thematic Analysis

This part of the investigation is involved with qualitative data analysis of information obtained from the open ended aspects of the questionnaire distributed to the NZIOB award recipients. The projects were coded from P1 to P40 in line with AUTEC requirements. The objective of this analysis is to determine construction project strategies and reasons to use them.

Under the analysis, the data gathered were inserted in an Excel spreadsheet consisting of 13 columns. The first seven columns were related to the qualitative variables taken into account: procurement method, payment method, type of project, amount of contingency, duration and project value. The last six columns were for the data collected from six open ended questions. Among the six open ended questions, three questions were related to conceptual strategies, emerging strategies at implementation and sub-strategies. Sub-strategies are construction project strategies that assisted the main strategies which emerged either at the conceptual and implementation stage. Other three open ended questions were asked to determine reasons why the three kinds of strategies are used. The content of the six questions were analysed separately and themes were identified. These analyses were done in accordance with the framework mentioned in chapter 3. The result of the content analysis is described under two sub-headings below which are types of strategies and reasons for the use of strategies.

5.3.6.1 Types of Construction Project Strategies

In the three kinds of strategies (conceptual, emerging at implementation and sub-strategies) there were seven themes identified: visualization, design related, effective use of technology, planning related, stakeholder management, external related and others. The colour codes used for the seven themes are given in the 2nd column of Table 5.26. To identify the predominant themes within three kinds of strategies, frequencies were counted. The frequencies and qualitative information on each theme are described separately under the following sections for conceptual, emerging at implementation and sub-strategies. At the end of these three analyses, the primary investigation considered variations for each of these seven themes according to the type of strategies.

Table 5.26: The seven themes and their frequencies in conceptual, emerged at implementation and sub-strategies

Themes identified	Colour code used for theme	Conceptual		Implementation		Sub		Total	
		No.	%	No.	%	No.	%	No.	%
Visualization	Green	3	8	1	5	0	0	4	5
Design related	Yellow	4	11	1	5	1	5	6	7
Effective use of technology	Blue	3	8	5	25	5	23	13	16
Planning related	Red	18	50	5	25	6	27	29	35.5
Stakeholder management	Purple	8	22	5	25	10	45	23	28
External related	Orange	2	6	0	0	2	9	4	5
Others	No color	0	0	3	15	0	0	3	3.5
	Total	38		20		24		82	

Analyses of Conceptual Strategies

Conceptual strategies are strategies, which construction project managers craft to plan and implement their projects at the conceptual stage, before actual construction is started. Related to the conceptual strategies, there were 36 useful responses provided by the NZIOB awardees. In these 36 responses, there were 38 strategies mentioned as crafted within the conceptual stage of the construction projects used on this primary investigation. Within the seven themes identified through the content analysis of these 38 conceptual strategies, there were sub-themes emerging for some of the seven themes. The seven themes with their sub-themes are described in detail under the following sub-section.

'Planning Related' Development through Conceptual Strategies

According to the frequency count shown in Table 5.26, among the conceptual strategies, 'planning related' strategies were predominant and used in 18 projects which are counted for 50% of the construction projects that provided useful answers to the first open-ended question. There were four sub-themes that could be identified within the major theme 'planning related': 'minimizing constraints', 'finer planning', 'segmental programing' and 'collaborative planning'. The constitution of 'planning related' strategies related to the conceptual stage is summarized in Table 5.27 with respect to these four sub-themes.

Table 5.27: Constitution of 'planning related' theme at the conceptual stage

Sub-themes of 'planning related' theme	**No. of projects**	**% of total planning related strategies**
Minimizing constraints	8	44
Finer planning	5	28
Segmental programming	3	17
Collaborative planning	2	11
Total	*18*	*100*

There were eight strategies (44% of planning related conceptual strategies) identified related to the sub-theme 'minimizing constraints'. Usually, resource unavailability was an issue hence strategies focused on minimizing influences due to constraints. Under resource uncertainties, sometimes, the awardees allocated limited resources first to the critical elements of construction to minimize the influence toward project implementation. When resource limitations risked the program of project implementation, there were some approaches to apply safety to the program in the responses of the NZIOB awardees. Looking-ahead planning and material deliveries scheduling together with program schedules considering reasonable safety time for material deliveries, are some examples. Use of alternative construction methods to reduce consumption of limited resources was another strategy that the NZIOB awardees used under the conceptual stage. They emphasized that use of these strategies could minimize the influence of resource uncertainties and to contribute to achieve desired goals. A few observations given by the NZIOB award recipients can be mentioned as follows:

Identify critical elements and allocate resource first for them; use of alternative construction methods -P4

Scheduled material deliveries together with program schedules and applied reasonable safety time to material deliveries –P6

Make sure that enough alternative construction activities were available at any time in a case of contingencies -P25

Four weeks look ahead plan used to give certainty to implementation -P22

In traditional planning tools such as CPM first assume unlimited resource availability and then adjust the program through complementary analysis (such as resource balance) to reflect resource limitations. In literature, it is discussed that these complementary analyses are reductionist and hence usually conflicts timely achievements (section 2.3.3.2). From this analysis of the primary investigation, the study determined that strategy-led approach has a different approach over other complementary approaches. For example resource limitations are considered first and then schedules are made to complete projects on time after remedial strategies are considered. Further, there were strategies set to ensure the effectiveness of resource supply under uncertainties by applying safety times to deliveries.

The second sub-theme of ‘planning-related’ strategies at the conceptual stage was ‘finer planning’. In 28% of planning related conceptual strategies, the NZIOB awardees emphasized that detailed and clear project plans at the conceptual stage were considered the key to success. Finer detailing of construction activities is required to identify opportunities and threats related to project implementation. In addition, finer planning has the ability to make implementation process realistic through setting goals for critical construction activities after in detail analysis is done, the NZIOB awardees responded. Some of the strategies are as follow:

Goals are made to be realistic through detailed analysis of each and every critical activity -P12 Detailing as finer as possible and controlling stick to the program -P30 Identify the most probable and important opportunities associate with activities and assign priorities -P40

The requirement of ‘finer planning’ can be considered as reinforcement of the argument by scholars (Hegazy & Mensi, 2010) that the activity level, which traditional planning tools use as the unit of analysis, is not a suitable level to plan construction projects. Within activities, opportunities and threats should be considered in detail and planning should reflect those considerations according to the primary investigation of the open-ended responses given by the NZIOB awardees.

Another sub-theme of ‘planning related’ conceptual strategies was ‘segmental programming’ which was mentioned in three projects. In P10, construction implementation was done under four separate segments due to the scope of the project. The construction project manager emphasized that the strategy could assist each team to learn from other segments while making competitive working environment among the four segmental constructions. P9 was implemented through segmental programing but sequencing was done between stages as opposed to the separate segmental construction of P10. P28, which was a traditionally procured project, broke the project down into four phases and staged the tendering process to reflect the building consent breakdown.

As the last sub-theme of ‘planning-related’ category, two participants (P5 and P20) mentioned ‘collaborative programming’ with key players, who were sub-contractors and suppliers. It should be noted that these two strategies could be considered under 'team building' too. According to the responses of these two construction project managers, collaborative programming could ensure minimum interruptions and conflicts between the parties involved in the projects when uncertainties challenged the main contractors' program. These strategies could integrate other stakeholders' artistry into project implementation done by the main contractor. For example:

Making program and construction sequence with sub, suppliers and staff together to facilitate agreeing and getting confirmed – P5

From the analysis done on the 'planning related' strategies at the conceptual stage, the primary investigation concluded that there are no universal strategies that construction project managers can use to plan construction projects. However, these strategies had in common to focus on identifying opportunities and constraints, acting to minimize influences of constraints and maximizing use of opportunities through planning. These strategies which were crafted at the conceptual stage by the NZIOB awardees become preconditions for the schedules and plans made to implement construction projects.

After these concluding remarks of 'planning-related' development, the primary investigation considers 'stakeholder management' through development of strategies at the conceptual stage.

Stakeholder Management through Conceptual Strategies

The second highest frequency (22%) of the conceptual strategies is represented by 'stakeholder management' under construction project implementation. There were eight conceptual strategies in total related to conceptual strategies mentioned by the awardees. According to the responses of the primary investigation, 'stakeholder management' was to make advantaged of knowledge that the relevant stakeholder is associated with.

The construction projects that mentioned 'stakeholder management' focused on conceptual strategies as the key to success and belonged to the kind of projects that were characterized by complexity. Consequently, tacit knowledge that comes from experience and skills, was required to understand the scope of projects, decide value adding techniques and advance mutual benefits during project implementation.

Among the projects that mentioned 'stakeholder management' as the key focus at the conceptual stage, 50% of them (P11, P23, P24 and P26) considered all stakeholders as their focus. The remaining 50% of the projects (P13, P16, P21 and P27) singled out the 'client' as their key focus under strategy crafting. There were two projects for which the consultant was mentioned together with the client as the key focus of conceptual strategies. According to the responses of the primary investigation, deciding the strategic path with clients and consultants caused smooth project implementation at later stages due to the agreements and integration toward the strategic path of the projects at the conceptual stage. In addition to the client and consultant, sub-contractors and suppliers were mentioned under 'stakeholder management'. Potential threats of interference between schedules and complexities in resource supply were the reasons to focus on sub-contractors and suppliers, respectively.

By considering these responses, the primary investigation concluded that 'stakeholder management' strategies can assist the integration of knowledge associated with different parties of a construction project to make reliable implementation plans.

'Design Related' and 'Effective Use of Technology' through Conceptual Strategies

These two themes of the conceptual strategies mentioned by the NZIOB awardees were considered together because the strategies related to both themes had the common intentions to minimize constraints as well as to optimize opportunities to increase productivity. Therefore, the conceptual strategies mentioned under these two themes should be considered as closely related with 'minimizing constraints' which was one of the sub-themes of 'planning related' development discussed before.

There were four strategies (11%) related to 'design' changes under the conceptual strategies mentioned in the primary investigation. Out of these four, two of them mentioned redesigning to eliminate resource constraints as the key to success: P14 is a project where duration allowance was inadequate to deliver the project on time. The construction project manager used alternative designs allowing application of faster construction methods. In P7 and P23, the construction managers realized at the conceptual stage that the buildability of structures was impracticable and hence the initial design solutions were changed to simplify implementation.

The responses given by the NZIOB awardees revealed that the conceptual strategies related to 'effective use of technology' had similar focus to 'design related' strategies.

There were three projects (P3, P31 and P37) for which making conceptual strategies related to 'effective use of technology' was considered a key to success. In P3, lack of carpentry work was the barrier to implement the project, consequently, the construction project manager used alternative construction methodologies that required less carpentry work. Use of conceptual strategies on 'effective use of technology' to increase productivity was mentioned in P31 as follows:

Using effective construction technologies………..to ensure on time delivery and to increase profit margins – P31

Other Themes of Conceptual Strategies: 'Visualization' and 'External Related'

In the responses to the open-ended questions about aspects of conceptual strategies, two themes emerged: 'visualization' and 'external related'. While describing these two themes, the following discussion emphasizes the relevance of these themes toward the previously discussed theme of the conceptual strategies which was 'planning related'.

P1, P8 and P32 are the three projects, which used conceptual strategies on 'visualization'. These visualization strategies were intended to identify constraints and opportunities associated with the projects by assisting to imagine complex areas of the projects. In P1, the use of 3D modelling to understand complex areas was mentioned as the key to success. The project manager of P1 explained that the strategy of using 3D modelling for the project could assist in identifying issues in advance and hence to take precautions in a proactive manner. By considering these pieces of information, 'visualization' was considered a part of the process related to the first theme, 'planning related'.

Under 'external related' theme of the conceptual strategies, two projects, P19 and P38, were considered. Associated conceptual strategies with both projects had the common intention to avoid potential protest from neighbours of the construction project sites. The construction project managers of the projects emphasized that these two strategies were the key to success because the conceptual strategies could avoid interruptions to project implementation. While having the same attention, the construction project managers used two different strategies to prevent public protest against the projects.

In P38, the project manager handled public protest by integrating locals into the construction projects to deliver advantages to the neighbours during the project implementation. However, P19 scheduled noisy construction at weekends to minimize interruptions. The nature of the neighbourhood may become the reason to use two different strategies to handle public protest toward these construction projects. P19 was surrounded by office premises while environmental issues were the reasons to public offence in P38.

According to the strategies belonging to the ‘external related’ theme, these strategies focused on constraints, i.e. public protest, to take actions against uncertainties. The strategy directly influenced schedules and plans of P19 by scheduling noisy activities at non-peak hours. Thus, the primary investigation considers this strategy as belonging to the context of the first theme, ‘planning related’.

As a summary to the conceptual strategies mentioned by the NZIOB award recipients, development of early strategies was apparent in the construction projects. These strategies focused on identifying constraints as well as opportunities which were associated within the scope of the construction projects that the NZIOB awardees provided information for. Under complex and uncertain project situations, the construction project managers used visualization and integration of other stakeholders to use their tacit knowledge for project planning. Identifying constraints and opportunities early let them select the most appropriate construction methods as well as consider alternative design solutions at the conceptual stage. To minimize interruptions between schedules of the main contractors and sub-contractors, some projects used corroborative programming. Since these proactive strategies directly influence scheduling and planning, the primary investigation considers them as pre-condition to make schedules and plans for the implementation stage.

Analyses of Strategies Emerging in the Implementation Stage

In addition to the 38 strategies mentioned at the conceptual stage, there were 20 strategies (Table 5.26) which emerged at the implementation stage of the construction projects according to the NZIOB awardees responses. When the projects were advanced from the conceptual stage, these strategies emerged through workshops and option analysis.

The frequency count of the content analysis, which is shown in Table 5.26, shows that ‘stakeholder management’, ‘effective use of technology’ and ‘planning related’ ranked equally with highest frequency of occurrence. Together, the strategies related to these three themes counted for 75% (five strategies each) of emerging strategies at the implementation stage of the construction projects.

Considering the strategies belonging to ‘planning related’ theme, four out of five strategies (P2, P27, P34 and P35) were made to improve monitoring and adjustment. According to the responses of the open-ended questions, monitoring and feedback assisted to identify drawbacks of the plans and schedules made at the conceptual stage. In addition, reviewing of the construction projects at the implementation stage provided opportunities to solve unforeseen issues as well as to use emerging opportunities at the implementation stage of the projects by making subsequent strategies such as value-adding techniques. For example, at the implementation stage of P2, the construction project manager realized the opportunity to construct the roof before the structure was finished, consequently, the initial construction procedure was reschedules to reflect that opportunity.

Among the ‘stakeholder management’ strategies, only P6 mentioned the whole project team as a strategy focus. Clients were focused by two implementation strategies, but together with local community (P7) and design team and subcontractors (P38). In P12, the project manager focused on giving responsibilities to his/her own team. There was one implementation strategy (P21) which focused on taking advice from one of the leading specialists in the NZ construction industry.

Each of the five strategies related to ‘effective use of technology’ had a different intention: e.g. fast track construction to minimize schedule variations (P28), defects-free construction to avoid extra work potentially causing delay (P30), and minimize onsite-interruption due to vehicle movements (P36). In addition to the technology focused strategies, there was one project (P14) in which the construction project manager applied alternative design strategies to minimize the life-cycle cost by taking advantage of emerging opportunities at the implementation stage.

In addition to the strategies belonging to the above themes, there were three strategies classified as ‘other’ themes. In P9 and P27, the construction project managers mentioned that conducting workshops was the strategy that emerged as a requirement at the implementation stage to cope with uncertain and complex situations. By conducting workshops, the construction project managers created opportunities to integrate the knowledge of others to determine the most appropriate construction methods and design solutions. Therefore, in this way, conducting workshops can be considered a sub-strategy of the strategies mentioned under ‘effective use of technology’ and ‘design related’ themes.

Having considered the conceptual strategies and emerging strategies at the implementation stage, the study analysed the sub-strategies that the NZIOB award recipients used to support their main strategies.

Analyses of Sub-strategies

Among the supporting strategies (sub-strategies) of the main strategies applied in the construction project population of the primary investigation, there were 24 usable answers to the related open-ended question. Similar to the conceptual strategies and strategies emerging at the implementation stage, content analysis was done on the information provided by the NZIOB awardees and frequencies were counted for the identified themes as shown in Table 5.26.

The highest frequency of occurrence was for the theme ‘stakeholder management’ representing 45% of the sub-strategies. The majority of the sub-strategies mentioned all stakeholders together as the focus of ‘stakeholder management’. The construction project managers of P11 and P20 mentioned sub-contractors alone as the focus for stakeholder integration of the sub-strategies. P8 and P27 mentioned specialists and client as the sub-strategy focus, respectively. In the sub-strategies, integration of sub-contractors into project implementation was usually mentioned, which is a different observation than the stakeholder management strategies of the conceptual stage where the client was mentioned as the most important single party in the responses given by the NZIOB awardees.

The second majority of sub-strategies belonged to ‘planning related’ theme and counted for 27% of the total sub-strategies. It could be seen that sub-strategies focused on parallel activities of scheduling such as financial planning (P7), resource balancing (P9) and risk management plan (P23). Other intentions of the sub-strategies related to ‘planning related’ theme were monitoring (P1), detail planning (P7) and collaborative planning (P27).

Effective use of technologies was ranked as the third-most frequent occurrence (23%) among the sub-strategies. Among them, use of pre-fabrication was applied to P3 and P6 to minimize on-site congestion. In P10, the construction project manager leveraged design changes with cost effective construction methodologies to cope with variations such that both client and contractor could benefit from the advantages of these strategies. Only in P28 where adapted piles were used instead of a standard foundation, design changes were mentioned as the sub-strategy.

In the sub-strategies identified in the analysis of the primary investigation, the construction project managers used ‘external related’ strategies in two projects, P19 and P38. The conceptual strategies of these two projects had similar attention of taking precautions against public protest. The sub-strategies were set by the construction project manager to assist the ‘external related’ strategies which were crafted at the conceptual stage of these two projects.

Having analysed the three types of strategies (conceptual, implementation and sub) separately under the identified themes, the primary investigation continues by evaluating similarities and differences of the strategies due to their type.

Similarities/Differences of Strategy Focus among Conceptual, Emerging during Implementation and Sub-strategies

According to Table 5.26, planning related strategies were predominant. Among 82 strategies, 35.5% were planning related strategies. From planning related strategies, more than 60% were made at the conceptual stage (Table 5.28). Implementation and sub-strategies counted for nearly 17% and 21%, respectively.

At the conceptual level, ‘planning related’ strategies focused mainly on identify opportunities as well as constraints. Having recognized constraints and opportunities, the NZIOB awardees crafted early strategies before making schedules; examples are prioritizing limited resources, collaborative planning, and use of alternative design solutions and construction methods. When the construction projects used for the primary investigation advanced to the implementation stage, ‘planning related’ strategies had different focus which was mainly to improve monitoring and feedback.

This implied that schedules and plans could go wrong despite careful consideration at the conceptual stage. Yet, the projects could still lock in success by adapting strategies. For example, the construction project managers of P35 mentioned only ‘planning related’ strategies as the reasons of success. Having made schedules very carefully after risk assessment at the conceptual stage, P35 still faced variations of 20% in schedules. Indeed, reviews and adjustments finally ensured project success (overall success of 1.01). Further, sub-strategies related to the planning related category focused on parallel planning such as financial management, resource management and risk management. Thus, the nature of the 'planning related' strategies mentioned in the questionnaire survey varies according to the type of strategies.

The second highest focus was on stakeholder management. The category counted for 28% in total. Among them, 35% were crafted at the conceptual stage while implementation and sub-strategies counted for 22% and 43%, respectively. Unlikely in the 'planning related' strategies, there was no drastic frequency difference related to the three types of strategies in 'stakeholder management'. However, the considered stakeholders were different according to the type of strategies. The client was mentioned as the most dominant single stakeholder under the conceptual strategies. As the construction projects were advanced into the implementation stage, the individual focus diverted toward sub-contractors, contractor's team and suppliers although the clients were significantly mentioned. Despite these differences, the three types of 'stakeholder management' strategies had similar focus on sharing knowledge to clarify situations better, create mutual advantages and minimize interruptions between the schedules of stakeholders.

Table 5.28: Use of conceptual, implementation and sub strategies under different themes

	Visualization		**Design**		**Eff. use of technology**		**Planning related**		**Stakeholder mgmt.**		**External related**		**Others**	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Conceptual	3	*75*	4	*67*	3	*23*	18	*62*	8	*35*	2	*50*	0	*0*
Implementation	1	*25*	1	*17*	5	*38*	5	*17*	5	*22*	0	*0*	3	*100*
Sub-strategy	0	*0*	1	*17*	5	*38*	6	*21*	10	*43*	2	*50*	0	*0*
Total	4		6		13		29		23		4		3	

Effective use of technology was the third highest strategies with 16%. At the conceptual level, technology focused strategies aimed at eliminating resource limitations as well as maximizing ultimate outcomes by making the program reliable and more effective. Implementation and sub-strategy emphasized to lock in the program when unavoidable variations had happened. In addition, they intended to add value in terms of time and cost.

Seven per cent of strategies belonged to the 'design related' category. Two thirds of design focused strategies were crafted at the conceptual stage once major constraints (such as unavailability of carpentry) were identified. The focus of the emerged strategies at the implementation stage and sub-strategies of the ‘design related’ strategies was to add value once opportunities were identified. One example is design changes to reduce the life-cycle cost.

The strategies related to ‘visualization’ theme counted for five per cent of the total strategies mentioned by the NZIOB awardees. Out of four visualization strategies, three of them were crafted at the conceptual stage due to complexity of the project. The focus of these conceptual level strategies was to understand the project better and hence to craft proactive strategies to cope with potential issues. The visualization strategy, emerging during the implementation stage, was to assist to the conceptual strategy by facilitating visualization through use of 3D modelling.

There were four strategies related to ‘external’ category. These four strategies were mentioned in P19 and P38 as the conceptual and sub-strategies. These two projects mentioned only external related strategies as the key to success. The purpose was to eliminate potential public offence due to disturbance for day-to-day activities and surrounding environment. According to the cause of public protest, the construction project managers crafted and implemented proactive strategies.

In addition to P19 and P38 (average overall success achieved = 1.03), there were another seven projects implemented by using strategies that belonged to the same theme. There were three projects (P22, P33 and P35) during which only ‘planning related’ strategies were used (average overall success achieved = 1.12). ‘Stakeholder management’ strategies were the keys of success in P11 and P21 (average overall success achieved = 1.09). P14 and P3 mentioned only ‘design related’ and ‘technology’ focused strategies respectively (overall success of 1.01 and 1.03, respectively). From the 36 projects used for the content analysis, the majority (75%) was implemented through strategies which had multiple focuses of attentions.

5.3.6.2 Reasons to use Strategies

The current study evaluates the suitability of construction project strategies to implement projects successfully based on two postulations: firstly, construction project strategies can cope with the characteristics of construction projects, which usually challenge project planning and implementation, and, secondly, construction project strategies can improve productivity.

The participants of the primary investigation were asked to provide reasons for using the strategies they mentioned as keys to success. The analysis of the qualitative information in this section identifies five themes related to the reasons of using strategies. These five themes were complexity, uncertainty, dynamism, uniqueness and productivity. The first four themes were the characteristics of construction projects. There were 43 usable responses mentioned as reasons to use the construction project strategies.

Table 5.29 provides a summary of the analysis with frequencies and examples. The operational definition given in chapter 3 was used to identify complexity, dynamism, uncertainty and uniqueness within the responses of the NZIOB awardees.

Table 5.29: Reason to use strategies in construction projects

Themes within reasons	Examples	Sample projects	No. of projects	%
Complexity	Misconception among stakeholders, congestion, fast delivery , complexity in the design	P5, P6, P8	7	16
Productivity	Maximize profit and fast delivery, cut down running costs such as labour initiatives, increase the performance of strategies, integrating stakeholders to enhance the team performance, focus on any other area	P1, P2, P3, P5, P7, P9, P10, P12, P13, P14, P24	15	35
Uncertainty	Long duration makes schedules uncertain, resource limitations including labour, low commitment, public offence	P1, P2, P4, P20, P22, P27	8	19
Dynamism	Considerable variations, design variation and errors	P11, P19, P25, P35, P38	6	14
Uniqueness	Specific client's needs, which are unclear, specific stakeholder involvement, specific resource requirement, new technologies	P1, P21, P36, P37	5	12
Other	Find success, concrete innovation	P37, P40	2	5

Increasing productivity was the reason to use of the strategies mentioned by the NZIOB awardees in 35% of situations. Maximizing profit, fast delivery, increase performance of the project team, focus on unattended opportunities and cut down on-site activities, are some examples, which were considered under the theme 'productivity'.

In 60% of the situations, the four characteristics of construction projects were the reasons to use construction project strategies. ‘Uncertainty’ was the second-most frequent reason of using the strategies after ‘productivity’. Reasons considered under ‘uncertainty’ summed up to 19% of the 43 reasons. Uncertainties were mentioned related to schedules, resources and stakeholder behaviour. Further, complexity was mentioned for 16% of the reasons to use the strategies. These strategies included complexities in the design, stakeholder relations as well as in construction program. Variations, errors and changing client desires were mentioned under ‘dynamism’ to which 14% of the 43 reasons belonged. Sometimes, public offence made construction project implantation dynamic. ‘Uniqueness’ happened to be the reason to use strategies in 12% of incidents. In some situations, the NZIOB award recipients crafted construction project strategies to deal with client’s unique needs. Further, involvement of specific stakeholders needed some engagement strategies to integrate them into the desired end-results. New technologies and particular resource requirement were some other causes that were considered under ‘uniqueness’.

In addition to these five themes, two participants mentioned reasons which were classified under ‘other’. P37 and P40 are the projects for which the project managers mentioned ‘other’ reasons to use their strategies. These two projects mentioned ‘find success’ and ‘concrete innovation’ as their reasons to use strategies, respectively.

As a summary to this analysis, one can observe that 95% of the 43 reasons that were discovered as the reasons to use the construction project strategies in the primary investigation belonged to the four project characteristics or productivity. This concluding remark is considered as a supporting factor for the postulations of the current study that project strategies are used to cope with challenges, which are the four characteristics of construction projects, and to increase productivity.

Having finished the qualitative analysis, the study continues investigations on construction project strategies through quantitative techniques to explore the three dimensions of strategies process, content and context.

5.3.7 Natures of Technical Rationality (TR) versus Reflective Practice (RP) in Construction Project Strategies

Previously, in section 5.3.5, issues of construction project implementation were reviewed with respect to the characteristics of TR and RP. Under this section, solutions given are reviewed with respect to TR and RP. The characteristics of TR are recognized in literature as deficiencies of traditional planning tools. Thus, RP natures in construction project strategies are important when investigating the suitability of the strategy-led approach to implement construction projects. The relevant hypotheses, H7 and H8, are described in section 3.6 where operational definitions and scales are explained.

Characteristics of TR and RP in construction project strategies were investigated under two sections: 'practitioner dependency versus practitioner independency' and 'context dependency versus context independency'.

5.3.7.1 Practitioner Dependency versus Practitioner Independency

As described in chapter 3, the use of tacit knowledge from experience and qualities of construction project managers are considered as an indication of practitioner dependency. Conversely, use of theoretical knowledge was considered as an indication of practitioner independency. The participants were requested to rate their perceptions on the contributions of education, experience and qualities (skills and characteristics) to the seven steps of the strategy process as identified in literature (see chapter 2). A Likert scale of 1-5 is used as described in chapter 3.

The responses given in this enquiry are graphically shown in Figure 5.5. From the figure, it could be seen that use of experience and qualities toward strategy-process were occasionally mentioned as moderately important. For most of the circumstances, use of knowledge based on experience and qualities was extremely important or important. For the seven steps of strategies, the use of theoretical knowledge was mostly moderately important, but there were situations where theoretical knowledge was not important or not at all important toward the steps of strategy process. Table 5.30 represented the central tendencies for use of theoretical knowledge, experience and qualities toward the seven steps of strategy process. These three central tendencies are mean, median and mode.

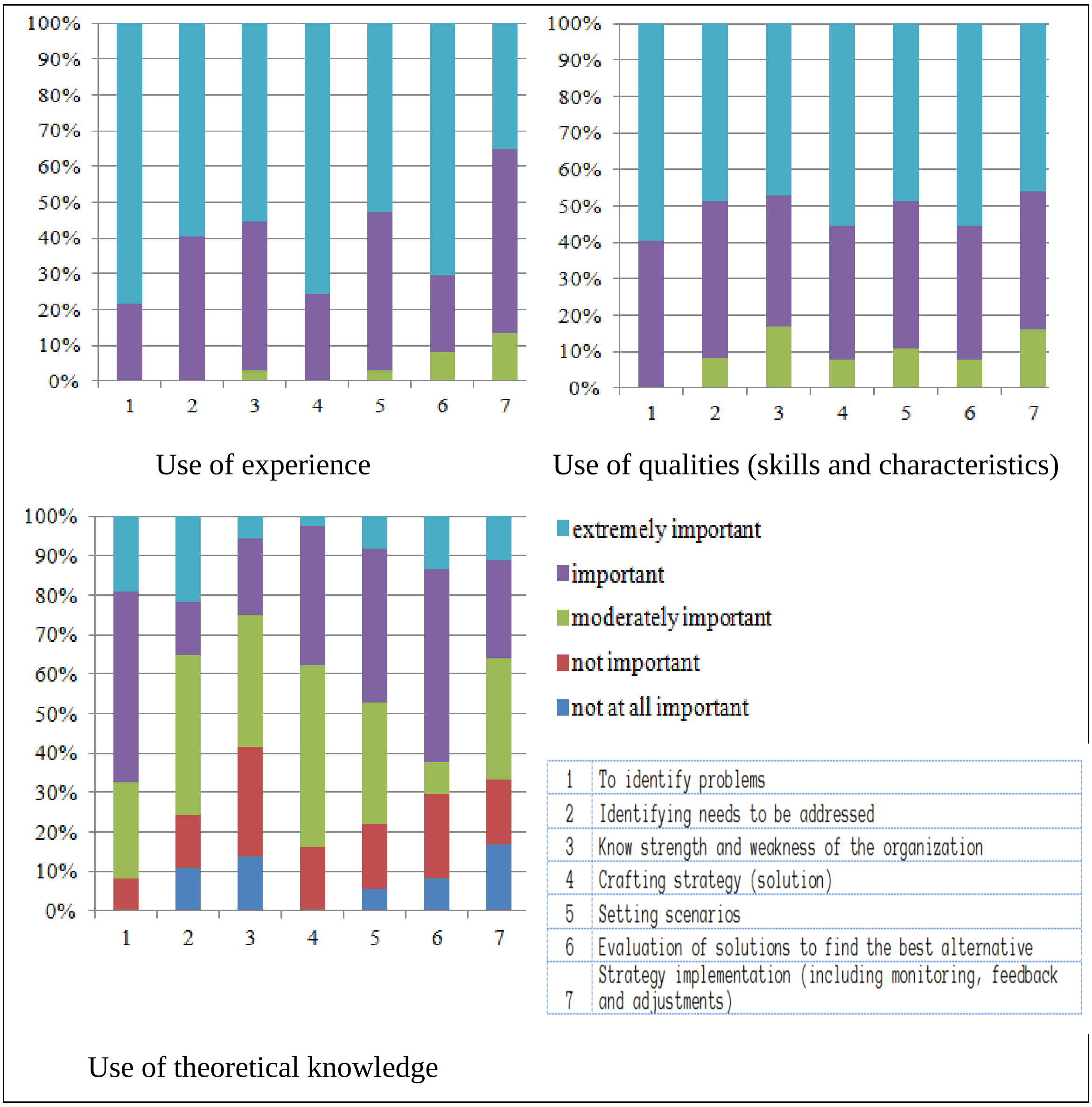


Figure 5.5: Ratings of contributions of tacit and explicit knowledge to each step of the strategy process

Table 5.30: Central tendencies of the effect of theoretical knowledge, experience, and skills and characteristics

Steps of strategy process	Central tendency (mean, median and mode)		
	Theoretical knowledge	Experience	Qualities
To identify problems	(3.78,4,4)	(4.78,5,5)	(4.59,5,5)
Identifying needs to be addressed	(3.22, 3,3)	(4.59,5,5)	(4.41,4,5)
Know strength and weakness of the organization	(2.75,3,3)	(4.53,5,5)	(4.31,4,5)
Crafting strategy (solution)	(3.24,3,3)	(4.76,5,5)	(4.46,5,5)
Setting scenarios	(3.28,4,4)	(4.50,5,5)	(4.36,4,5)
Evaluation of solutions to find the best alternative	(3.38,4,4)	(4.62,5,5)	(4.46,5,5)
Strategy implementation (including monitoring, feedback and adjustments)	(3.03,3,3)	(4.17,4,4)	(4.26,4,5)

The highest central tendency value for use of theoretical knowledge was four, and was found for median and mode of the first, fourth and fifth steps. Therefore, the influence of theoretical knowledge was high for these three steps according to the central tendencies of the sample. In the other four steps, central tendencies of the received responses were around three, which indicated that influence of theoretical knowledge is moderate. Experience and qualities had their central tendencies mostly around five, which meant that their effects on the seven steps of strategy process were rated as ‘very high’ in the sample. The least rate for experience and qualities was four which was the highest rate for use of theoretical knowledge. Having noticed this difference related to the sample responses, inferential statistics was considered to investigate the significance of different uses of theoretical knowledge, experience and qualities.

Table 5.31: Wilcoxon signed rank test results for effects of education, experience, and skills and characteristics

Steps of strategy process	Central tendency (median)
To identify problems	Education < Experience/ Qualities Experience = Qualities
Identifying needs to be addressed	Education < Experience/ Qualities Experience = Qualities
Know strength and weakness of the organization	Education < Experience/ Qualities Experience = Qualities
Crafting strategy (solution)	Education < Experience/ Qualities Experience = Qualities
Setting scenarios	Education < Experience/ Qualities Experience = Qualities
Evaluation of solutions to find the best alternative	Education < Experience/ Qualities Experience = Qualities
Strategy implementation (including monitoring, feedback and adjustments)	Education < Experience/ Qualities Experience = Qualities

To find out the different usage of theoretical knowledge, experience and qualities, seven Friedman and post-hoc Wilcoxon signed ranked tests were done for each step of the strategy process. The seven Friedman tests showed that there were differences between use of theoretical knowledge, experience and qualities in strategy process. Table 5.31 summarizes interpretations that are made through the post-hoc Wilcoxon signed ranked tests. According to the inferential statistical analysis, there was no significant difference between the use of experience and qualities at $\alpha=0.05$ level. For the seven cases, influence of theoretical knowledge was less important compared to experience and qualities.

Considering this result, the primary investigation concludes that the strategy-led approach in construction project planning requires rather the use of tacit knowledge than the use of explicit knowledge which is the verification to H8 which is mentioned in section 3.6. Therefore, by considering practitioner dependency and practitioner independency, construction project strategies are considered as predominantly derived from the characteristics of RP.

5.3.7.2 Context Independency versus Context Dependency

Traditional planning tools are criticized due to their inability to consider project context under planning (section 2.3.3.2). This study postulates that construction project strategies can assist to bring contextual variables into construction project planning, which is a characteristic of RP. This analysis investigates the validity of this postulation. Contextual variables that this study considered are value, duration, scheduling, procurement, scope, design, legitimacy and site conditions. Some of these contextual variables (such as design and site condition) emerged in the inductive analysis as the focus of construction project strategies (section 5.3.6). The participants were asked to rate their perception on influence of these contextual variables toward determining construction project strategies. The responses given by the participants for this enquiry are graphically shown in Figure 5.6.

For these responses, both descriptive and inferential statistical analyses were performed and the summary of both investigations is given in Table 5.32. The descriptive statistics of the sample indicated that construction project strategies were influenced by the contextual variables to a high extent except in the case of legitimacy where the influence was rated as moderate. Therefore, from the sample statistics, the primary investigation found that influence of project context was high toward construction project strategies mentioned in the questionnaire. The last column of Table 5.32 indicates the population median values found under non-parametric one sample test at $\alpha=0.05$ significance level.

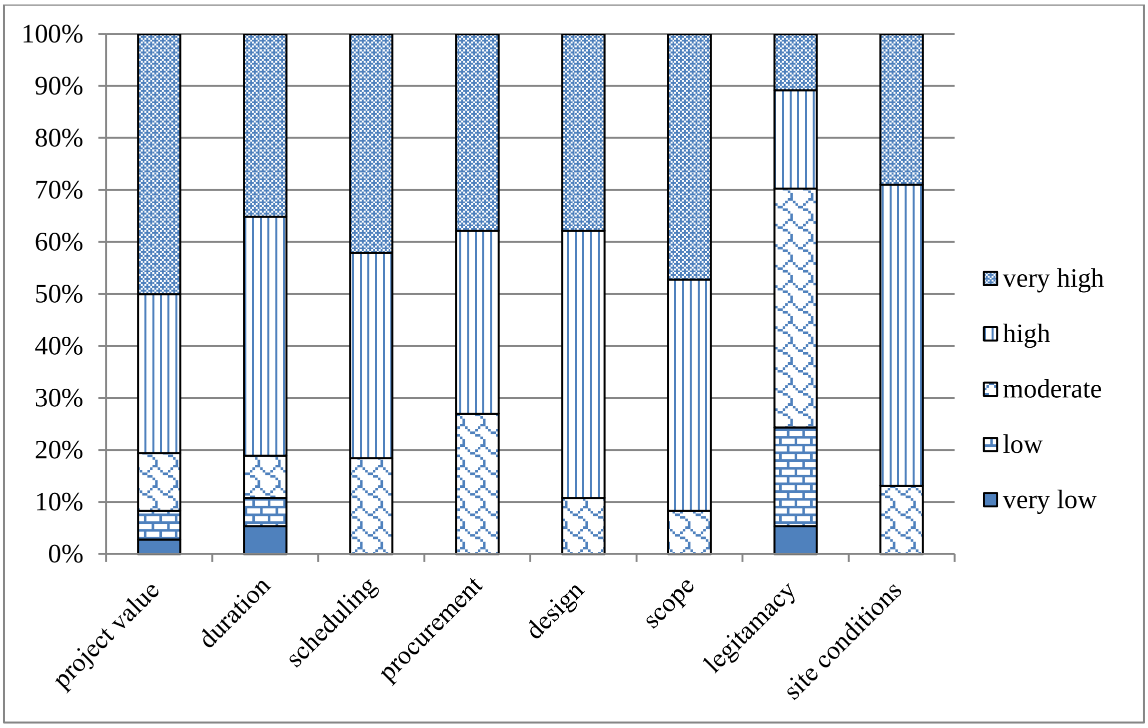


Figure 5.6: Ratings of the contextual variables toward construction project strategies

According to the population, central tendencies of scope and design of the projects influence the construction project strategies to a high or very high extent. The only variable that has moderate influence on construction project strategies is legitimacy. All other contextual variables considered under this investigation highly influence the construction project strategies. Therefore, this investigation concludes that construction project strategies are context dependent, and hence, characterized by the features of RP. This statement supports the applicability of the strategy-led approach as a complement to traditional planning tools, which are known to exclude project context for scheduling and planning. Therefore, H7 which is described in section 3.6 is validated.

Table 5.32: Influence of contextual variables toward construction project strategies

Contextual variables	**Mean**	**Median**	**Mode**	**Hypothesized median**
Project value	4.2	4.5	5	4
Project duration	4.0	4	4	4
Scheduling	4.2	4	5	4
Procurement	4.1	4	5	4
Scope	4.4	4	5	4.5
Design	4.3	4	4	4.5
Legitimacy	3.1	3	3	3
Site conditions	4.2	4	4	4

After analysing the characteristics of TR and RP in construction projects strategies, the primary investigation determined the different typologies which are suggested in past literature to craft construction project strategies.

5.3.8 Strategy Characteristics: Typologies

This section of the questionnaire (Section C of Appendix C) required the participants to provide information on the strategy making typologies they used to craft construction project strategies. The objective of this enquiry is to describe the strategy content in line with the fifth objective of the current study. The hypothetical constructs (H9, H10 & H11) tested under this section are in line with section 3.7.

Six typologies, which are generative, rational, spontaneous, deliberate, transformational and revolutionary, were used in the primary investigation. The operational definitions given to the respondents were defined in section 3.7 based on the perceptions of past scholars. These six typologies were measured by using three alternative choices: deliberate versus spontaneous, transformational versus revolutionary and rational versus generative. The responses are exhibited in Figure 5-7.

The figure shows that the data was distributed equally along upper and lower quartiles, but the upper and lower whiskers showed uneven data distributions.

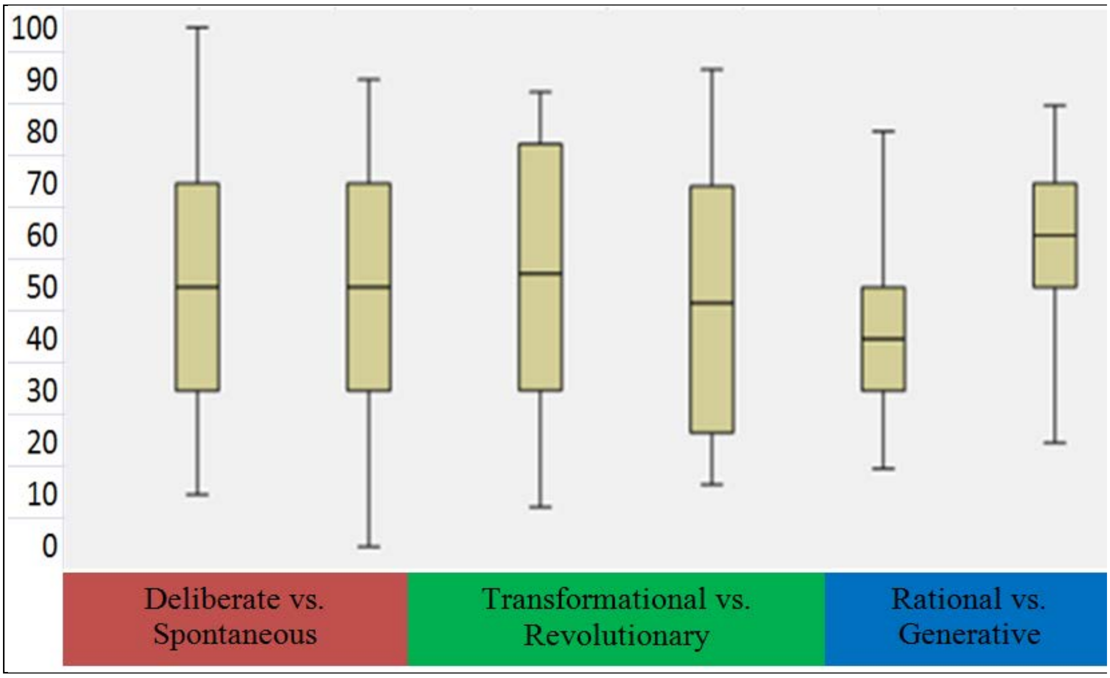


Figure 5.7: The box-plots of the 6 typologies

5.3.8.1 Descriptive Statistics for Typologies

The six data distributions were non-normal, so median and quartiles were used to describe the sample in terms of central tendency and variations. Table 5.33 summarizes the sample statistics.

Table 5.33: Descriptive statistics for the 06 strategy typologies

Statistics		Choice 1		Choice 2		Choice 3	
		Deliberate	**Spontaneous**	**Transformational**	**Revolutionary**	**Rational**	**Generative**
Mean		48.13	51.88	56.63	43.38	40.50	59.50
Median		50.00	50.00	55.00	45.00	40.00	60.00
Percentiles	25	30.00	30.00	30	20.00	30.00	50.00
	50	50.00	50.00	55.00	45.00	40.00	60.00
	75	70.00	70.00	80.00	70	50.00	70.00

For the first choice, both deliberate and spontaneous typologies showed same values for 25th, 50th and 75th percentiles. For both cases, 25% of data contained values less than 30 and 25% of data was above 70. As the difference, the maximum and minimum values of deliberate typology were 100 and 10 respectively whereas spontaneous typology had 90 and 0, respectively.

The second choice showed differences in sample statistics for its two items: transformational and revolutionary typologies. For transformational, 25% of data entities were below 30 whereas the 25% percentile of revolutionary was 20. Further, 25% of data values were above 80 for transformational and for revolutionary, 25% of data were distributed between 70 and 95.

The biggest differences were recorded for the quartiles of the third alternative choice. For rational typology, 75% of data entities were below 50 and the value was equal to the 25th percentile of generative typology. For generative methodology, 25% of data were above 70. In this case, generative typology was predominant over rational strategies according to the sample statistics.

Thus, in the sample statistics, generative typology showed significant difference over rational methodologies in use of construction project strategies. There was minor difference between use of spontaneous and deliberate strategies. Use of transformational typology was slightly more prevalent than revolutionary typology. The primary investigation used inferential statics to determine whether these observations are significant in the population.

5.3.8.2 Inferential Statistics for Typologies

The inferential statistics were applied to find out any difference in the population related to the choices considered. To select the most appropriate inferential statistics, normality checks should be done for the pair-wise difference within the each choice. Three new variables introduced by using SPSS18: 'deliberate minus spontaneous', 'revolutionary minus transformational' and 'generative minus rational'. Only one variable, 'deliberate minus spontaneous', showed normality. Consequently paired t-test was selected to evaluate the difference of means in the population. Other two distributions were non-normal and Wilcoxon signed rank test was used to evaluate the difference of medians in the population. The null hypotheses and alternative hypotheses were set as follows:

H0: $\mu_{difference} = 0$ (parametric) or $M_{difference} = 0$ (non-parametric)
H1: $\mu_{difference} \neq 0$ (parametric) or $M_{difference} \neq 0$ (non-parametric),
Where μ= mean and M=median

Table 5.34 shows the results of the paired t-test results for deliberate and spontaneous typologies. Since the level of significance was 0.619 (> 0.05) the null hypothesis could not be rejected consequently the mean values of spontaneous and deliberate typologies were equal in the population. Therefore, both deliberate and spontaneous strategies were equally used in the construction projects to craft project strategies.

Table 5.34: Paired t-test for deliberate and spontaneous strategies

		Paired Differences					**t**	**df**	**Sig. (2-tailed)**
		Mean	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval of the Difference**				
					Lower	**Upper**			
Pair 1	Deliberate spontaneous	-3.750	47.268	7.474	-18.867	11.367	-.502	39	.619

Table 5.35 and Table 5.36 show the results of Wilcoxon signed rank test for the remaining two alternatives. For 'revolutionary minus transformational', Table 5.36 indicates that the level of significance was 0.06 consequently, the null hypothesis could not be rejected at α=0.05 significance level. Thus, the median values of revolutionary and transformational typologies were similar in the population. The concluding remark is that both transformational and revolutionary typologies are equally important to construction project planning. Therefore, construction project implementation strategies can remain unchanged or changed frequently

Table 5.35: Wilcoxon signed ranks test for revolutionary – transformational and generative – rational (ranks)

		N	Mean Rank	Sum of Ranks
Revolutionary - transformational	Negative ranks	20	21.43	428.50
	Positive ranks	15	13.43	201.50
	Ties	5		
	Total	40		
Generative - rational	Negative ranks	4	11.00	44.00
	Positive ranks	23	14.52	334.00
	Ties	13		
	Total	40		

Table 5.36: Wilcoxon signed ranks test for revolutionary – transformational and generative – rational (Z and significance)

	Revolutionary - transformational	Generative – rational
Z	-1.880	-3.527
Asymp. Sig. (2-tailed)	.060	.000

This is supported by the sample statistics shown in the box-plot, where 'generative – rational' had a clear difference between negative and positive ranks (4 versus 23). Further, the level of significance was 0.000 and hence the null hypothesis could be rejected at α=0.05 significance level. Having greater central tendency value and more positive ranks compared to rational typology, it could be seen that generative typology dominated over rational typology in construction project planning strategies. Therefore, use of explicit knowledge that comes from experience and skills was more important than theoretical knowledge to craft construction project strategies. To clarify this, use of historical data with probabilistic rigours is considered under rational typology whereas use of historical data from the experience of a similar project scope is considered under generative typology.

Considering the findings of these three inferential statistics, tested hypotheses and inferences made are summarized in Table 5.37.

Table 5.37: Interpretation on H9, H10 & H11

Related Hypothesis		**Inference**
H9	Generative typology is more common in construction project implementation strategies over rational typology	**Supported.**
H10	Deliberate typology is more common in construction project implementation strategies over spontaneous typology	Not supported. Both typologies are used equally.
H11	Transformational typology is more common in construction project implementation strategies over revolutionary typology	Not supported. Both typologies are used equally.

5.3.9 Who Makes Strategy: Stakeholder Contribution

This analysis is related to the research enquiries that are used to achieve the fifth objective of this research study. In this section, the primary investigation focuses on the contributions of stakeholders toward strategy crafting and implementation. There are three sub analysis described under this section: bottom up versus individual strategy making, stakeholder contribution toward construction project strategies and how stakeholders are integrated into construction project strategies.

5.3.9.1 Bottom Up versus Individual Strategy Making

The related hypothesis of this analysis is H12 which is described in section 3.8 with the operational definitions set for 'bottom up' and 'individual' strategy making. This section measures how strategies were crafted with respect to the construction project manager's involvement. In 'individual' strategy making, construction project managers craft strategies without integrating other stakeholders, whereas in 'bottom-up' strategy making, other stakeholders are integrated in deciding on strategic directions. The participants were asked to rate contributions from bottom-up (P) and individual (100-P) strategy making procedures such that the total contribution would become 100%. The responses to the enquiry are given in Table 5.38.

Table 5.38: Responses for 'individual strategy making and bottom-up strategy making

Individual strategy making	:	Bottom-up strategy making	Number of projects	%
0	:	100	0	*0*
10	:	90	6	*15*
20	:	80	9	*22.5*
30	:	70	6	*15*
40	:	60	8	*20*
50	:	50	1	*2.5*
60	:	40	1	*2.5*
65	:	35	1	*2.5*
70	:	30	2	*5*
75	:	25	2	*5*
80	:	20	1	*2.5*
85	:	15	1	*2.5*
100	:	0	2	*5*
		Total	*40*	*100*

According to the sample statistics of the two data distributions, 'individual' strategy making had mean, median and mode values of 40, 30 and 20, respectively. 'Bottom-up' strategies had 60, 70 and 80 as mean, median and mode, correspondingly (Table 5.39). All central tendencies were above 60 for 'bottom-up' strategy making whereas 'individual' strategy making had values below 40 for the central tendencies. Therefore, according to the central tendencies of the sample, the construction project managers crafted strategies more by integrating with other stakeholders. An inferential statistical analysis was performed to evaluate whether there was a significant difference between these strategy making methods in the population of the primary investigation.

Table 5.39: Central tendencies related to individual and bottom up strategies

		Individual	Bottom-up
Mean		40.00	60.00
Median		30.00	70.00
Mode		20	80
Percentiles	25	20.00	45.00
	50	30.00	70.00
	75	55.00	80.00

The distribution for pair wise difference (bottom-up – individual) was non-normal and hence non-parametric Wilcoxon signed rank test was selected to test the null hypothesis that 'median values of bottom-up and individual strategy making are equal'. In 29 cases, bottom up strategy making was predominant over individual strategy making whereas individual strategy making showed more contribution in 10 cases only (Table 5.40). According to Table 5.41, the level of significance was 0.015 and the null hypothesis of the test could be rejected.

Therefore, in the population, the median value of 'bottom-up' strategy making was higher than 'individual' strategy making. Therefore, the study concluded that construction project managers are crafting project implementation strategies more by integrating other stakeholders into the strategy making process. Having observed that other stakeholders are important to craft construction project strategies, the primary investigation considered other stakeholders' contribution into strategy making.

Table 5.40: Wilcoxon signed rank test related to individual and bottom up strategies (rank)

		N	Mean rank	Sum of ranks
Bottom-up - individual	Negative ranks	10	21.65	216.50
	Positive ranks	29	19.43	563.50
	Ties	1		
	Total	40		

Table 5.41: Wilcoxon signed rank test related to individual and bottom up strategies (Z value and significance)

	Bottom-up - individual
Z	-2.433
Asymp. sig. (2-tailed)	.015

5.3.9.2 Stakeholders' Contribution toward Strategy Crafting and Implementation

The purpose of finding out contributions of each strategy was to compare the importance of stakeholders toward strategy-led approaches. The construction managers provided information on each other's contribution toward strategy crafting as well as implementation together. The responses given by the participants are shown in Figure 5.8.

In the sample data, both contributions of construction project manager and client were rated either 'extremely important' or 'important'. Contributions of site managers, site engineers, sub-contractors and foremen were rated between moderately important to extremely important. Consultant's contribution had rated unimportant in 4% of the construction projects of the sample. According to the sample data given by the respondents, top management and labours' contributions were the least important. From the sample data, it could be seen that there were differences between each stakeholder's contributions. To investigate the significance of the differences of stakeholder contribution in the population, inferential statistical tests were done.

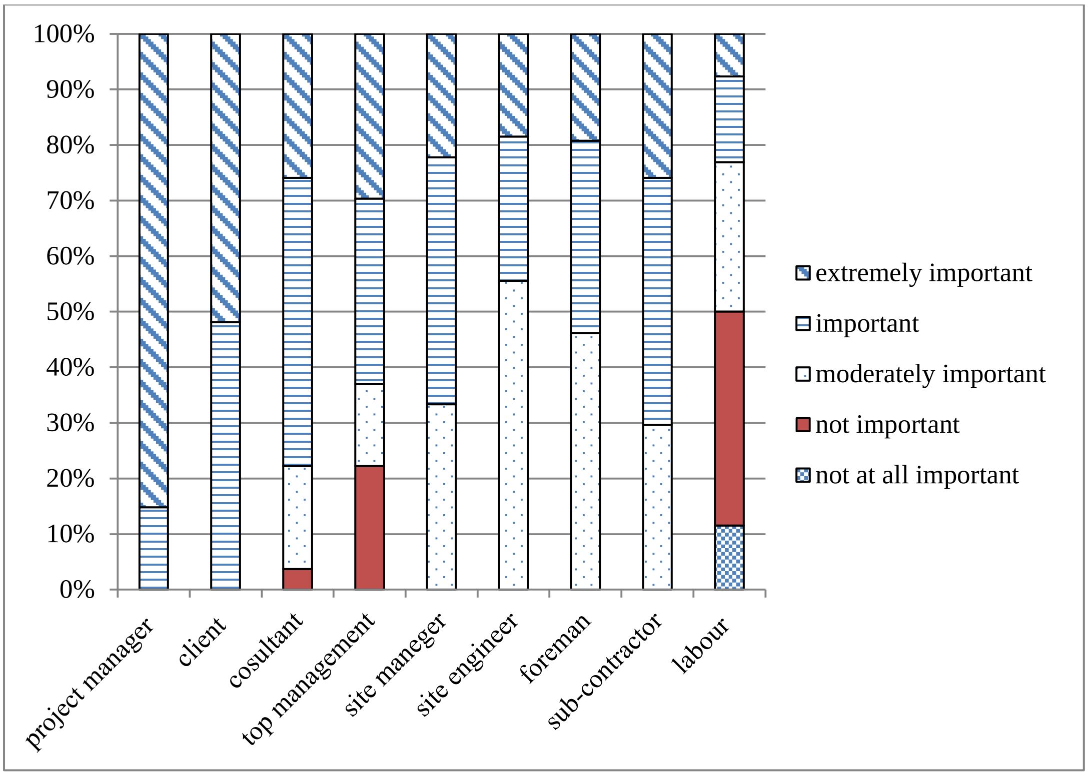


Figure 5.8: Rating of the stakeholder contribution

Since there were nine stakeholders, their contributions could be compared by using ANOVA. However, since the data distributions were non-normal, the non-parametric alternative of ANOVA test, Friedman test, was performed. The null hypothesis was set as 'there was no difference between stakeholder contributions'. The Friedman test statistics gave level of significance as 0.000 (<0.05) at $\chi^2(8) = 93.93$. Therefore, the null hypothesis could be rejected, and, consequently, there was a difference among stakeholders' contributions. From the Friedman test alone, it was not possible to determine where those differences occurred. For that, Wilcoxon ranked sign test was done as a post-hoc test.

Table 5.42: Comparison of stakeholder contribution with PM's contribution

	Client - PM	**Consultant - PM**	**Top Mgmt. - PM**	**Site Mgmt. - PM**	**Site Eng – PM**	**Foreman - PM**	**Sub Cont. - PM**	**Labour - PM**
Z	-2.324	-3.906	-3.581	-3.729	-4.034	-3.849	-3.619	-4.177
Asymp.	.020	.000	.000	.000	.000	.000	.000	.000

Project manager's (PM) contribution was considered as the point of reference to compare others' contributions. The null hypotheses were set for each stakeholder type that 'there was no difference in contribution to construction project strategies compared to the construction project manager's contribution'. Since, the test involve 8 comparisons, Bonferroni correction was applied to the accepted level of significance (α=0.05) to eliminate type I error. To apply the correction, the level of significance of this study, which is α=0.05, was divided from number of comparisons (08) and hence $\alpha_{modified}$ was 0.006 to the hypothesis testing.

Table 5.42 showed that level of significance was higher than $\alpha_{modified}$ (=0.006) only for one case: client-PM (Asymp. sig. of 0.02). The null hypothesis related to the client's contribution could not be rejected. Therefore, both construction project managers and client are equally important to craft and implement construction project strategies. All other stakeholders are less important than the project manager toward strategy crafting and implementation in construction projects. Therefore, developing the strategy-led approach by focusing on the construction project manager is considered suitable.

Further, the central tendencies related to the population were evaluated by using non-parametric Wilcoxon signed rank test. In this way, the primary investigation could find the importance of each stakeholder to craft and implement project strategies with respect to the population of the primary investigation.

Table 5.43: Comparison of stakeholder contribution with hypothesized median values

Stakeholder	**Population median at α=0.05**	**Remarks**
Project manager	5	Extremely important
Client	4.75	Extremely important
Consultant	4	Highly important
Top management	4	Highly important
Sit management	4	Highly important
Site engineer	3.5	Highly important to moderately important
Foreman	4	Highly important
Sub-contractor	4	Highly important
Labour	3	Moderately important

The median values of the population are shown in Table 5.43. The least median value was found for labour and which was three at α=0.05 level. Therefore, the least important stakeholder is at least 'moderately important' to the strategy-led approach. Site engineers were the second least important party, having rated between 'moderately important' to 'highly important'. Construction project managers and clients are extremely important to craft and implement strategies at the project implementation level.

Having found that other stakeholders are important to construction project strategies, the primary investigation investigated how construction project managers could integrate others into the strategy-led approach.

5.3.9.3 How Stakeholders are integrated into Construction Project Strategies

Determining stakeholder integration to the strategy-led approach is another analysis performed to achieve the fifth objective of this research study, which is to propose strategy-led approach as a suitable planning approach to implement construction projects.

The participants of the questionnaire survey rated their agreement to use six project integration methods toward the construction project strategies by using a Likert scale of 1 to 5. These six integration methods are vision, mission, transact with stakeholders to decide strategic direction, learn and improve, experiment and risk taking, and responsibilities benchmarked against performance. A graphical representation to the responses is given in Figure 5.9.

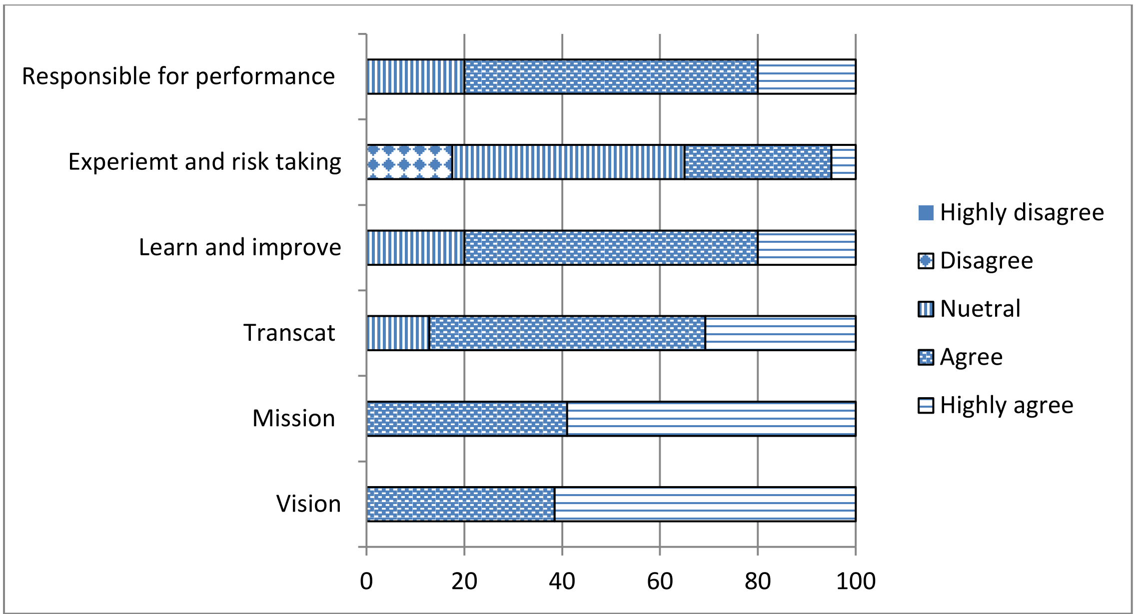


Figure 5.9: Rating to integration method in a strategy context

According to Figure 5.9, 'vision' and 'mission' were almost equally rated the highest. Every participant rated these two criteria as 'agree' (40%) or 'highly agree' (60%) to engage stakeholders into their strategies. These two engagement politics were followed by 'transact with stakeholders to decide strategic direction' by having the least rating as 'neutral' (13%) while 87% of the participants agreed or highly agreed to use this integration method. 'Learn and improve' and 'responsible for performance benchmarking' were rated at the 4th place; the majority (60%) of the participants agreed to use these two integration politics. 20% of the participants highly agreed to use these two methods while another 20% of the participants were 'neutral'. 'Experiment and risk taking' showed a different behaviour to other five methods by having 17.5% of the participants disagree to use this method. According to the graphical representation of the responses given in Figure 5.9, the agreements to use these six methods to integrate stakeholders into the strategy-led approach were different. The study investigated whether these differences were significant in the population.

Since the data distributions were non-normal, non-parametric Friedman test was used to test the null hypothesis that 'there is no difference between the agreements to use these six methods to integrate stakeholders into the strategy-led approach'. The level of significance was 0.000 for $\chi^2(5) = 87.11$ and hence null hypothesis could be rejected. Therefore, to integrate stakeholders into strategy crafting and implementation, construction project managers have different levels of agreements on these six methods.

Wilcoxon ranked sign test was done as a post-hoc test to investigate where the differences of agreements existed by using 'vision' as the point of reference. The results are shown in Table 5.44. According to the results, there was no difference between use of vision and mission at $\alpha=0.05$ significance level. Thus, the study concludes that vision and mission are equally used by construction project managers to integrate other stakeholders into project implementation strategies. Compared to use of vision and mission, there is less agreement of using the remaining four methods in crafting and implementing construction project strategies.

Table 5.44: Wilcoxon signed rank test of project politics

	Mission - vision	**Transact with stakeholders to decide strategic direction - vision**	**Learn and improve - vision**	**Experiment and risk taking - vision**	**Responsible for performance benchmarking - vision**
Z	-.277	-3.368[a]	-4.044	-5.048	-3.933
Asymp. sig. (2-tailed)	.782	.001	.000	.000	.000

To find out the central tendencies of these six integration methods in the population, non-parametric t-test was done at α=0.05 level. The median was considered as the most appropriate measure of central tendency due to non-normality.

Table 5.45: Comparison of politics with hypothesized median values

Stakeholder	**Population median at α=0.05**	**Remarks**
Vision	4.5	Agree to highly agree
Mission	4.5	Agree to highly agree
Transact with stakeholders to decide strategic direction	4	Agree
Learn and improve	4	Agree
Experiment and risk taking	3	Neutral
Responsible for performance benchmarking	4	Agree

According to the results shown in Table 5.45, construction project managers agree or highly agree to use 'vision' and 'mission' to integrate other stakeholders into the strategy-led approach. Construction project managers agree to use 'transact with stakeholders', 'learn and improve' and 'responsibility for performance benchmarked' to integrate other stakeholders to craft and implement strategies. Construction manger's average perception to use 'experiment and risk taking' as an integration method is neutral.

At the end of this analysis, the primary investigation could find the suitability of construction project managers to develop the strategy-led approach by focusing as the most important stakeholder. The client is similarly important to implement construction projects through the strategy-led approach. Labour is only moderately important to craft and implement construction project strategies whereas other stakeholders' contributions are important. To integrate other stakeholders, construction project managers use vision and mission as the most important methods while risk taking has a neutral perception to use in the strategy-led approach.

The hypotheses related to these analyses are summarized in line with section 3.2 of the development of the theoretical framework.

Table 5.46: Interpretation on H12, H13 & H14

Related Hypothesis			Inference
H12: Bottom-up strategy making is the dominant strategy making methodology in construction project implementation strategies.			Supported
H13	H13a	The construction project manager is more important than client to craft and implement construction project strategies	**Not supported. Both are 'very high' important.**
	H13b	The construction project manager is more important than consultant to craft and implement construction project strategies	Supported
	H13c	The construction project manager is more important than Top managers to craft and implement construction project strategies	Supported
	H13d	The construction project manager is more important than site managers to craft and implement construction project strategies	Supported
	H13e	The construction project manager is more important than site engineers to craft and implement construction project strategies	Supported
	H13f	The construction project manager is more important than foremen to craft and implement construction project strategies	Supported
	H13g	The construction project manager is more important than sub-contractor to craft and implement construction project strategies	Supported
	H13h	The construction project manager is more important than labours to craft and implement construction project strategies	Supported
H14	H14a	'Vision' is more agreeable to use than 'mission'	**Not supported Both are 'agreeable' to 'very high agreeable'**
	H14b	'Vision' is more agreeable to use than 'transact with stakeholders to decide strategic direction'	Supported
	H14c	'Vision' is more agreeable to use than 'responsibilities assigned against benchmarked performance'	Supported
	H14d	'Vision' is more agreeable to use than 'learn and improve'	Supported
	H14e	'Vision' is more agreeable to use than 'experiment and risk taking '	Supported

5.3.10 Timing of Strategy: Crafting Strategies at the Conceptual and Implementation Stages

The purpose of this analysis is to investigate the strategy-led approach through the involvement of construction project managers by considering the conceptual and implementation stages of projects. Crafting strategies at the conceptual level emphasizes the importance of early development strategies; strategy making at the implementation stage encourages construction project managers to utilize the strategy-led approach to plan projects at the implementation stage. The participants were requested to provide information on the following questions (Appendix C).

- Did construction managers craft strategies at the conceptual stage?
- Were their strategies at the implementation stage emerging through option analysis and workshops?
- Were the conceptual strategies replaced later through the emerging strategies?
- Were there sub-strategies to support the main strategy?

100% of the participants answered ‘yes’ for the first question whether main strategies were made under the conceptual stage (Table 5.47). 38% of the participants answered as ‘yes’ for the second enquiry. From the participants of the questionnaire, 90% of the respondents said that the strategies they made at the conceptual stage remained as the main strategy throughout the project. 100% of them used sub-strategies to support the main strategies crafted under their projects.

Table 5.47: Strategy making under conceptual and implementation stages

Question	**P**	**t x SE**	**upper limit**	**lower limit**
Are strategies made at conceptual stage? (yes)	1.00	0.00	1.00	1.00
Are strategies made during implementation stage (which can work as main strategy level)? (yes)	0.38	0.15	0.53	0.24
Are conceptual strategies replaced? (no)	0.90	0.09	0.99	0.80
Sub-strategies are used? (yes)	1.00	0.00	1.00	1.00

To generalize these responses to the population at 95% confidence level, critical t value was calculated by using t-distribution table. For 38 degree of freedom and 95% confidence level, $t_{0.05}$ is 2.024. The standard deviations of the sample mean were calculated and ($t_{0.05}$ x σ_x) values are shown in Table 5.47. Based on these parameters, upper and lower limits are calculated to the responses in the population.

According to the findings at α=0.05 significance level, construction project managers involved in early development of strategies at the conceptual stage of construction projects. There is a probability between 24% and 53% for emerging main strategies at the implementation stage. There is 80% to 99% potential for the conceptual strategies to remain as the major strategy throughout project implementation. Use of sub-strategies to support main strategies is usual in construction project implementation.

With this investigation, the objective of evaluating the strategy-led approach in terms of three dimensions was achieved within the scope of this research study.

5.3.11 Influence of Strategies toward Critical Success Factors

Traditional planning tools aim to improve construction project implementation through the development of scheduling tools, but there are many concerns beyond the planning tools contributing to the success of a construction project (Belassi and Tukel, 1996). This research study believes that construction project strategies can influence toward construction project implementation as a whole. Thus, this investigation considers the suitability of construction project strategies to influence construction project implementation as a whole to achieve one of the objectives to propose the strategy-led approach as a suitable planning approach.

To represent the scope of construction project planning, the primary investigation considered 35 critical success factors which are found from literature and the preliminary analysis of this study by using an inductive analysis (section5.2.5). The participants were asked to rate the influence of strategies on these critical success factors by using a 1-10 scale as described in section 3.9. The analysis included both descriptive and inferential statistics.

Except in six cases, data distributions of the critical success factors were non-normally distributed. These six cases were coping with legal/statutory requirements, minimizing delays and errors in the design documents, reducing test time for samples, getting top management support, coping with low efficiencies of plants and minimizing weather uncertainties (Appendix E12). Since more than 80% of the variables were non-normally distributed, all the critical factors were considered as non-specific distributions consequently, median and quartiles were considered as the most appropriate distribution parameters.

After descriptive statistics were calculated in SPSS18, the result was imported to an MS Excel spreadsheet. Thereafter, the information was sorted by considering the central tendency and variance (25^{th} and 75^{th} percentiles).

First, the information was sorted by the 75^{th} percentile and then followed by 50^{th} (median) and 25^{th} percentiles. The sorting was done from the largest to smallest. In this way, it was possible to find out the top most influenced critical success factors related to all measures. These critical success factors were divided into several groups according to median values. A summary of the analysis is given in Table 5.48.

Table 5.48: Descriptive statistics of strategy influence on critical success factors

Critical success factors	**Mean**	**Median**	**Mode**	**25th**	**50th**	**75th**
Improving schedules and plans	8.5	9	9	8	9	10
Better handling of design complexities	8.7	9	9	8	9	10
Setting clear objectives	8.9	9	9	8	9	9.5
Improving communication	8.7	9	9	8	9	9
Speeding up decision making	8.7	9	9	8	9	9
Dealing with client's characteristics	8.4	9	8	8	9	9
Improving site management and supervision	8.5	9	9	8	9	9
Minimizing material shortages	8.3	9	9	8	9	9
Coping with necessary variations	8.2	9	9	7.5	9	9
Coping with site conditions	8.3	8.5	9	8	8.5	9
Minimizing political issues	8.3	8.5	9	7	8.5	9
Minimizing delays and errors in design documents	8.3	8	8	8	8	9
Smoothing work with sub-contractors	8.4	8	8	8	8	9
Deciding on off-site prefabrication	8.3	8	8	8	8	9
Ensuring feedback and monitoring	8.1	8	8	7	8	9
Developing project organizational structure	7.9	8	8	7	8	9
Coping with material changes	8.0	8	9	7	8	9
Effective use of technology	7.5	8	9	6	8	9
Getting lower cadres' support	7.5	8	9	6	8	9
Minimizing economic issues	7.6	8	8	6	8	9
Handling labour shortages	7.8	8	8	7	8	9
Handling unforeseen ground conditions	7.6	8	7	7	8	8
Ensuring contractor's cash flow	7.8	8	8	7	8	8
Getting top management support	7.4	8	8	7	8	8
Minimizing social issues	7.7	8	8	7	8	8
Improving project finance from client	7.3	8	8	6	8	8
Overall effect toward critical success factors	***7.7***	***7.7***	***7.5***	***-****	***-****	***-****
Coping with low skill levels	7.2	7.5	8	6	7.5	8
Coping with estimation errors	7.3	7	7	7	7	8
Coping with legal/statutory requirements	7.3	7	7	6	7	8
Reducing waiting time for test samples	7.0	7	7	6	7	8
Handling plant shortages	7.0	7	7	6	7	8
Avoiding wrong selection of plants	6.9	7	7	6	7	8
Minimizing weather uncertainties	7.2	7	7	6	7	8
Coping with low efficiency of plants	6.3	6	6	5.5	6	7
Coping with plant breakdown	6.1	6	6	5	6	7

*because of normality, standard deviation was used to measure variance

There were nine critical success factors (nearly 25%), for which the median of strategy influence was rated as nine out of 10 (green region of Table 5.48). Among these factors, the top two third belonged to the ‘project related’ category of the questionnaire. Out of 10 project related factors used in the primary investigation, 60% of them were rated here. There were two other factors belonging to the ‘organizational’ category and one factor related to ‘resources’, for which the median values were nine. All the factors except ‘coping with variations’ had at least 75% of responses rating the influence of strategies as ‘very high’ ($\geq$ 8).

The factors, for which the central tendencies were rated 8.5, are ‘coping with site conditions’ (project related) and ‘minimizing political issues’ (external related). The first and second factors had 75% and 50% of data entities respectively which were rated as ‘very highly’ influenced from strategies.

To the next, the factors had central tendencies as eight were considered (blue region of Table 5.48). There were 15 (43%) factors under this category and nearly 50% of them were ‘organizational’ factors. There were three ‘project’ related and ‘organizational’ factors per each while there were two factors belonging to ‘external’. All other factors of this category had at least 75% of values rated as highly or very highly influenced from strategies.

It was therefore apparent that nearly 75% of 35 critical success factors were influenced very highly ($\geq$ 8) from construction project implementation strategies according to their central tendencies of the sample data.

The overall effect of strategies toward 35 critical factors was rated next. All the central tendencies of the overall effect of strategies were about 7.5. Since the distribution for the overall effect was normal, standard deviation was calculated to measure variance as opposed to quartiles. Having a standard deviation of 0.781, the 95% interval was (6.2, 9.2). By looking at the frequency distribution, only one project (2.5%) had overall effect rated below 6. Therefore, 97.5% of projects in the sample were highly or very highly influenced from construction project implementation strategies, if the overall influence on the critical success factors is considered.

In the sample, there were nine variables rated below the overall influence of strategies. Nearly 50% of them were material related factors. Although these nine factors were rated lowest, the first seven factors still had 25% data entities stating to be ‘very highly’ influenced. Further, for these seven factors, only 25% of data entities were rated below ‘highly’ influenced (< 6). The least influenced two factors had only 50% of data entities rated in the ‘high’ region. Therefore, as an overall observation, in the sample strategies had influenced the 35 critical success factors highly. With this, influence of strategies was considered in the population through inferential statistical analysis.

Overall influence of construction project strategies toward the 35 critical success factors was considered under the inferential statistics to test H15 set in section 3.9. Since overall influence of strategies was non-normally distributed, parametric one sample test was done to determine the mean value of overall influence of strategies. By looking at the sample mean (7.7), the population mean were null hypothesized as $\mu = 7.5$.

One sample t-test showed that the level of significance was 0.174 (> 0.05) with $t = 1.386$ and 39 degree of freedom. Therefore the null hypothesis could not be rejected. Hence, the study came to the conclusion that the overall effect of strategies toward critical success factors was rated as 7.5 in the population. According to the scale used, overall strategy influence was rated on the upper fraction of the ‘high’ region.

As the concluding remark to the analysis, construction project strategies have a high influence on critical success factors, which contribute to project success. Therefore, while improving schedules and plans, construction project strategies can improve other factors that traditional planning tools do not address. This observation is considered as another fact to corroborate that the strategy-led approach is a suitable planning approach to plan and implement construction projects.

5.3.12 Correlation between Strategies and the Characteristics of Construction Projects

In section 5.3.4, the primary investigation evaluated the four characterises of construction projects (complexity, dynamism, uncertainty and uniqueness) within the contexts of the construction projects of the population of this study. In past literature, these four characteristics are considered as barriers to plan construction projects by traditional planning algorithms. Based on reviews of past literature, this study postulated that construction project strategies can cope with these four project characteristics. The preliminary analysis of this study as well as the content analysis of this primary investigation described under section 5.3.6.2 showed that strategies were used to cope with these four characteristics. This section of the primary investigation investigates any relationship between the four project characteristics and construction project strategies quantitatively. To measure influence of strategies, the study used the 35 critical factors which are given in Table 5.5 under the preliminary investigation. The primary investigation used correlation analysis to test hypothesis (H16 mentioned in section 3.10) which had been set as follows:

$H_{0:}$ There is no significant linear correlation between influence of strategies and the project characteristics ($r = 0$)

H_1: There is a significant linear relationship between influence of strategies and the project characteristics ($r \neq 0$)

The analysis was done by using SPSS 18, and Spearman correlations were found between the contingency variables and the influences of strategies toward critical success factors (Table 5.49). Spearmen correlation was used as opposed to Pearson correlation because variables related to influence of strategies toward critical success factors were non-normally distributed. At α=0.05 significance level, some of these two kinds of variables showed significant positive relationships toward each other as mentioned in Table 5.49. Inference is made in the Table to H16 which assumes that '*When the extent of the characteristics of a construction project increase, the influence of strategies on project planning and implementation increase'*.
Complexity showed significant positive correlations at α=0.05 with nine variables related to the critical success factors. It had the highest and the second highest correlations toward 'improve schedules and plans' (0.719) and 'better handling design complexities' (.496), respectively. Similarly, dynamism showed significant correlation at α=0.05 with 10 variables, having its highest and second correlations toward 'coping with necessary variations' (0.627) and 'ensuring feedback and monitoring' (0.511). Further, uncertainty had its correlation significantly at α=0.05 with 10 variables. The highest and the second highest correlation occurred with 'improve schedules and plans' (0.546) and 'minimizing economic issues' (0.512), respectively. Finally, uniqueness had significant correlations with seven variables at α=0.05, having its highest and the second highest correlations toward 'improve schedules and plans' and 'effective use of technology' which were 0.612 and 0.556, respectively. Further, Table 5.49 shows that 21 out of 35 critical success factors (60%) correlated with at least one of the project characteristics at α=0.05 significance level.

By considering these positive correlations, this study concludes that influence of strategies toward critical success factors increases when complexity, dynamism, uncertainty and uniqueness become higher. Thus, construction project strategies can assist to solve problems under complex and uncertain situations by improving planning and implementation. This finding is considered as another fact to support the strategy-led approach as a suitable planning approach for construction project implementation.

Table 5.49: Spearman correlations between the project characteristics and the influence of strategies toward critical success factors

Strategy influence on success factors	**Inference to H16**			
	Complexity	Dynamism	Uncertainty	Uniqueness
Coping with necessary variations	**Supported r=0.358**	**Supported r=0.627**	**Supported r=0.366**	Not supported
Improving communication	Not supported	Not supported	Not supported	Not supported
Speeding up decision making	Not supported	Not supported	**Supported r=0.332**	Not supported
Handling unforeseen ground conditions	Not supported	Not supported	**Supported r=0.344**	Not supported
Improving schedules and plans	**supported r=0.719**	Not supported	**Supported r=0.546**	**Supported r=0.612**
Coping with legal/statutory requirements	**Supported r=0.327**	Not supported	Not supported	Not supported
Ensuring feedback and monitoring	Not supported	**Supported r=0.511**	**Supported r=0.384**	Not supported
Better handling of design complexities	**Supported r=0.496**	**Supported r=0.380**	**Supported r=0.336**	Not supported
Coping with estimation errors	Not supported	**Supported r=0.379**	**Supported r=0.377**	**Supported r=0.509**
Effective use of technology	Not supported	Not supported	Not supported	**Supported r=0.557**
Dealing with client's characteristics	**Supported r=0.333**	**Supported r=0.388**	**Supported r=0.436**	Not supported
Improving project finance from client	Not supported	**Supported r=0.472**	Not supported	Not supported
Getting top management support	Not supported	**Supported r=0.384**	Not supported	**Supported r=0.539**
Developing project organizational structure	Not supported	**Supported r=0.322**	Not supported	Supported
Getting lower cadres' support	Not supported	Not supported	Not supported	**Supported r=.0443**
Minimizing material shortages	**Supported r=0.328**	Not supported	Not supported	Not supported
Coping with low skill levels	**Supported r=0.398**	Not supported	Not supported	Not supported
Handling plant shortages	Not supported	Not supported	**Supported r=0.363**	Not supported
Minimizing political issues	**Supported r=0.466**	**Supported r=0.336**	Supported	**Supported r=0.509**
Minimizing economic issues	Not supported	**Supported r=0.372**	**Supported r=0.512**	**Supported r=0.328**
Minimizing social issues	Supported r=0.466	Not supported	Not supported	Not supported
Overall influence	**Supported r=0.537**	**Supported r=0.322**	**Supported r=0.444**	**Supported r=0.509**

Finally, the primary investigation performs one of its main analyses to achieve the fourth objective of this research study: quantify the influence of construction project strategies toward success in terms of cost, time, quality, client satisfaction and overall success.

5.3.13 Interrelation between the Characteristics of Projects, Influence of Strategies and Project Success

This analysis was performed in line with section 3.11 of the development of the theoretical framework. The four project characteristics, complexity, dynamism, uncertainty and uniqueness, influence construction project success negatively (section 2.2), whereas construction project strategies can influence success positively. This analysis of the primary investigation performed a regression analysis between success, project characteristics and influences of strategies on critical success factors.

The independent variables of the regression analyses were 35 variables related to influence of strategies toward critical success factors and the four project characteristics. Achievements of cost, time, quality, client satisfaction and overall success are used as the dependent variables. From this analysis, one can understand the behaviour of project success under complex and uncertain situations if the project is planned through the strategy-led approach. To make mathematical models between the three variables, SPSS 18 was used.

The analysis procedure involved four steps:

- To examine the variables of project characteristics to ensure their suitability as the independent variables in multiple regression analysis.
- To evaluate the suitability of 35 critical success factors, which are used to measure the influence of strategies, to serve as the independent variables in the multiple regression analysis.
- To assess the suitability of the success parameters to work as the dependent variables in multiple regression analysis.
- To analyse the dependent variables and independent variables together to construct models.

Since the accuracy of the regression analysis is highly influenced by the degree of satisfaction of its assumptions, normal distribution and multi-collinearity were considered thoroughly for both dependent and independent variables. Neither of the two requirements was met, variables were considered as inappropriate for the regression analysis. Under such circumstances, transformation of the original variables was done by using diverse methods. These analyses are described in detail under the following sub-sections.

5.3.13.1 Determine the Suitability of Variables of Project Characteristics

There were four variables considered to represent the characteristics of a construction project: complexity, dynamism, uncertainty and uniqueness. In section 5.3.4.1, normality was checked for the four variables. Therefore, under this section, only multi-collinearity was considered. SPSS 18 was used to check multi-collinearity among the four variables.

For this purpose, a regression analysis was done between the four variables. For the regression model, 'complexity' was used as the dependent variable and the remaining three variables were set as the independent variables. The two collinearity statistics tolerance and VIF were calculated by using SPSS 18.

Table 5.50 shows that the tolerance values were higher than 0.1 for all the cases and the VIF values were less than 10. According to the criteria mentioned in section 4.7.1, there was no multi-collinearity issue among the four variables. Hence, both normality and multi-collinearity requirements were satisfied by the data of these four project characteristics. Thus, these four independent variables were considered as suitable for the regression analysis.

Table 5.50: Collinearity statistics among contingency variables

Model	Collinearity Statistics	
	Tolerance	**VIF**
Dynamism	.765	1.308
Uncertainty	.809	1.236
Uniqueness	.871	1.148
Dependent Variable: Complexity		

5.3.13.2 Assess the Suitability of Variables related to Influences of Strategies

As mentioned previously, influences of strategies were measured by using 35 critical success factors. In section 5.12, non-normal distributions were founds for 29 of variables related to critical success factors. Since one assumption of regression analysis was violated, these independent variables were not suitable for regression analysis. Therefore transformation of the original variables was considered as a requirement according to the procedure mentioned in section 4.7.1.

The most commonly used transformational techniques, which are Log, square and inverse transformations, were performed, but the SW test showed that normality could not be ensured though these transformations (Appendix E).

Identification of closely related variables through a correlation matrix is another method to transform variables by combining them. In this case there were 1225 (35x35) entities in the correlation matrix. It was not possible to use the correlation matrix to identify closely related variables.

These 35 variables are categorized under four groups, which were ‘project related factors’, ‘organizational related factors’, ‘material related factors’ and ‘external factors’, according to the perceptions of literature. Therefore, as an alternative, it was considered to combine the variables under these four categories.

Table 5.51: Spearman correlations presented among the items toward different categories

Project related factors	P2	O3	R4	E3
Setting clear objectives	-0.124	0.047	0.067	0.1
Coping with necessary variations (P2)	1	.543**	.426**	.570**
Improving communication	.736**	.458**	.575**	.614**
Speeding up decision making	0.017	0.276	0.164	0.115
Handling unforeseen ground conditions	.437**	.537**	.613**	.527**
Improving schedules and plans	.593**	.362*	.421**	.390*
Coping with legal/statutory requirements	.359*	0.274	0.232	.396*
Ensuring feedback and monitoring	.445**	.526**	0.031	0.279
Better handling of design complexities	0.266	.442**	0.23	.537**
Coping with estimation errors	0.245	.404*	0.245	.346*
Effective use of technology	.481**	.417**	0.074	0.306
Coping with site conditions	0.275	.462**	.509**	.622**
Organization related factors				
Dealing with client's characteristics	.320*	0.272	0.192	0.24
Improving project finance from client	0.299	.332*	0.115	0.241
Ensuring contractor's cash flow (O3)	.543**	1	.387*	.394*
Minimizing delays and errors in design documents	0.096	0.156	0.007	0.006
Reducing waiting time for test samples	.496**	.546**	0.262	.400*
Improving site management and supervision	.533**	.488**	.565**	.620**
Smoothing work with sub-contractors	0.03	0.156	.339*	0.108
Getting top management support	-0.028	0.021	0.188	0.056
Developing project organizational structure	-0.104	0.113	0.158	0.164
Getting lower cadres' support	0.242	0.093	0.124	0.184
Resource related factors				
Minimizing material shortages	0.242	.339*	.571**	.373*
Coping with material changes	0.139	.342*	.343*	0.313
Deciding on off-site prefabrication	0.031	0.248	0.259	0.152
Handling labour shortages (R4)	.426**	.387*	1	.449**
Coping with low skill levels	.391*	.432**	.640**	.407*
Handling plant shortages	0.285	.481**	.777**	.337*
Coping with low efficiency of plants	0.036	0.322	.590**	0.325
Coping with plant breakdown	0.13	.402*	0.319	.335*
Avoiding wrong selection of plants	0.279	.406*	.515**	.519**
External factors				
Minimizing political issues	.457**	0.315	0.133	.449**
Minimizing economic issues	0.216	0.242	.440**	.426**
Minimizing social issues (E3)	0.57**	.449**	.394*	1
Minimizing weather uncertainties	0.214	.492**	0.13	0.228

P2: Coping with necessary variations; O3: Ensuring contractor's cash flow; R4: Handling labour shortages; E3: Handling social issues

Table 5.51 represents four original variables and their correlations to the 35 factors. In the table, these four variables showed higher correlations toward other categories than the category they belong to. For example ensuring contractor’s cash-flow (O3) and minimizing social issues (E3), which were ‘organization related’ and ‘external’ factors, respectively, showed correlation more toward ‘project related’ factors rather than their own categories at α=0.05 significance level. Therefore, this categorization based on literature seemed unreliable. Instead, a unique way was considered to transform variables through a decision support model (

Figure 5.10).

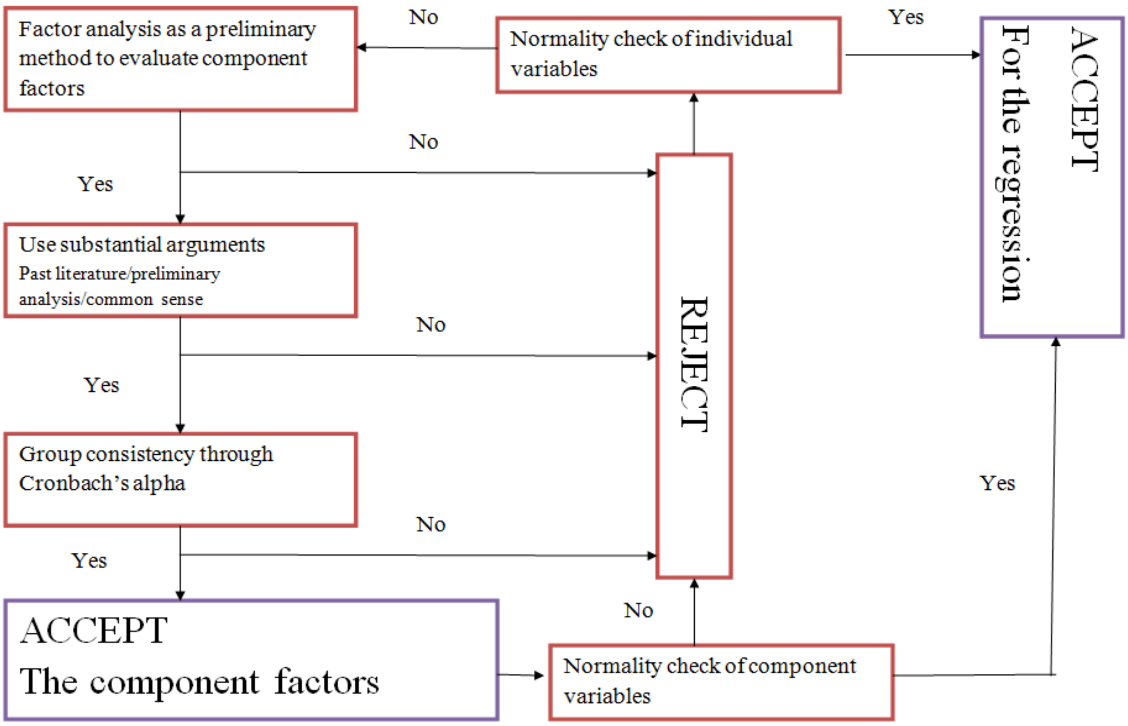


Figure 5.10: Decision support model to transform variables

In

Figure 5.10, each red box, which is either a process or a decision, was a step to reject transformation. If components factors were not rejected from all the steps, those solutions were accepted for the regression analysis.

The first process was to use factor analysis. Since the data was non-normal, factor analysis can give misleading component factors and hence the study recruited factor analysis as a preliminary method, only. Criteria mentioned in section 4.7.1 were considered to accept the factor solutions as preliminary solutions. All 35 items could not be considered together due to sample inadequacy. Therefore, the factor analysis was a heuristic procedure on the four categories (project related, organization related, material related and external) used in the data collection. The items were interchanged between the categories when the factor analysis was in progress. When an acceptable solution was given through the factor analysis, that solution was tested for accuracy through the second step which is to use past literature, the preliminary data analysis as well as general knowledge associated with construction project implementation to make substantial arguments. When the solution was accepted through the second step, internal consistency was checked through Cronbach’s alpha values as the final step to accept the transformation. Then, the transformed variables were checked for normality which was the ultimate purpose of the transformation process.

Transforming Resource Related Factors

First, factor analysis was performed on nine resource related factors. After several trials, only seven items could be extracted into two component factors. Table 5.52 shows that the component factors had KMO of 0.748 (> 0.5). Therefore the sample was adequate (Williams, Onsman, & Brown, 2010). Bartlett's test of sphericity tested the null hypothesis that ‘variables were uncorrelated in the population’ (Tobias & Calson, 1969). The level of significance was 0.000 (< 0.05) and hence the null hypothesis was rejected. Both component factors counted 56% and 15% (71% cumulative) variances of the original variables, respectively. Thus, the two component factors were accepted.

Table 5.52: Factor analysis of the resource related factors

Kaiser-Meyer-Olkin measure of sampling adequacy		.748
Bartlett's test of sphericity	Approx. chi-square	140.939
	Sig.	.000
Rotated component matrix	**Component**	
	1	**2**
Minimizing material shortages		.864
Coping with material changes		.960
Deciding on off-site prefabrication	.772	
Handling labour shortages	.826	
Coping with low skill levels	.733	
Handling plant shortages	.868	
Avoiding wrong selection of plants	.738	

The second component factor contained two original variables which were related to coping with material shortages and material changes. Both are related to construction material and generally, these two variables can be expected to behave together. The archival analysis showed that construction project managers had used similar strategies such as looking ahead plan to cope with these kinds of situations (Charted Institute of Building, 2009). Therefore, the second component factor was accepted through the second step of the decision making model shown in

Figure 5.10.

The first component factor had four original variables: deciding on off-site prefabrication, handling labour shortages, handling plant shortages and avoiding wrong selection of plants. In the archives used for the preliminary study, it was mentioned that off-site fabrication had been a strategy to eliminate labour shortages and low skill levels (CMYA, 2010a). Further, in the primary data collection, P02 used steel form works to avoid on-site timber formwork construction due to lack of skilled carpenters. Similar to the labour shortages, plant shortages can require off-site prefabrication. Therefore, the first component factor was considered as acceptable.

Internal consistencies were checked for the two component factors by using Cronbach's alpha: the first and second factors gave 0.841 and 0.901 (> 0.7), respectively and hence the component factors were internally consistence.

These two component variables were transformed by taking the mean values of the original variables. The first factor was named as 'labour and plant shortage related' and the second factor was named as 'material related'.

The SW test showed that the level of significances were 0.671 and 0.0052 (> 0.05) for 'labour and plant shortage related' and 'material related' variables correspondingly after some outliers were removed. For 'material related', the skewness and kurtosis values were -0.833 and 0.576 (< 1) correspondingly; these values were 0.270 and -0.199, respectively, for the component factor 'labour and plant related shortage'. Therefore, the component factors were considered as normal distributions.

There were two 'resource related' variables ('coping with low efficiency of plants' and 'coping with plant breakdown') remained after seven factors were transformed. These two factors were further considered to transform with the variables of other categories.

Transforming Organization Related Factors

After several iterations of factor analysis, seven factors out of 10 could be transformed into three component variables. KMO test showed value of 0.54 (> 0.5) and the Bartlett's test of sphericity gave the level of significance as 0.00 (< 0.05). Consequently the data was suitable for factor analysis as a preliminary method (Table 5.53). Three factors together counted for 78% cumulative variances of the original variables.

Therefore, the preliminary solution given by the factor analysis was accepted for further consideration.

Table 5.53: Factor analysis of the organization related factors

Kaiser-Meyer-Olkin measure of Sampling adequacy			.540
Bartlett's test of sphericity	Approx. chi-square		86.950
	Sig.		.000
Rotated component matrix	**Component**		
	1	**2**	**3**
Getting top management support			.782
Reducing waiting time for test samples		.954	
Getting lower cadres' support			.587
Developing project organizational structure			.889
Improving site management and supervision		.838	
Improving project finance from client	.861		
Dealing with client's characteristics	.907		

The first component factor contained two original variables: improving project finance from client (O1) and dealing with client characteristics (O2). From the 10 organization related variables, these two were the only variables related directly to the client and hence could be expected to be under one component factor. It could be expected to have ‘reducing waiting time for test samples’ (O5) within the context of ‘improving site management and supervision’ (O6) and hence together under the second component factor. The third factor had three items: ‘developing project organization structure’ (O9), ‘getting top management support’ (O8) and ‘getting lower cadres’ support’ (O10). Factors O9 and O10 can be achieved through developing an effective project organization (O10) (Fryer, 2004). Thus, the preliminary solution was considered as acceptable.

The first, second and third component factors had the Cronbach’s alpha values of 0.721, 0.727 and 0.724, respectively. Since these values are greater than 0.7, related component factors were considered internally consistent. The component variables were transformed by taking the mean values of the original items. The first variable was named as ‘dealing with client’. The second and third variables were respectively named as ‘site supervision’ and ‘contractor’s organization’.

After an outlier was removed in the second component factor, all these transformed variables had level of significance above 0.05 for their SW tests, and hence accepted as normally distributed. Therefore, these three component factors were suitable for regression.

The transformation of the factors 'ensuring contractor's cash flow' (O3), 'smooth working with sub-contractors' (O7) and 'minimizing errors and delays in documents' (O4) was not possible. It could be seen that O3 was correlated more highly with project related factors than with its own category. Since O3 is a major part of construction project planning, and many variables of the 'project related' category belonged to planning related concerns, O3 was further considered with 'project related' factors.

Transforming Project Related Factors

From the 13 original variables that were used, the factor solution contained only seven items (Table 5.54). KMO test (0.679) and Bartlett's test of sphericity (level of significance = 0.000) showed that the factor analysis could be conducted. Both factors together counted for 74% of cumulative variances of the original variables. Thus these two component factors were considered acceptable as a preliminary solution.

Table 5.54: Factor analysis of the project related factors

Kaiser-Meyer-Olkin measure of sampling adequacy		.679
Bartlett's test of sphericity	Approx. chi-square	92.827
	Sig.	.000
Rotated component matrix	**Component**	
	1	**2**
Setting clear objectives		.836
Coping with necessary variations	.817	
Speeding up decision making		.763
Improving schedules and plans	.791	
Ensuring feedback and monitoring	.802	
Effective use of technology	.773	
Ensuring contractor's cash flow	.718	

The first factor contained 'coping with necessary variations' (P2), 'improving schedules and plans' (P6), 'ensuring feedback and monitoring' (P8) and 'ensuring contractor's cash flow' (O3). These items are recognized as part of construction project scheduling (Fryer, 2004). The remaining factor was 'effective use of technology' (P11). Both preliminary and primary investigations of this study investigated construction project manager's use of alternative construction methodologies to ensure progress. Therefore, having P11 under the first component factor was acceptable.

The second component factor consisted of two original items: 'setting clear objectives' (P1) and 'speeding up decision making' (P4). Setting clear objectives can be generally considered as a strategy to improve decision making capacities. Further, from a study done on Scottish farmers, Willock et al. (1999) have found that there are significant correlations between setting objectives (on success, status as well as quality of life) and decisions that the farmers made on their business-oriented behaviours. Considering these arguments, the second component factor was accepted through substantial arguments.

The first component factor had a Cronbach's alpha value of 0.833 (> 0.7), and hence could be considered as internally consistent. It was noted that removing O3 can reduce the internal consistency of the group. Thus, the decision of considering O3 with project related factors was strengthened. The internal consistency of the second factor was 0.710 and hence both factors were internally consistent.

The first and second component factors were transformed by taking the mean values of the original variables and named 'planning related development' and 'objective and decisions', respectively.

The SW test performed for 'planning related development' showed level of significance as 0.359 (> 0.05), whereas for 'objectives and decisions' the level of significance was 0.086. Thus the transformed variables were considered normally distributed.

From the remaining items of project related factors that did not fit this factor analysis, 'coping with site conditions' (P12) showed clear correlation toward external related factors. Therefore, P12 was considered with external related factors under the next preliminary factor analysis.

Transforming External Factors

'Minimizing weather condition' was not considered under this category since it was already found as internally inconsistent with the other three original items (section 5.3.13.2). Thus, P12 was considered with other three variables which are 'helping to minimize political issues' (E1), 'helping to minimize economic issues' (E2) and 'helping to minimize social issues' (E3). Table 5.55 shows the factor solution for the four items: E1, E2, E3 and P12.

Table 5.55: Factor analysis of the external factors

Kaiser-Meyer-Olkin measure of sampling adequacy		.572
Bartlett's test of sphericity	Approx. chi-square	50.271
	Sig.	.000

Rotated component matrix	**Component**	
	1	**2**
Coping with site conditions		.941
Minimizing political issues	.924	
Minimizing economic issues	.871	

Both the KMO test (0.572) and Bartlett's test of sphericity (level of significance = 0.000) showed that the factor analysis could be conducted. Table 5.55 showed that four original items could be reduced to two component factors. The first and second component factors accounted for 84% of the variances of the original four variables. Hence, the preliminary factor solution was accepted.

The first factor contained two original variables: E1 and E2. The factors E3 and P12 belong to the second component factor. The first factor included political and economic issues where authority of changing these environments with the government. Therefore, the first factor was accepted. Furthermore, under the preliminary investigation of this research study, it was found that many social issues occurred due to site conditions like surrounding environment (CMYA, 2010b). Therefore, the second component factor was considered as acceptable.

Reliability was checked through Cronbach's alpha in SPSS 18. The first component had the Cronbach's alpha of 0.767 and the second component factor gained internal consistency with 0.805 Cronbach's alpha. Since both values were above 0.7, the two component factors were considered as internally consistent.

The transformation was done for the two component factors by taking mean values of the original items. The component factors were named 'economy plus political' and 'coping with site conditions'.

SW test showed that the level of significances was more than 0.05 (0.06 and 0.111) for both variables, and consequently, the two transformed variables were considered normal distributions. Having transformed 25 original variables through the decision support model, there were 10 more variables left to assess before the regression analysis was done.

Analysis of the Remaining Variables

The remaining 10 items were considered together under factor analysis without considering the initial categories they belonged to. Table 5.56 shows that only eight items could be transformed into two-component variables. The KMO test statistics, 0.713 (> 0.5) of and the significance of the Bartlett's test of sphericity, 0.035 (< 0.05), showed that the factor analysis could be conducted. However, the first and second factors, for which the cumulative variance (63%) was lower compared to the other four preliminary factor analyses performed under this section, could account only for 39% and 24% of the variances of the original eight variables, respectively.

Table 5.56: Factor analysis of the remaining factors

Kaiser-Meyer-Olkin Measure of sampling adequacy		.713
Bartlett's test of sphericity	Approx. chi-square	43.037
	Sig.	.035
Rotated component matrix	**Component**	
	1	**2**
Improving communication	.727	
Handling unforeseen ground conditions	.765	
Coping with legal/statutory requirements	.591	
Better handling of design complexities	.598	
Coping with estimation errors	.741	
Minimizing delays and errors in design documents		.709
Smoothly work with sub-contractors		.710
Minimizing weather uncertainties		.521

The first factor had five original items which were ‘improving communication’ (PO3), ‘handling unforeseen ground conditions’ (P5), ‘coping with legal/statutory requirements’ (P5), ‘better handling of design complexities’ (P9) and ‘coping with estimation errors’ (P10). ‘Minimizing delays and errors in design documents’ (O4) ‘smoothly working with sub-contractors’ (O7) and ‘minimizing weather uncertainties’ (E4) belonged to the second component factor.

As a substantial argument toward the preliminary factor solution, Spearman correlation was performed by using SPSS 18. The correlation matrix is shown in Table 5.57. According to the solution, only among the original variables of the first component factor, there were significant correlations at α=0.05. Therefore, only the first component factor was considered as valid for further considerations.

Table 5.57: The Spearman correlations among the remaining factors

	P3	**P5**	**P7**	**P9**	**P10**	**O4**	**O7**	**E4**
P3	**r=1**	**r=0.343**	**r=0.395**		**r=0.418**			
P5	**r=0.343**	**r=1**	**r=0.456**	**r=0.332**	**r=0.352**		**r=0.387**	**r=0.335**
P7	**r=0.395**	**r=0.456**	**r=1**					
P9		**r=0.332**		**r=1**	**r=0.441**			
P10	**r=0.418**	**r=0.352**		**r=0.441**	**r=1**			
O4								
O7		**r=0.387**						
E4		**r=0.335**						

The component factor which is accepted had the Cronbach's alpha value of 0.732 (> 0.7). Thus, then component factor was considered as internally consistent. The transformation was done by taking the mean values among the five original items and the factor was named 'dealing with complexities through communication'. The SW test statistics indicated that the level of significance was 0.148 (> 0.05) for the transformed variable consequently, the data distributions could be assumed as normal. There were five original items still left.

Among the remaining five variables related to the 35 critical success factors that could not be transformed by the procedure described in this section, O4, E4 and 'coping with low efficiency of plants' (R10) could be used in regression as individual variables because they were normally distributed. The SW test showed that the level of significance was 0.055 and 0.149 for O4 and E4, respectively. O4 had the skewness (-0.55) and kurtosis values (0.46) below one. Similarly E4 had the skewness and kurtosis as -0.22 and -0.58, respectively. R10 showed the level of significance as 0.162 for SW test and hence the null hypothesis of normality could not be rejected. Further, the skewness was -0.09 and kurtosis was 0.30.

The decisions taken on the remaining two variables, which were 'coping with plant breakdown' (R8) and 'smooth working with sub-contractor' (O7), were considered as the most appropriate decisions to increase the accuracy of the results of the regression analysis.

Factor R8 was the least improved critical success factor by strategies, which had the population central tendencies (median) as moderately influenced. One sample non-parametric test, Wilcoxon signed rank test, was used to calculate the population central tendency and it was discovered that central tendency was less than six out of 10 at α=0.05 significance level. Due to this moderate influence from construction project strategies, R8 was removed from the regression analysis. However, O7 had a sample median of eight consequently the influence of strategies was high. Therefore, elimination from regression was considered unacceptable. Although SW test showed non-normality with the level of significance of 0.03 (< 0.05), the skewness and the kurtosis were below one (-0.27 and 0.76, respectively). By looking at the histogram, no outliers were found, hence no data cleaning could be done to improve the distribution toward normality. Since working with sub-contractors is a major factor toward project success (Fryer, 2004; Sambasivan & Soon, 2007), the primary investigation under this analysis considered O7 to be used in regression analysis although SW test showed non-normality.

After the variables were modified toward normality, the only concern left was to check multi-collinearity among the 35 critical success factors.

5.3.13.3 Multi-collinearity of the Independent Variables

Table 5.58 demonstrates the collinearity statistics of the 14 variables that are related to the influence of construction project strategies. Among them, there were 10 variables transformed and analyzed as discussed above, and the remaining four variables belonged to the original variables used in this study. A regression analysis was done between these variables. For the regression model, 'minimizing delays and errors in design documents' was used as the dependent variable and the remaining 13 items were set as the independent variables. Table 5.58 shows that the tolerance values were all higher than 0.1 and the VIF values were less than 10. Therefore, there was no multi-collinearity issue, and consequently the 14 independent variables were ready to be subjected to regression analysis.

After the two types of independent variables were assessed, the dependent variables should be considered to determine their suitability for a regression analysis.

Table 5.58: The Collinearity statistics of the independent variables related to the strategies' influence toward critical success factors

Model	**Collinearity statistics**	
	Tolerance	**VIF**
Smoothing work with sub-contractors	.477	2.097
Minimizing weather uncertainties	.556	1.798
Material shortage related	.546	1.833
Coping with site conditions	.285	3.506
Economy and political	.256	3.902
Coping with complexities through integration	.148	6.776
Dealing with client	.298	3.355
Site supervision	.318	3.142
Coping with low efficiencies of plants	.213	4.677
Contractor's organization	.360	2.776
Planning related development	.352	2.839
Objectives and decisions	.619	1.615
Labour and plant shortage related	.403	2.483
Dependent Variable: Minimizing delays and errors in design documents		

5.3.13.4 Assess the Dependent Variables: 'Success Measures'

Under the regression analysis, achievements on cost, time, quality, client satisfaction and overall success were considered as the dependent variables, and these parameters were calculated in accordance with the equations given in chapter 3.

Since the five variables of project success were considered separately under the regression, no multi-collinearity issue was relevant to the dependent variables and hence the assessment focused only on the nature of the distributions. Normality of the dependent variables was considered as more important than in the case of the independent variables, where a group of variables act together. In a group of variables, approximation can be done for some variables without significantly affecting total accuracy (Malhotra et al., 2002).

Further, the analyses of section 5.3.3 indicated that the data distribution of overall success and client satisfaction were normal while cost, time and quality had non-normal distributions. Therefore, transformation was necessary for the three non-normally distributed variables prior to regression analyses.

It was required to investigate the individual behaviour with strategies of time, cost and quality. Therefore, the original variables could not be combined. This requirement left the study to consider eight mathematical operations under the transformation of these three non-normal distributions: square root, inverse, cos, sin, exponential, ln and log. SPSS 18 was used to transform variables into new distributions and SW test was performed on the transformed variables to identify the nature of the new variables (Appendix E). Only sin transformation could achieve the level of significances above 0.05 for SW test. For time, cost and quality, the sin transformations gave the level of significances as 0.056, 0.054 and 0.104. Thus, the null hypotheses related to normality could not be rejected, and consequently, the data distributions of the sin transformations were assumed as normal. Further checks were performed for verification.

Although there were some deviations still apparent, the new histograms of '$\sin_{cost}$' and '$\sin_{time}$' had improved compared to the original variables (Appendix E). The distribution related to '$\sin_{quality}$' seemed to have close behaviour to the normal curve. Further, the normal Q-Q plots demonstrated that the observed values varied close to the expected normal distribution and hence the transformed variables were assumed to be normally distributed according to graphical methods.

The distributions of '$\sin_{time}$' and '$\sin_{cost}$' had approximately similar central tendencies (0.89 and 0.90, respectively) for mean, median and mode. Only the mean of '$\sin_{quality}$' (0.86) showed 2% difference from its median and mode (0.84). From the three variables, '$\sin_{time}$' showed the highest skewness and kurtosis which were 0.549 and -

0.714 respectively. However, these highest deviations were less than one and within limits, and hence, the data distributions were considered to be normal.

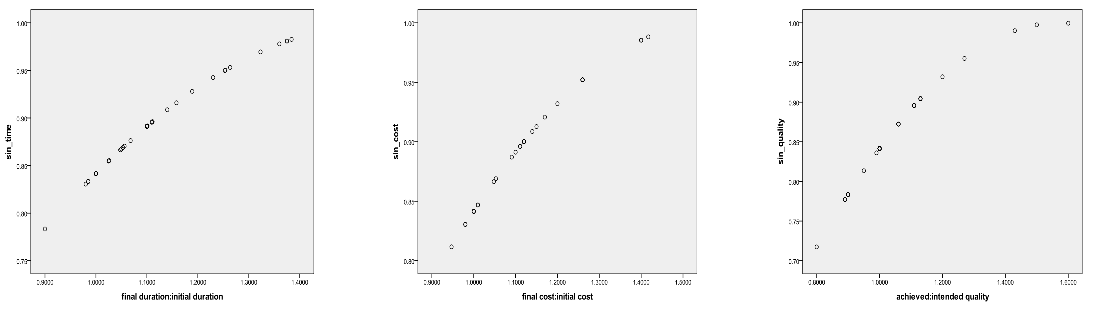
As a conclusion, the graphical, numeric and formal tests conducted confirmed that the transformed variables were approximately normally distributed. Therefore, the five data distributions were suitable for multiple regression analysis. Before the regression, the following section discusses the validity of this transformation.

Validating the Factor Transformation

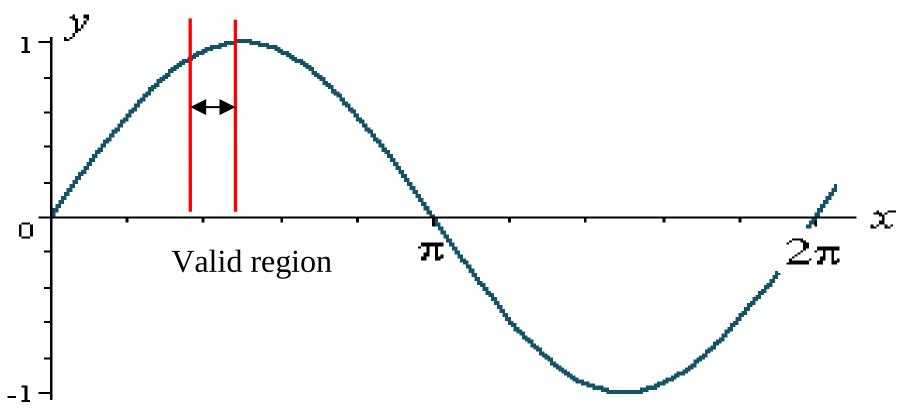
For the independent variables, the transformation technique that was used to create new variables was component variables and hence validity of any transformation could be checked by Cronbach’s alpha values coupled with substantial arguments available in literature. As an alternative method, correlations were checked between the original and transformed variables in the case of the dependent variables.

Table 5.59: The correlation exists between final /initial duration and transformed variables

Original Variables	sin transformation
Time	.989
Cost	.985
Quality	.956



(a) Time vs. $\sin_{time}$ (b) Cost vs. $\sin_{cost}$ (c) Quality vs. $\sin_{quality}$



(d) The region within the transformations

Figure 5.11: The depiction between the original and sin transformation

Table 5.59 showed that high Spearman correlations exist among the original and transformed variables. The highest correlation was observed between the variables of time (0.989), followed by cost (0.985) and quality (0.956). Since all correlation coefficients were close to one, the disturbance made to the original variables due to the sin transformation was considered as insignificant.

However, since the original variables vary linearly while the sin curves change with varying amplitudes, these high correlations could be questionable. This could be understood with the graphical explanation given in Figure 5.11.

Figure 5.11 (a), (b) and (c) depicted the relationships among the original and sin transformed variables. The three graphs showed approximate linear relationships between the original and new variables. Further, in Figure 5.11 (d), there are two red lines showing the range for which data is relevant to this case. Here, one can notice that the high Spearman correlations occurred because these data entities of this investigation belonged to a small portion of a curvilinear variation. Therefore, any extrapolation beyond this region was considered as unacceptable under interpretations of the regression analysis.

5.3.13.5 Making Regression Models

Making mathematical models for the five dependent variables can assist to quantify the influence of strategies on construction project success, and hence, to propose the strategy-led approach as a suitable planning method for construction project implementation.

The dependent variables were analysed with 18 independent variables which contained four variables of project characteristics and 14 variables related to influences of strategies on critical success factors. Initial trials showed that all individual variables could not provide statistically significant solutions. Therefore, step-wise regression was done using SPSS 18 as described in chapter 4. The study could not achieve statistically significant solution for client satisfaction under regression. Thus, only four analyses, which are cost, time, quality and overall success, are described below.

Regression Analysis on Cost

Regression analysis of the dependent variables models the behaviour of achievements in terms of cost according to the characteristics of projects planned and implemented through the strategy-led approach. SPSS 18 was used to perform the regression analysis.

There were two independent variables, 'planning related development' and 'minimizing delays and errors in design documents', on which the regression analysis with 'sin_{cost}' was performed (Table 5.60). R^2 was 0.48 which implied that 48% variance of 'sin_{cost}' was determined by the two independent variables. The difference between R^2 and adjusted R^2 values were only 2.9%. The overall regression model result was F=10.770 for degrees of freedom of 2 and 35. Further, the level of significance was 0.000 and hence the model was statistically significant at α=0.05.

Table 5.60: The model summary for sin cost

Model	**R**	**R square**	**Adjusted R square**	**Std. error of estimate**	**Change Statistics**				
					R square change	**F change**	**df1**	**df2**	**Sig. F change**
1	.693[a]	.480	.435	.03436	.480	10.770	3	35	.000

a. Predictors: (constant), minimizing delays and errors in design documents, planning related development
Dependent variable: sin_{cost}

The null hypotheses were set as B = 0 for each independent variable and were checked by using SPSS18 (Table 5.61). Since the levels of significances were less than 0.05 for both variables, 'planning related development' (X1) and 'minimizing delays and errors in design documents' (X2), the null hypotheses could be rejected. The collinearity statistics given by tolerance were found close to one (<0.1) consequently no multi-collinearity issue was associated with the regression model.

Table 5.61: The regression coefficients and collinearity statistics: sincost

Model		**Unstandardized coefficients**		**Standard. coef.**			**95.0% confidence interval for B**		**Collinearity statistics**	
		B	**Std. error**	**Beta**	**t**	**Sig.**	**Lower bound**	**Upper bound**	**Toler ance**	**VIF**
1	(Constant)	.583	.057		10.156	.000	.467	.700		
	Planning related development	.024	.006	.524	4.229	.000	.013	.036	.976	1.02
	Minimizing delays and errors in design documents	.015	.005	.357	2.883	.007	.004	.025	.976	1.02

Dependent variable: sin_{cost}

The normal probability plot nearly represented a straight line between (0, 0) and (1, 1) points, and little deviation could be seen (Appendix E). Therefore, the normality assumption related to the hypotheses testing was considered as satisfied by the actual data. The residual plot showed that there were no clear relationships seen between the residual and predicted values and hence the assumption of constant variance could be assumed as secured (Appendix E). Once all the tests were accepted, the raw (Equation 5.2) and standard (Equation 5.3) equations were written according to Table 5.61.

Equation 5.2

$$Sin(y) = 0.583 + 0.024\,X1 + 0.015\,X2 \qquad 5 \leq X_1, X_2 \leq 10$$

Equation 5.3

$$Sin(y) = 0.524\,X1 + 0.357\,X2$$

Where y: cost related achievement

X1: effects of strategies on planning related development

X2: effects of strategies on minimizing delays and errors in design documents

Table 5.62: Strategy influence versus cost

Independent variable rating *(i)*	1	2	3	4	5	6	7	8	9	10
Cost*: X_1=X_2=*i	-	-	-	-	0.89	0.96	1.03	1.11	1.21	1.34
***Cost*: X_1=*i*, X_2 = 5**	-	-	-	-	-	0.93	0.97	1.02	1.06	1.12
***Cost*: X_2=*i*, X_1 = 5**	-	-	-	-	-	0.92	0.94	0.97	0.99	1.02
					Moderate		High		Very high	

The component variables, $X_{1,}$ had data values distributed from 4.80 to 10, while X_2 stretched between 5 and 10. Thus, the valid region of the model was taken as (5-10) for both independent variables: X_1 and X_2. Table 5.62 shows how achievements of cost vary according to X_1 and X_2. The values given for cost were derived by taking inverse values of $\sin_{cost}$.

The second raw in Table 5.62 indicates the variance of cost when both variables are changed similarly. When influence of strategies moves from five (beginning of neutral region) to seven (beginning of high region), achievements on cost vary from 89% to 103%. The maximum influence on X1 and X2 from strategies on cost that can be achieved is 134%. The last two rows show variances of achievements of cost when X_1 and X_2 are changed while other variables are fixed at X=5. Greater effect is created when X_1 is changed, but the maximum achievement of success can achieve only 112%. By changing X_2 only, success on cost is limited for 102% of the maximum, which is the success that can be achieved by influencing both independent factors up to seven out of 10. These observations coupled with Equation 5.3 provide credence that focusing on X_1

can deliver more benefits to construction projects in terms of cost. However, one can understand that X_1 is a component factor while X_2 behaves individually.

For the region of dependent variables, for which the interpretation was done, correlation was checked between cost and sin_{cost}. It could be seen that parametric correlation was 0.991 while non-parametric correlation was 1.0. Therefore, the above results were considered as valid.

The concluding remark for this analysis on the effects of strategies on planning related strategies to minimize delays and errors in design documents is that construction project managers can achieve significant achievements in terms of cost. Planning related development includes strategies which are focused on coping with variations, improving schedules and plans, ensuring feedback and monitoring, effective use of technology and ensuring contractor's cash-flow. Influences of strategies toward these critical success factors can contribute 46% of achievements on cost. Thus, the study concludes that the strategy-led approach is a suitable planning approach to plan and implement construction projects to achieve successful outcomes at the end of construction projects in terms of cost.

Regression Modelling for Time

Regression analysis on the achievement of time can model the behaviour of timely achievements in construction projects according to the characteristics of projects, when construction projects are planned and implemented through the strategy-led approach. SPSS 18 was used to perform the regression analysis.

From the step-wise regression, only three independent variables contributed to a statistically accountable model at $\alpha=0.05$ level. Table 5.63 shows the model summary of the solution. The R^2 value was 0.373, and hence 37.3 % of variance of the model was accounted for by the three variables: 'minimizing delays and errors in design documents', 'coping with site conditions' and 'coping with complexities'. The difference between the R^2 and adjusted R^2 values were only 5.7%. The regression model had F = 6.931 and degrees of freedom of 3 and 35. The level of significance was 0.007, and hence the model was significant at $\alpha=0.05$ significance level.

Table 5.63: The model summary for sin time

Model	R	R square	Adjusted R square	Std. error of the estimate	Change Statistics				
					R square change	F change	df1	df2	Sig. F change
1	.611[a]	.373	.316	.04200	.373	6.931	3	35	.007

a. Predictors: (constant), coping with complexities, planning related development, coping with site conditions

Dependent Variable: sin_{time}

The regression coefficients (B and Beta) and collinearity statistics are shown in Table 5.64. The levels of significance related to the null hypotheses, B = 0, were all less than 0.05, and hence the individual variables fitted well into the model. The tolerance levels were larger than 0.1 and the VIF values were smaller than 10 and hence no collinearity was present. However, validity of the model would depend on the assumption made for the analysis.

Table 5.64: The regression coefficients and collinearity statistics: sin time

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.	95.0% confidence interval for B		Collinearity statistics	
	B	Std. error	Beta			Lower bound	Upper bound	Tolerance	VIF
1 (Constant)	.662	.082		8.362	.000	.496	.828		
Coping with site conditions	.016	.006	.408	2.217	.013	.003	.029	.682	1.466
planning related development	.017	.006	.417	3.008	.008	.005	.029	.957	1.045
Coping with complexities	-.008	.004	-.306	-1.807	.032	-.020	.004	.718	1.393

Dependent variable: sin_{time}

The normal probability plot (Appendix E) showed that the snake-like distribution nearly represented a straight line between (0, 0) and (1, 1). Therefore, the normality assumption related to the hypotheses testing was satisfied by the actual data. Standardized residual versus standard predicted values (Appendix E) showed a cloud-like distribution and hence there were no relationships between the residuals and predicted values. Therefore, the assumption of constant variance was secured. After the assumptions were checked statistically, the model was accepted and hence the standard and raw equations could be written as follows:

Equation 5.4

$$Sin(y) = 0.662 + 0.016\,X1 + 0.017\,X2 - 0.008\,X3$$

$5 \leq X_1, X_2, X_3 \leq 10$

Equation 5.5

$$Sin(y) = 0.408\,X1 + 0.417\,X2 - 0.306\,X3$$

Where y: timely achievement

X1: effects of strategies to coping with site conditions

X2: effects of strategies to planning related development

X3: coping with complexities

The independent variables of X1 (effects of strategies to coping with site conditions), X2 (effects of strategies to planning related development) and X3 (coping with complexities) had ranges of (4.5-10), (4.8-10) and (5.2-9.8) in the actual data. Therefore, for the above equations, the valid range of the independent variables was set as (5-10) for all the variables.

It could be seen that X3 influences negatively toward timely achievements. The component factor X3 is the transformation of the individual factors ‘handling unforeseen ground conditions’ (P5), ‘coping with legal and statutory requirements’ (P7), ‘better handling of design complexities’ (P9), ‘coping with estimation errors’ (P10) and ‘improving communication’ (P3). Further, within 95% confidence level, the influence of X3 changes from negative to positive.

Table 5.65: Strategy influence versus time

Independent variable rating *(i)*	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Time*: X_1=X_2=X_3=*i	-	-	-	-	0.90	0.95	0.99	1.04	1.09	1.15
Time*: X_1=X_2= *i and* X_3=*5	-	-	-	-	-	0.96	1.02	1.09	1.17	1.26
Time*: X_1=X_2=5 and X_3=*i	-	-	-	-	-	0.89	0.88	0.87	0.86	0.84

Moderate ⟷ High ⟷ Very high

Table 5.65 indicates changes of achievements of time according to the independent variables by using Equation 5.3. The second raw indicates how achievements of time change according to the three independent variables. One can see that when all the independent variables are influenced neutrally (five out of 10) through strategies, construction projects can achieve only 90% of success in terms of time. When influences reach the lower limit of the high region (seven out of 10), achievements become nearly 100%. The maximum success that can achieve through strategies is limited to 115%, and are hence less influenced from strategies than from cost. Cost has almost the same achievements as time (90%) when the independent variables are five, but at the highest influence, cost has 15% more achievements than that of time.

The third raw equation shows variance according to the positively affected two variables and when the negative influenced variable is fixed at five. Under this situation, at 95% confidence level, achievements can go up to 126% which is still lower than that of cost. From the third raw equation, one can see that achievements become reduced by 1% for each unit of increment toward X3 when other two variables, X1 and X2, are fixed at five.

For the region of dependent variables, for which the interpretation was done, correlation was checked between time and sin_{time}. It could be seen that parametric correlation was 0.998, while non-parametric correlation was 1.0. Therefore, the above results were considered as valid.

As the concluding remark to this analysis, planning related strategies can contribute to achievements in terms of time similarly as to the achievement of cost. There can be negative consequences due to influence of strategies made toward coping with complexities, the scope of which is handling of unforeseen ground conditions, coping with legal and statutory requirements, better handling of design complexities, coping with estimation errors, and improving communication. The model shows that construction project managers can achieve 126% of success compared to the initial expectations, if strategies related to planning related development and cope with site conditions are considered. Thus, the study concludes that the strategy-led approach is a suitable planning approach to plan and implement construction projects to achieve successful outcomes at the end of construction projects in terms of time.

Regression Analysis for Quality

The regression analysis for the dependent variables of quality models the behaviour of achievements of quality according to the characteristics of projects, when construction projects are planned and implemented through the strategy-led approach. SPSS 18 was used to perform the regression analysis.

Only 'planning related development' could influence '$sin_{quality}$' at α=0.05 (Table 5.66). R^2 implied that 20.8% variance of the model was determined by 'planning related development'. The difference between R^2 and adjusted R^2 was only 2.1%. The overall regression contained F = 9.977 for degree of freedom 1 and 38. The level of significance was 0.003 (<0.05) consequently, the overall model was significant.

Table 5.66: The model summary for sin quality

Model	R	R square	Adjusted R square	Std. error of the estimate	Change statistics				
					R square change	F change	df1	df2	Sig. F change
1	.456[a]	.208	.187	.05969	.208	9.977	1	38	.003

a. Predictors: (Constant), planning related development

Dependent Variable: $sin_{quality}$

The level of significance values (0.000 and 0.003) related to the null hypotheses, B = 0, were given Table 5.67. Since levels of significances were less than 0.05, the null hypotheses could be rejected, and consequently, influence of planning related development on achievements of quality is significant. Since there was one individual variable, no multi-collinearity issue was relevant.

Table 5.67: The regression coefficients and Collinearity statistics: sin_quality

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.	95.0% confidence interval for B	
	B	Std. error	Beta			Lower bound	Upper bound
1 (Constant)	.640	.070		9.196	.000	.499	.780
Planning related development	.027	.009	.456	3.159	.003	.010	.045

The normal probability plot (Appendix E) nearly represented a straight line between point (0, 0) and point (1, 1). Therefore, the normality assumption related to the hypotheses testing was considered as satisfied. Further, the residual plot showed a cloud-like data spread and hence there were no clear relationships shown between the residuals and predicted values. Considering the coefficient values given in Table 5.67, the raw equation was written as follow:

Equation 6 $5 \leq X_1 \leq 10$

$$Sin(y) = 0.640 + 0.027X1$$

Where y: quality related achievement

X1: effects of strategies toward planning related development

Table 5.68: Strategy influence versus quality

Independent variable rating *(i)*	1	2	3	4	5	6	7	8	9	10
Quality*: X_1=*i	-	-	-	-	0.89	0.93	0.98	1.03	1.08	1.14
					Moderate		High		Very high	

Although number of influencing variables was the least for quality, almost similar influence can be seen to timely achievements according to the calculations given in Table 5.68. It can be seen that 98% of success can be achieved in terms of quality when influence of strategies toward X1 is high (seven out of 10). The model shows further that quality achievements can go up to 114% by influencing project related development by using construction project strategies.

For the region of dependent variables, for which the interpretation was done, correlation was checked between quality and $\sin_{quality}$. It could be seen that parametric correlation was 0.998 while non-parametric correlation was 1.0. Therefore, the above interpretations were considered as valid.

The concluding remark to this analysis is that, through effects of strategies on planning related strategies, construction project managers can achieve significant achievements in terms of quality. Influences of strategies toward planning related development can contribute to 20% of achievements on quality. Thus, the study concludes that the strategy-led approach is a suitable planning approach to plan and implement construction projects to achieve successful outcomes at the end of construction projects in terms of quality.

Regression Analysis for 'Overall Success'

Regression analysis for the dependent variables of overall success models the behaviour of achievements in construction projects in a holistic manner according to the characteristics of projects, when construction projects are planned and implemented through the strategy-led approach. SPSS 18 was used to perform the regression analysis. The dependent variable was calculated by considering achievements of cost, time, quality and client satisfaction with priorities given for each concern.

From the 18 independent variables used, only two independent variables could contribute to a statistically significant solution for 'overall success' at $\alpha=0.05$ level (Table 5.69). The resultant R^2 value was 0.391 and hence 39.1% of variances of overall success were determined by the two independent variables 'planning related development' and 'minimizing delays and errors in design documents'. The difference between R^2 and adjusted R^2 values was only 3.5%. Further, Table 5.69 shows that the overall regression model had F=11.225 with degree of freedom values 2 and 35. The level of significance (0.000) was smaller than 0.05 and hence the overall model was significant.

Table 5.69: The model summary for overall success

Model	R	R square	Adjusted R square	Std. error of the estimate	Change Statistics				
					R square change	F change	df1	df2	Sig. F change
1	.625[a]	.391	.356	.06747	.391	11.225	2	35	.000

a. Predictors: (Constant), minimizing delays and errors in design documents, planning related development.

Table 5.70 shows the regression coefficients and collinearity statistics for each independent variable. The fifth and sixth columns respectively showed the 't' values and levels of significance for the null hypothesis that 'the coefficient (B) of an individual predictor was zero when other variables were included'. Since the levels of significances were less than 0.05, the null hypothesis could be rejected for each case. Further, the last two columns implied that collinearity statistics were at acceptable levels (tolerance > 0.01 & VIF < 10).

Table 5.70: The regression coefficients and collinearity statistics: overall success

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.	95.0% confidence interval for B		Collinearity statistics	
	B	Std. error	Beta			Lower	Upper	Tolerance	VIF
(Constant)	.564	.112		5.024	.000	.336	.793		
Planning related development	.037	.011	.440	3.282	.002	.014	.060	.967	1.034
Minimizing delays and errors in design documents	.028	.010	.371	2.765	.009	.007	.048	.967	1.034

a. Dependent variable: overall success

The normal probability plot showed that the snake-like distribution nearly represented a straight line between (0,0) and (1,1) (Appendix E). Therefore, the normality assumption related to the hypotheses testing could be considered as satisfied by the actual data. Standardized residual versus standard predicted values were plotted and the graph seemed to simulate a cloud-like distribution and hence there were no relationships seen between the residuals and predicted values.

Table 5.71: Strategy influence versus overall success

Independent variable rating *(i)*	1	2	3	4	5	6	7	8	9	10
***Overall success*: $X_1=X_2=i$**	-	-	-	-	*0.889*	*0.954*	*1.019*	*1.084*	*1.149*	*1.214*
***Overall success*: $X_1=i$, $X_2=5$**	-	-	-	-		*0.926*	*0.963*	*1*	*1.037*	*1.074*
***Overall success*: $X_2=i$, $X_1=5$**	-	-	-	-		*0.917*	*0.945*	*0.973*	*1.001*	*1.029*

Moderate ◄► High ◄► Very high

After all checks were done, the raw (Equation 5.7) and standard (Equation 5.8) equations were written based on the unstandardized and standardized coefficients given in Table 5.70. To find out the valid region of the model, the ranges of X_1 and X_2 were considered. The component variable X_1 had values distributed from 4.80 to 10, while component variable X_2 stretched over (5-10). Therefore, the valid region for the model is taken as (5-10) for both independent variables: X_1 and X_2.

Equation 5.7

$$f(x) = 0.564 + 0.037\,X1 + 0.028\,X2$$

Equation 5.8 $5 \le X_1, X2 \le 10$

$$f(x) = 0.440\,X1 + 0.371\,X2$$

Where f(x): overall project success

X_1: effects of strategies toward planning related developments

X_2: effects of strategies toward minimizing delays and errors in design documents

Using Equation 5.7, influence toward 'overall success' due to strategies was calculated as shown in Table 5.71. For the valid region, the second raw equation provides the variation of overall success according to X_1 (effects of strategies toward planning related developments) and X_2 (effects of strategies toward minimizing delays and errors in design documents). It could be noted at 95% confidence level that overall success could be increased from 89% to about 100% by increasing influence of strategies from five (the lower level of moderate influence) to seven (entering the high region). With maximum influence, construction projects can achieve success up to 120% in terms of overall success.

Thereafter, X_2 and X_1 were fixed at five and variances of overall success were measured separately for each independent variable. By increasing influence of strategies toward the component factor (X_1) up to eight, construction project can reach 100% success while X_2 need to be improved up to nine to have the similar effect. According to this observation as well as to the standard equation, strategy focus on X_1 can make a greater influence toward overall success.

As the concluding remark to this analysis follows that through effects of strategies on planning related strategies to minimize delays and errors in design documents, construction project managers can achieve significant achievements in terms of overall success. Influences of strategies toward these critical success factors can contribute to 39% of achievements on overall success. Thus, the study concludes that the strategy-led approach is a suitable planning approach to plan and implement construction projects to achieve successful outcomes at the end of construction projects in terms of overall success.

5.4 Conclusion

This chapter summarizes the research findings and their interpretations of the objectives of this study both, for preliminary and primary investigations. Quantitative and qualitative methods are used under mixed-method research methodology to determine whether the strategy-led approach is a suitable planning approach for construction project managers to plan and implement construction projects.

In this chapter, the preliminary investigation is discussed in relation to the problem identification of this research study while corroborating facts towards the research questions of this study. By using the qualitative information provided by the CIOB, UK, the preliminary research investigation has determined that the four characteristics of construction projects, which are complexity, dynamism, uncertainty and uniqueness, usually challenge construction project planning and implementation, and hence, construction project managers use construction project strategies to cope with issues, which cannot be described through theoretical formulations in a reductionist approach. The construction project strategies emerging from the award statements are context-dependent solutions, in which construction project managers use tacit knowledge along with explicit knowledge. These findings are considered as validation to the aim and objectives made in this research study to develop a strategy-led approach as a context dependent and practitioner depended approach to introduce characteristics of RP into construction project planning.

In the preliminary analysis, construction project managers are recognized as the focal point of the strategy-led approach although other stakeholders are important to shape up construction project strategies and hence provided supporting facts to leverage construction project managers, who are the NZIOB award recipients, at the primary data collection stage to provide information about the strategy-led approach. Further, the inductive analysis that is done under the preliminary investigation could uncover some foci of attention for strategies, which could not be found through the review of literature. Thus, the findings of the preliminary analysis are a comprehensive piece of work for the subsequent phase of this research study, which is the primary investigation.

The primary investigation stage comprises mainly of, but not limited to, the quantitative analysis to the responses given by the NZIOB awardees to the questionnaire survey. Forty responses, equivalent to a 58% of response rate, are analysed to achieve the aim and objectives of the research study.

Sections 5.3.3 and 5.3.4 focus on describing measures of success and the characteristics of construction projects, respectively, by using both descriptive and inferential statistics.

Hypotheses (H1-H4) are tested at 95% confidence level where it is necessary, and the findings of the analyses in these two chapters describe the scope of construction project planning in terms of ultimate achievements and challenges within the ambit of project planning and implementation. Thus, the findings are in line with the first objective of this study.

Based on reviews of literature, to achieve the third objective of the research investigation, this study has found that traditional planning algorithms have drawbacks due to underpinnings of TR such as reductionism and selective inattention. Hence, this study proposes the strategy-led approach as the alternative planning approach to introduce the features of RP and which are holism and reflective interaction. In section 5.3.5, the hypotheses, H5 and H6, are verified using appropriate inferential statistics at $\alpha=0.05$, with which the study could support its preposition that holism and reflective interaction (characteristics of RP) are more prevalent natures of issues in construction project planning over reductionism and selective inattention.

The next investigation (section 5.3.6.1) is done on another key term of this research study, construction project strategies. Responses to the open-ended questions are analysed by using content analysis to identify the focus of conceptual strategies, the emerging strategies at the implementation stage and any sub-strategies. The analysis could identify major themes that the strategy-led approach applies to plan and implement construction projects. The findings describe the strategy-led approach in terms of 'what' and hence assist to achieve the fifth objective of this study.

In section 5.3.6.2, this study investigates the four project characteristics (complexity, dynamism, uncertainty and uniqueness) and productivity issues for being the reason that project strategies are used in 95% of construction projects. The finding could support this study's position to develop the strategy-led approach in order to cope with these four characteristics to increase productivity in terms of cost, time, quality and client satisfaction.

Similar to the investigation of issues of construction project implementation in terms of TR and RP, construction project strategies are evaluated under TR and RP in section 5.3.7. From statistical verification of H7 and H8, the finding shows that construction project strategies can bring context and practitioners' tacit knowledge into construction project planning as opposed to traditional planning tools based on theoretical formulations that are suggested to any general project context.

Section 5.3.8 identifies the strategy-led approach in terms of typologies. Typologies describe how strategy should be crafted, and hence the findings explain the strategy-led approach in terms of content. By testing H9 at α=0.05 significance level, generative typology is found as more common in construction project implementation strategies over rational typology, and hence construction project managers are encouraged to plan their projects by integrating tacit knowledge extensively in addition to theoretical knowledge. Use of historical data with probabilistic rigour is considered a rational method whereas generative typology considers historical data from a project with similar scope. Further, this section has found that both deliberate and spontaneous typologies are equally important for the strategy-led approach by testing H10 at 95% confidence level. Related to the stability of the planned strategies, both, transformational and revolutionary, natures are equally established under the strategy-led approach (testing of H11).

'Stakeholder management' has emerged as the second most frequent strategy focus in section 5.3.6.1, and thus section 5.3.9 focuses on finding stakeholder contributions (testing hypotheses of H12, H13 and H14). The study has found the construction project managers and clients as the most important stakeholders to the strategy-led approach and hence this study considers that conducting this research study by focusing on experienced construction project managers is justifiable. The study finds that all stakeholders are highly important, except labours that have moderate importance, for the strategy-led approach. Thus, integration methods are considered, and this study has found vision and mission as the most important methods to integrate other stakeholders into the strategy-led approach. Allowing other stakeholders to 'risk taking and experiments' under the strategy-led approach is recognized as unacceptable, sometimes.

Section 5.3.11 considers the influence of strategies towards critical success factors. It is found that all the critical success factors which are found in the literature review and the preliminary investigation are highly influenced by construction project strategies, except in the case of 'coping with plant breakdown', and hence serve as a supportive fact to the current study's position that the strategy-led approach can influence project planning and implementation as a whole.

Section 5.3.12 considers the correlation between the influence of strategies toward critical success factors and the characteristics of construction projects at α=0.05 significance level by using H16. Positive correlations are found, which say that when complexity, dynamism, uncertainty and uniqueness increase, influence of construction project strategies towards the critical concerns of project planning and implementation also increases. Testing of H16 helps this study to support the postulation that construction project strategies are made to cope with complex and uncertain situations in construction projects; an ability that is not present in traditional planning algorithms.

The last section, 5.3.13, considers quantification of the influence of strategies toward achievements in terms of cost, time, quality, client satisfaction and overall success. Since the data distributions of both dependent and independent variables were non-normal, this section uses different transformation techniques, which include both statistical and mathematical operations, to make the variables normal so that they can be analysed under regressions. To find out the significance of the overall models and between the individual variables dependent variables, H17 and H18 are used. With 95% confidence level, and from step-wise regression, this study has identified statistically significant regression models toward the achievements of cost, time, quality and overall success, which is used to achieve the fifth objective of this study: propose the strategy-led approach as a suitable planning approach to cope with the characteristics of construction projects and to achieve ultimate success.

The summary of the inference to the conceptual relationships that are made in Chapter 3 is shown in Table 5.72, which was used for the focus of the validation exercise of this study.

Table 5.72: Summary of the inference to the conceptual relationships made in Chapter 3

Hypothesis	Description	Inference to the hypothesis at α=0.05
H1	Construction project environments are complex to 'high' extent	**Supported**
H2	Construction project environments are dynamic to 'high' extent	**Supported**
H3	Construction project environments are uncertain to 'high' extent	**Supported**
H4	Construction project environments are unique in nature to 'high' extent	**Supported**
H5	Reflective interaction is more important than engineering theories to identify issues related to construction project planning and implementation	**Supported** The ratio of Reflective interaction: Engineering theories is 55:45
H6	Problems related are characterised more towards holism than reductionism	**Supported.** The ratio of reductionism: holism is 35:65
H7	The strategy-led approach is a practitioner dependent planning methodology	**Supported**
H8	The strategy-led approach is a context dependent planning methodology	**Supported**
H9	Generative typology is more common in construction project implementation strategies over rational typology	**Supported** Ratio of 60:40
H10	Deliberate typology is more common in construction project implementation strategies over spontaneous typology	**Not supported**. Both typologies are used equally.
H11	Transformational typology is more common in construction project implementation strategies over revolutionary typology	**Not supported**. Both typologies are used equally.
H12	Individual strategy making is the dominant strategy making methodology in construction project implementation strategies	**Not supported**
H13	The construction project manager's contribution is more important than other stakeholders toward construction project planning and implementation strategies	**Supported** except in the case of client who are equally important
H14	Construction project managers use vision/mission/transact/ learn and improve/ experiment and risk taking/ assign responsibility to integrate other stakeholders into strategy contexts so as to achieve performance benchmarks	**Supported** except in the case of 'experiment and risk taking'.
H15	The overall influence of strategies is high toward construction project planning and implementation.	**Supported** All critical success factors were influenced highly except the moderated influence towards 'coping with plant breakdown'
H16	When the extent of the characteristics of a construction project increase, the influence of strategies on project planning and implementation increase.	**supported**
H17-H18	There is a significant impact from influence of strategies toward the achievements of cost, time, quality, client satisfaction and overall success.	**supported** except in the case of client satisfaction

The mathematical models which were resulted from the regression analysis at 95% confidence level can be summarized as follow for achievements of cost, time, quality and overall success.

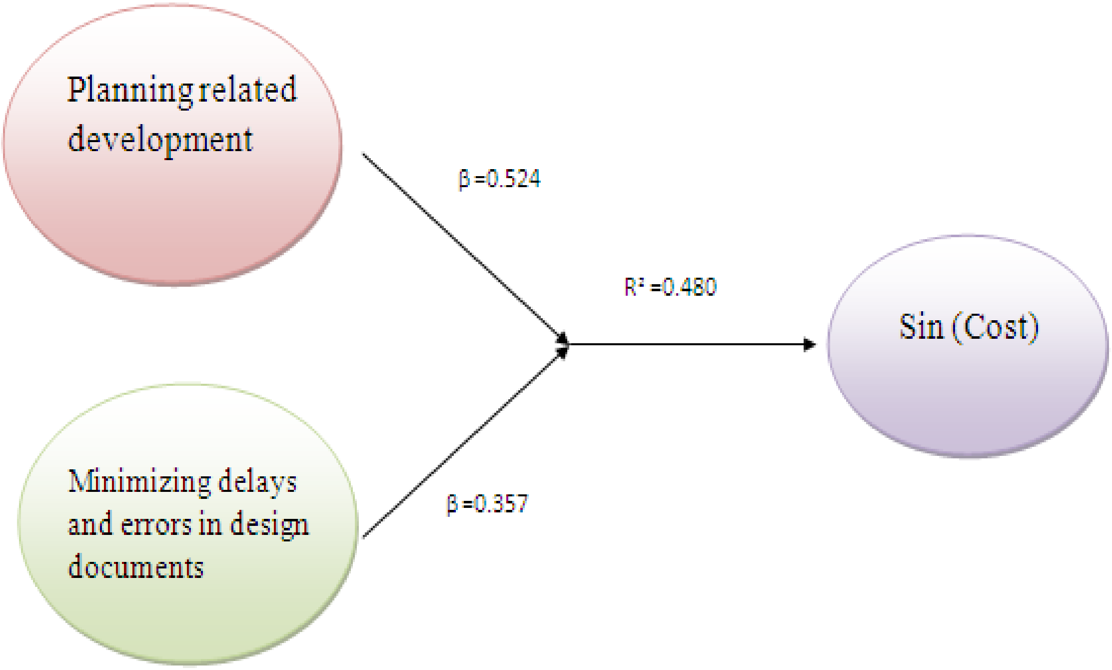


Figure 5.12: Influence of 'Planning related development' and 'Minimizing delays and errors in design documents' towards the Sin value of the achievements of 'Cost'

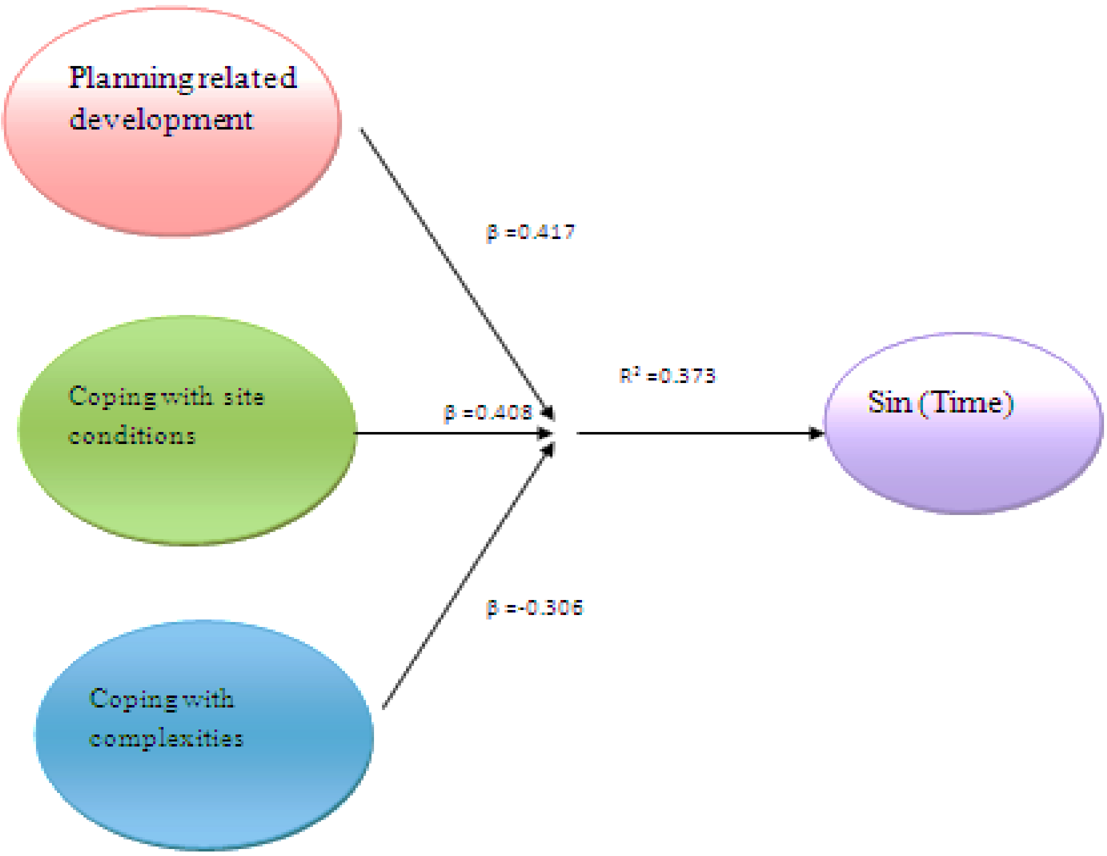


Figure 5.13: Influence of 'Planning related development', 'Coping with site conditions' and 'Coping with complexities' towards the Sin value of the achievements of 'Time'

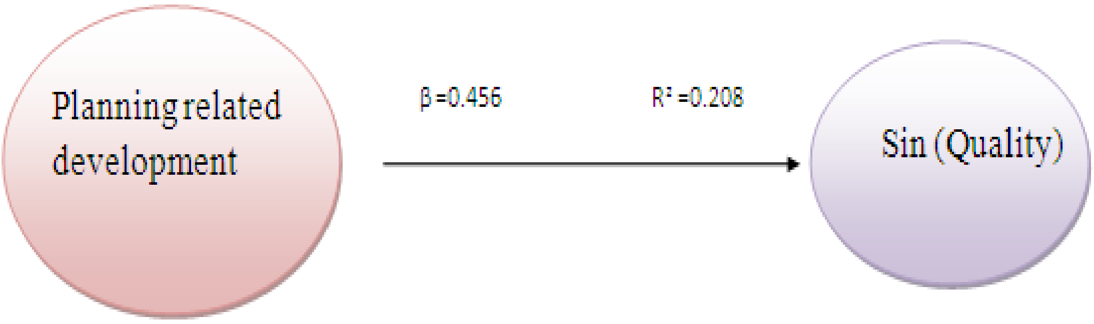


Figure 5.14: Influence of 'Planning related development' towards the Sin value of the achievements of 'Quality'

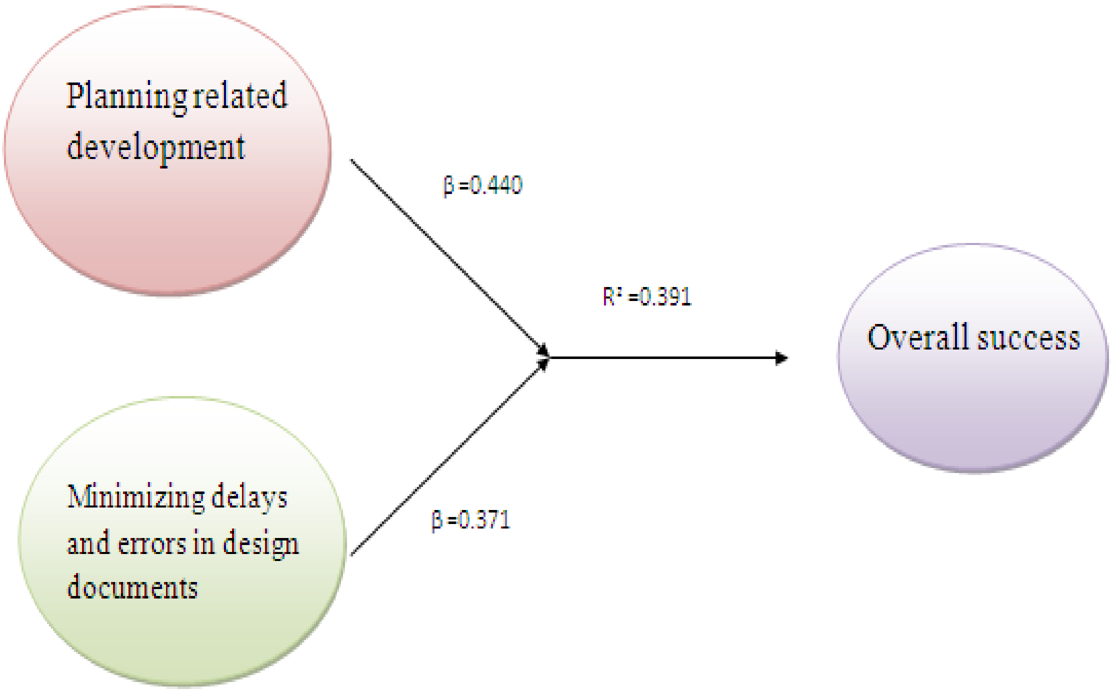


Figure 5.15: Influence of 'Planning related development' and 'Minimizing delays and errors in design documents' towards 'Overall success'

Chapter 6. Validation Exercise

6.1 Introduction

Verification of the findings is a further step of the current research study. Some subject matter experts (SMEs) were approached to provide validation of the study findings and to extend knowledge of the research outputs by way of their personal opinions and perceptions.

The SMEs were requested to provide their opinions and perceptions through semi-structured interviews. Section 6.2 provides a demographical description of the SMEs while subsequent sections present their comments to questions asked during the interviews. All the SMEs are senior construction project managers and NZIOB registered. A copy of the questionnaire is attached as Appendix D.

6.2 Demographic Data of the Participants

Table 6.1 provides an overview of the SMEs backgrounds. The first SME has a diploma qualification. The participant has worked in the industry for 21 years, 10 of which were as a construction project manager.

Table 6.1: Demographic information of the SMEs

Demographic information	**SME 1**	**SME 2**	**SME 3**
Highest level of education	Diploma/certificate	Degree or equivalent	Post graduate
Years of experience in the industry	21	18	15
Years of experience as a project manager	10	11	10

The second SME has an undergraduate degree and is a Chartered Professional Engineer (CPEng). This participant has 11 years of experience as a construction project manager during his 18 years of professional experience in the construction industry.

The last SME used in the study has post-graduate qualifications which include Masters degrees in both construction and business administration. While also being a Chartered Professional Engineer, this SME has 15 years of experience in the construction industry under various disciplines, in addition to experience of about 10 years as a construction project manager.

From the demographic details of the SMEs, it can be concluded that all three participants are well experienced both, as construction project managers and in the industry. Further, since the participants had various levels of educational qualifications, their answers would uncover unique perceptions on how to use educational backgrounds along with experience and judgment in planning for project execution. Since the three SMEs could represent different educational backgrounds related to construction project managers, the current study considered that the use of the three SMEs is adequate under the validation exercise if the findings could be validated by using them.

6.3 The Scope of Construction Project Planning and Implementation

The following key points, related to construction project planning and implementation, have been consistently highlighted throughout the research investigation (shaped through past literature, the preliminary and primary investigations). These key points are condensed here and detailed descriptions are given in chapter 7.

a) There are diverse measures of construction project success but cost, time, quality and client satisfaction are the most prominent.
b) Variations in terms of cost and time are prevalent in the construction industry and contractors are allowed to finish projects with considerable extensions according to the scope of projects.
c) Project environments are usually complex, dynamic, uncertain and unique such that planning as well as implementation becomes challenging.
d) Issues related to construction project implementation cannot be considered separately and further cannot be described by using theoretical formations only.
e) Finally, reductionism and selective inattention mentioned in d) make current planning techniques inadequate to handle construction projects, and consequently complementary planning tools are required to cope with widespread ineffectiveness in current sub-optimal planning tools.

What are the SMEs' Perceptions on these Key Points?

The key concerns mentioned above from a) to e) were rephrased (see Appendix D) and presented to the three SMEs. Their responses were evaluated through content analysis and presented below.

6.3.1 Measures of Success

On whether cost, time, quality and client satisfaction should be considered as the primary concerns of construction project implementation, the SMEs gave the following opinions.

All three SMEs agreed that cost, time, quality and client satisfaction are the primary measures of success in construction project delivery. Variations in terms of cost and time commonly become unavoidable in construction project delivery, but goals are set for each and every project at the beginning to complete the project within a certain duration and budgetary limit. Project schedules and plans are made mainly by taking these goals into account. There are specifications on quality, set for construction projects, and the contractor is bound to secure the quality up to the standard. According to their opinions, client satisfaction is a vital consideration for a contractor to survive in competitive industries, like construction. In addition to winning their future projects, clients' views about contractor's performance build reputations in the industry, which can ultimately help to grow future business opportunities.

SMEs perceptions on construction project success were not limited to these four measures. SME 2 mentioned sustainability consideration as well as, and SME 3 stressed the necessity to satisfy neighbourhood concerns.

According to views of SME 2, concepts of sustainability can be considered within the context of these primary measures of construction project success. For example, alternative design solutions, like reducing the maintenance cost of a building through applying green concepts, ultimately aim to make the client satisfied about the contractor and hence to enhance reputation among competitors.

Further clarification given by SME 3 to subsequent questions showed that satisfying neighbourhood concerns is more appropriate to consider as a critical success factors because it governs construction project success, but is not a measure of success. The ultimate of satisfying locals is to avoid public protest and disturbance of project implementation.

The SMEs' perceptions mentioned above have indicated important criteria to verify the current study's research postulation that cost, time, quality and client satisfaction are the primary measures of success in construction projects. Straightforwardly, SME 1 and SME 2 considered cost, time, quality and client satisfaction as their major concerns in construction project delivery. The third participant provided a versatile perception, but the clarification given through the subsequent question showed that satisfying other stakeholders and interest groups are important to achieve the primary measures of success.

Extracts of the SMEs views are presented below:

> "Every project has its major concerns to be completed within time and budget allocated, even though sometimes there are unavoidable extensions. We worked with the same client several times and their satisfaction is necessary to win future contracts. Clients can help to assure our reputation. There are quality standards set through specifications, and assurance of those quality standards is a must. There are other concerns, also, but it is unusual to have construction projects that consider only reducing life-time cost, while not thinking of reducing construction cost. So, our major concerns always go to cost, time, quality and client satisfaction." [SME 1]

> "Projects can have particular concerns to be achieved, at the end, but generally cost, time, quality and client satisfaction are required to survive as a contractor in business […] some sustainability criteria like green buildings can be treated within the context of client satisfaction." [SME 2]

> "As construction project managers, one of our responsibilities is to achieve goals set for cost, time and quality. We need to satisfy the client so that the company will get more opportunities in future to work under the same clients. The industry is competitive and usually we need to provide more value for their money. However, sometimes, we need to make the neighbourhood happy about the project before thinking of general concerns. Public protest can limit a construction project to an imagination, only. The amount of democracy varies from country to country according to their political constructs. When there is more democracy, we need to think more about potential controversies as well as negotiation methods if the project is to be realized. There are further concerns, also; for example, which kind of development is applicable. Public protest can be higher toward a private contractor than for public authorities." [SME 3]

6.3.2 The Characteristics of Construction Projects

Next, the SMEs were asked about challenges they faced and nature of challenges (key points mentioned in (c) and (d) respectively). For challenges, that construction projects may face, every SME explained how variations could challenge construction project planning and implementation.

SME 1 explained that "construction projects can be very complicated". The second SME said: "project environments are unpredictable, usually". SME 3 perceived: "Project environment is always volatile". Subsequent questions were asked from the SMEs to clarify challenges further.

SME 1 was of the opinion that "unique natures related to design, construction methodologies, stakeholder involvement and site conditions could make construction projects difficult to imagine and hence to plan accurately". SME 2 had a similar perception and made further clarifications: "in every construction project, there is something new, at least. At the beginning, precautions can be taken if projects are visualized. Always, variations should be expected: higher the flexibility generates better plans". To the question, asked to the third SME, on whether there would be a difference between variations and unique natures, he replied: "these issues can be interrelated, but we are usually concerned about what is new in advance; but variations may occur anytime and may become difficult to understand before situations occur".

From these perceptions, the four key words, complexity, dynamism, uncertainty and uniqueness, used throughout the study were mentioned. The SMEs agreed that construction project planning is challengeable due to these four characteristics and they further have articulated the necessity of dealing with four characteristics to deliver construction project successfully. Thus, the interpretation made as construction projects are complex, dynamic, uncertain and unique to a high extent by using hypothetical constructs during the primary investigation (H1, H2, H3 and H4) is considered valid.

The SMEs were then requested to provide their opinions about the nature of problems.

6.3.3 Nature of the Issues in Construction Project Implementation

The findings of the research study related to 'reductionism versus holism' and 'selective inattention versus reflective interaction' were rephrased into the validation questions as shown in Appendix D.

Reductionism versus Holism

The SMEs explained interconnectedness between issues, which are widespread in construction project implementation.

SME 1 was asked how resource constraints could be treated. As one of the options, he described that conservative allowances are made to cope with resource constraints. Thus, there is an opportunity to handle the consequences of resource constraints within the allowances such that other activities will not be influenced. Thus, making conservative allowances can be treated as a strategy belonging to reductionism. When allowances are impossible or inadequate, as an alternative strategy, SME 1 mentioned the use of alternative construction methods, which need holistic view on the consequences of using an alternative construction method. Alternative construction methods may become costlier, but due to the requirement of on-time completion, construction project managers need to apply costlier solutions and manage those cost implications with opportunities available in other activities. An extract of his view is as follows:

> "Usually, more conservative allowances for activity durations are used; when this is not possible, alternative construction methods are decided; this may become costlier, but if on-time completion is more important, alternative construction methods are used to manage resource limitations although construction may become costlier, but that cost can usually be covered by properly managing some other activities" [SME 1].

With no focus on a particular issue, SME 2 was directly asked whether problems could be solved separately without considering overall consequences and interactions. He answered that "Some problems may not have significant influence on other activities, but many do; if interrelations are not considered, the consequences of not doing so will make projects riskier than they used to be". For the subsequent questions he answered: "problems not affecting other issues should be still considered together under prioritizing. Otherwise, more important concerns may remain hidden, while minor concerns are resolved". Therefore, SME 2 seemed to prefer considering issues as a whole which is holism.

The third participant was requested to select any issue voluntarily and to describe, how he would act on that issue. For the selected issue that was to cope with cost variations, SME 3 recommended to "obtain an early estimate of the likely cost; consider additional cost, and ways it can be minimized through some other offsetting". By considering his comment, holistic considerations are required over reductionist approaches.

Therefore, the current study's finding that is shaped through the archival analysis and the hypothesis verification (H6) at the primary investigation as '*problems related to construction planning and to implementation are interrelated with each other*' was validated through the SMEs' articulations. While holistic considerations were usually mentioned in the CIOB award statements, in the primary investigation, the ratio between reductionism and holism was 35:65 at 95% confidence level.

On how the participants use theoretical considerations and their tacit knowledge to act on construction project issues, the participants expressed their opinions next.

Selective Inattention versus Reflective Interaction

According to the thematic analysis done on the participants' descriptions, tacit knowledge is predominant over explicit knowledge, but both types of knowledge together would make construction project implementation realistic. For example, SME 2 explained: "engineering theories have a major role, but intuition is more important". SME 1 and SME 2 described how tacit knowledge should be used in planning. According to the perceptions given by two SMEs, experience and skills of all stakeholders is required to identify issues in the context of construction project planning, including forming, norming, storming, performing and adjourning. Extracts of the transcripts can be given as follow:

> "Field planning!! Tacit knowledge is important, and think-tanks for knowledge and info sharing. A diversified team is always better, a team with, comprehensively, all roles to be included. Team norms and shared appreciation is very vital" [SME 1].

> "Inspiration is a must. Identify team performing phases very well, like forming, storming, norming, and performing and adjourning. Planning also should be phased to rhythm with these team dynamisms to be strategized. Share responsibilities and appreciation substantially" [SME 3].

By considering the above statements, the use of experience and qualities predominately over engineering theories in the CIOB award statements was considered as a valid fact. In the primary investigation, use of both explicit knowledge and tacit knowledge was mentioned, but H5, which says that '*experience and artistry is more important than engineering theories to identify issues related to construction project planning and implementation*', was validated as 45:55 at 95% confidence level. The SMEs had similar opinions.

Having discussed about the scope of construction project planning, the validation exercise focused the SMEs to gather information on how construction projects would be planned and implemented.

6.4 Strategy: its Complementary Role

The following list contains the key issues, which have been found throughout the study related to planning approaches. These key points were formed into interview questions and presented to the three SMEs.

a) Although there are many critiques developed on planning algorithms such as CPM and PERT, they are still in use. Could there be significant influences from them? If yes, how are these sub-optimal planning tools used effectively?
b) In addition to the planning algorithms mentioned in a), there are some strategies used to plan and implement construction projects. How are these strategies used along with other planning tools as a complementary approach to make planning effective and realistic?
c) Strategy-led approaches can bring project contexts into planning and further encourage the use of practitioners' artistry. These two features of strategy-led approaches bring the characteristics of RP into construction project delivery and make the strategy-led approach suitable to increase productivity. What are the SMEs' Opinions about Strategies and other Scheduling Tools?

The three SMEs used for the verification interviews explained how strategies were used along with other scheduling tools in their projects. The key points mentioned under a) and b) were rephrased into the interview questions mentioned in Appendix D.

SME 1 suggests that scheduling tools and strategies would both be important and further articulated purposes of each approach. His general perception of the importance of strategies and scheduling tools was rated as 55:45, and hence strategies would be slightly more important than scheduling tools. According to SME 1, a combination of both scheduling tools and strategies could result in improvements of productivity in terms of cost and time savings.

> "Planning tools are important in planning, tracking & managing construction work but construction strategies such as sequencing works, using alternative materials/techniques etc. usually lead to significant time and cost savings" [SME 1].

Therefore, in addition to the facts found under the primary investigation, the current study's postulation that strategies can improve productivity was validated through SME 1's opinions. In the primary investigation, this research has determined that construction project strategies contribute up to 48%, 37%, 20% and 39% of variance in terms of cost, time, quality and overall success, respectively, at α=0.05 significance level. This fact is an indication of the use of strategies to achieve successful outcomes in the context of construction project planning. Further, in the sample of the primary investigation, use of traditional planning algorithms was mentioned in 92.5% of the projects that were recognized as successfully implemented by NZIOB. The explanation given by SME 1 is a validation to propose the strategy-led approach as a complementary tool to plan construction projects.

To clarify the use of construction project strategies to improve schedules and plans, SME 1 explained how he estimates reliable rates for activity durations through strategic considerations. SME 1 encourages using practitioner artistry as well as contextual background when making estimates that are close to reality. Rather than using probabilities rigours (such as most likely, pessimistic and optimistic durations) without knowing the contexts, SME 1 encourages reviewing past construction projects that have been implemented with similar scope. In this way, construction project managers know the context of the project at the conceptual level, and hence schedules and plans are more reliable. Therefore, according to his perceptions, strategic considerations are to bring project context through practitioners' experience into schedules and plans.

His explanation provides credence to validate the findings of this study that the strategy-led approach is context-dependent and practitioner-dependent. Context dependency and practitioner dependency emerged predominantly from the preliminary investigation of the construction project strategies that the CMYA award recipients used rather than the general rules, which can be applied to any project context. H7 and H8 could verify context dependency and practitioner dependency over general nomothetic rules through statistical generalization.

In CPM algorithm, principle assumptions include unlimited resource availability, which is not the actual case, and hence complementary planning approaches are used for adjustments to the activity estimates after schedules are made. Lu and Lim (2008) describe that usually these complementary approaches conflict the timely achievements which are initially set under the traditional CPM algorithm. By considering these reviews, SME 1 was next asked about his considerations to handle material constraints.

Similar to suggestions given by past scholars, SME 1 recommended making more conservative allowances for activity durations, but conditionally. When project duration is limited, conservative allowances are not possible, and hence alternative planning approaches are required, although sometimes there may be cost implications with the alternatives. Thus, allocations suggested in traditional algorithms become appropriate occasionally. His emphasis on early considerations to construction methodologies indicates the validity of one of the themes, 'effective use of technology', determined under the qualitative analysis of this research study of both, preliminary and primary investigations. In the award statements of CIOB, UK, 'effective use of technology' was the most frequently mentioned strategy focus, whereas, in the primary investigation, 16% of the strategies, that the NZIOB award recipients mentioned as causes of project success, belonged to construction methodologies. Considering these facts, 'effective use of technology' was considered as a major focus of construction project strategies to make schedules and plans.

Further, SME 1 explains how to make allocations for variations, which is another major research focus in the ambit of construction management research discourses to improve traditional planning tools. SME 1 uses two different project calendars as the strategy to cope with variations in schedules. Schedules are made on the basis of a 5-day working calendar and work continues for 6 days if there are variations to recover. In this way, construction project managers can recover 20% of schedule variations, which is adequate to recover typical variations (10-20%) of the projects that were planned through the strategy-led approach as given by the award recipient of NZIOB.

> "…….scheduling the programme on a 5 working-day week, knowing that in practice work will usually occur on a 6 days per week basis. An allowance is usually made for inclement weather. No allowance is typically made for Client requested variations. These can often be accommodated without pushing out the completion date if they are off the critical path" [SME 1].

In traditional planning algorithms like CPM, buffers are suggested to be added to cope with variations, but critics complain about the consequences for productivity (Fallah, Ashtiani, & Aryanezhad, 2010). In the strategy that SME 1 uses, safety time is used only if variations occur and not illustrated in plans and schedules that are made for project implementation. Therefore, his strategy contains no productivity issue, which is an advantage similar to the CCPM algorithm, in which buffers are added strategically at the end of a project without adding safety to each and every construction activity. The addition of allowances for inclement weather should take prevailing climatic conditions into account.

Variations due to the client's desires would not affect schedules because of free-float in non-critical activities. SME1 opined that variations are claimed for client's variations if issues are related to critical activities. Subsequently, he emphasized to effectively negotiate consequences with the client to strategically handle variations outside the scope, especially when the clients has limited budget. Such emphasis can secure smooth cash-flow into the project, as well as client satisfaction and integration into the project, which is a similar observation from the archival analysis of the preliminary investigation, where the construction project managers used value adding techniques to cope with variations outside the project scope although the variations could have been claimed back.

Thus, the strategic considerations mentioned by SME 1 under estimates of activity durations, allocations for resource constraints and variations are all context-dependent and hence practitioner's artistry is required to decide the strategic path. This is a different procedure to traditional planning algorithms which are general and context-independent rules are implemented through mathematical operations where underpinnings are on probabilistic assumptions.

Therefore, SME 1's explanation assisted to expand knowledge on the use of the strategy-led approach to make schedules for construction project implementation, in addition to provide validation to the findings of this research study on the fourth objective, which is to *'propose strategy-led approach for adoption by project managers in the form of a suitable practice to deliver construction projects with successful outcomes'*.

Because SME 1 was asked about scheduling in terms of time predominantly, SME 2 was deliberately questioned about cash-flow planning. There are three strategic ways according to SME 2's articulation, which are front-end loading, tail-end loading and middle duration loading.

Similar to SME 1's perceptions on scheduling in terms of time, cost related planning that is described by SME 2 can occasionally be done through traditional planning algorithms. SME 2 explained that the S-curve is used as a trend line only, but financial planning should be done by modifying the trend line for the project context, which is the purpose of strategic considerations. A construction project can be implemented smoothly if the client's financial condition is considered at the beginning. This can be considered as a negative fact of the strategy-led approach suggested by Abeseykara (2007): rate and rhythm planning (e.g. 2.5 million $ per month for a 10 months project over 25 million $) that this research study postulated as a strategy could only occasionally be realized due to the context-independent nature (section 2.3.2.2). The procedure of financial planning given by SME 2 implies the importance of developing the strategy-led approach in a flexible way which is the objective of this study as described throughout the literature review.

> "Front end-loading and tail-end loading strategies are based on returns. In other cases, a middle duration loading strategy has to be adopted - depends on the country and clients financial capabilities. In that case, S-curve is used as a trend line. Go below the S-curve initially; alarm project staff and main office senior staff; alarm client. Condition the whole team that better team effort is vital; get all stakeholders support; continue on line in middle durations; change pace at the final duration to go ahead. Everybody is happy at last and secures more credit" [SME 2].

SME 2 has similar perceptions to SME 1 about developing schedules in terms of time. To improve schedules, SME 2 encourages understanding the scope of a project comprehensively at the conceptual stage by considering past experiences similar to SME 1. Similar to setting schedules at the conceptual stage, his clarification includes strategy making under the implementation stage to cope with variations and hence, SME 2 has the opinion that schedules made by the strategy-led approach are more flexible to adjust in case of situational change, in addition to reliability gained through consideration of the project contexts at the conceptual stage. Further, he stressed frequent communication with client, consultant and sub-contractors as a strategy to ensure feedback and monitoring towards quality. Quality is considered more suitable over cost by SME 2 to integrate client and consultant into the strategy-led approach; client and consultant may have little or no concern about the profit of the contractor, but quality is definitely one of their primary concerns.

SME 2 believes that uses of the strategy-led approach and planning methodologies like CPM, CCPM, PERT and EVM can deliver benefits to construction project implementation equally, but SME 3 has a different opinion on the importance of traditional planning tools and the strategy-led approach.

SME mentioned that the ratio between the importance of strategies and traditional planning algorithms is 3:2. This is a similar belief to SME 1 who explains construction project strategies are more important over other planning approaches which are widely used in the construction industry. The strategy-led approach is the way to plan construction projects and CPM, PERT, CCPM and EVM should be used to assist planning through the strategy-led approach. This perception agrees with one of the reviews of literature that there are many factors to be considered in addition to schedules, which are critical success factors (Belassi & Tukel, 1996). This research investigation uses Belassi and Tukel's(1996) argument with other scholars (Abeysekara, 2007; Kumar, 2002) to develop a strategy-led approach as a suitable planning method to implement construction projects instead of concentrating on developing traditional planning algorithms like CPM and CCPM (section 2.3.2.2).

According to SME 3, traditional planning tools are considered under the context of strategic considerations which is one of the other bases, that this study has found through the reviews of literature (Wong & Ng, 2010), with significant support to investigate strategy-led approach as a viable planning methodology. Thus, the validation of these reviews of literature through the research method of this study can be used to encourage strategic development in the realm of construction project planning and implementation.

An extract of SME 3's perception about the strategy-led approach is as follows:

> "The scheduling techniques are the tools for the strategies to be formulated. In construction, strategies are initially formulated but they need to be flexible and changed based on situations. Project environ is constantly volatile. Better planning means more room for flexibility" [SME 3].

Even for making schedules that the traditional planning algorithms concentrate on, SME 3 emphasizes that strategic consideration are the most important thing for the general rules, which those traditional planning algorithms bring into practice.

There are some general rules that he recommends. For example, as a strategy to cope with unforeseen conditions, SME 3 uses 10% of the total duration as buffer which is 40% less amount of buffer than that of recommended in CCPM algorithm. SME 3 recommends using 10% of buffer based on his past experience and explains that this amount is not less or more to keep as a safety margin. When time overruns occur, he suggests construction project managers to use subjective interpretations and analytical skills to predict whether the variation can be handled within this limit. When it is not possible, SME 3 keeps alternative construction methods, which may become costlier sometimes, on standby to recover from the influence of variations on the critical path. If there are cost implications with faster constructions, SME 3 recommends other opportunities to be used to recover from those consequences by using value adding techniques. Therefore, this general rule cannot be considered entirely as a context-independent approach. There are holistic and strategic considerations around these rules described above when the rule goes wrong.

> "Both norms and experience are required; Past experience of similar scope considered; the old rate should be still modified for complexities and unforeseen situations; further, consider motivational factors; then calculate volume consequently duration into schedules; evaluate project total duration – apply 10% safety time - adjust" [SME 3].

In the primary investigation, this study has found statistical significant regression models related to planning related development in terms of achievements of cost, time and quality at α=0.05 significance level. SME 3 explains how all these measures of success are integrated into the strategy-led approach by using 'effective use of technology' as requested in the interview. 'Effective use of technology' was selected because it emerged in the content analysis of the open-ended responses as one of the strategic methods to cope with constraints, as well as to benefit opportunities that will ultimately influence schedules and plans (section 5.3.6.1).

SME 3 explained that quality is considered as a pre-condition to select appropriate construction methodologies for all the alternative methods in practice. These construction methodologies may include selection of materials, plants as well as construction methods. To select alternative construction according to the project context, the specifications should be considered thoroughly as well as workmanship that can be achieved under each methodology with available skilled labours. Selecting suitable construction methods at the conceptual stage according to the quality expectations of the client reduce conflicts at the later stage among different parties involved in a construction project. When quality requirements are comprehensively considered at the conceptual stage under the context of strategic considerations, required strategic efforts to achieve initially expected quality at the implementation stage is mostly limited to a quality assurance plan according to the checklists prepared with other stakeholders' involvement.

> "Essential to secure quality according to client's expectations; both time and cost have safety margins; usually, within scope variations can be handled with that safety margins or through counterbalance with other opportunities" [SME 3].

Under strategies related to cost, SME 3 mentioned using 'economies of scale' as the strategy at the conceptual level to evaluate the most appropriate project delivery methodologies. He uses work study as a pre-analysis to comprehend the findings that come out from considering economies of scale. From the work-study, construction project managers identify materials, labour and plant requirements associated with each construction methodology. The output of work-study is used to identify resource limitations with respect to the project (for example unavailability of skilled carpenters to on-site timber construction) and hence to estimate preliminary cost implications to eliminate those constraints. Then, SME 3 uses economies of scale to compare preliminary cost implications and implementations cost with the construction volume to determine the most economical construction methodologies.

SME 3 described further that speed of construction should be considered with each alternative construction method used under economies of scale. This is done with compare to the duration and scope of the project. When cheapest construction method conflicts the achievements in terms of duration, SME 3 considers those situations in a holistic way by prioritizing the requirements and possibilities to discard negative consequences by using opportunities available with other construction activities. Thus, the response given by SME 3 indicates that issues of construction projects are considered in a holistic way (in the above case achievements of cost, time and quality with possible conflicts between achievements of each success measure), which is a validation fact derived through qualitative information to the finding of the primary investigation that holism is the predominant nature over reductionism (reductionism: holism = 35:65 at 95% confidence level).

Under the sub-headings of section 6.4, this study has considered the SMEs' perceptions about the findings that were evaluated through the literature review, preliminary and primary investigations, while expanding the knowledge of strategy-led approach. Having verified the strategy-led approach as a viable method to plan and implement construction projects through the SMEs' perceptions, the validation exercise considers dimensions of strategies.

6.5 Strategy: Its Dimension

In addition to strategy focus that has been mentioned for some selected critical success factors in section 6.4, there are some investigations performed throughout the study related to the dimensions of strategy. An outline of the findings is given below.

a) Both spontaneous and deliberate types of strategies are important. There are construction project implementation strategies which remain stable over time while others frequently change. Further, both generative and rational methods are used to craft strategies, but generative approaches occur more frequently than rational methods.
b) Construction project managers work as the focal point of construction project implementation strategies, but integration of other stakeholders is a must toward the strategy-led approach.

What is the SME's Perception about these Concerns

The three SMEs were required to comment on the research findings listed above. Particularly, they were to provide some more understanding of (a) strategy making typologies and (b) stakeholder involvement. Details of the questions asked are contained in the outline of the interview questionnaire included as Appendix D.

6.5.1 Strategy-making Typologies: Generative, Rational, Spontaneous, Deliberate, Transformational and Revolutionary

Generative versus Rational

In the primary investigation, testing of H9 at 95% confidence has shown that '*generative typology is more common in construction project implementation strategies than rational typology'* while both strategies are used with a ratio of 6:4.

For the question, which of the rational or the creative methods were used to craft strategies, the three SMEs had similar opinions that both typologies are being used, but creativity is more important. Both, SME 1 and SME 2, said that both typologies are used, but generative methods prevail". From the third SME, further clarification could be gained through subsequent questions that strategies can bring both theoretical knowledge and experience effectively into construction project planning; since other planning tools, i.e. scheduling and cash-flow forecast, are closer to theories, strategies in turn tend to be more general. Therefore, according to the SMEs' perceptions, the finding from the quantitative analysis of the questionnaire, which is the statistical verification to H9, is validated.

Spontaneous versus Deliberate

In the questionnaire survey, testing of H10 at α=0.05 significance has shown that '*deliberate typology is equally used in construction project implementation strategies as spontaneous typology'*.

The SMEs were asked to give their opinions on how spontaneous and deliberate strategy making typologies can be used in the strategy-led approach.

SME 1 said that "both typologies are very important and can go one over the other, slightly". SME 2 is of the opinion that both typologies are "equally important to implement projects". SME 3 agrees with SME 2 and further clarified the reason: "I would say 50:50; strategies set in a wide scope, including making schedules, minimize influences due to unforeseen conditions [...] pre-planning and taking emergency actions are both important equally, at the end, to achieve the desired end results".

These responses are indicative that both spontaneous and deliberate strategies are of equal importance. Thus the SMEs validate the findings from the research investigations.

Transformational and Revolutionary

In the primary investigation of this study, testing of H11 at 95% confidence level has shown that '*transformational typology is equally used in construction project implementation strategies with revolutionary typology'*.

The participants had diverse opinions about using transformational and revolutionary typologies. SME 1 opined that there are two kinds of strategies, short-term and long-term. Short-term strategies may focus on a few particular activities and hence could remain unchanged, but long-term strategies would change over time because their scope is broad. In the words of SME 1: "some strategies are made for some particular activities, only, usually easy to make and remain unchanged until work is done. Other strategies usually change over time". SME 2 emphasized that changes are advantageous toward construction projects because "changes keep people attached to schedules and plans". The third participant is of the opinion that strategies should be flexible. He said: "Day-by-day at least little changes can happen. But rigours, i.e. for example the main focus, can remain unchanged throughout the project".

Considering the SMEs' perceptions, both typologies are important although the contribution could not be found as 1:1 as determined through the statistical analysis of testing H11. Transformational strategies encourages the construction project managers to analyse strategic solutions to craft them up to a reasonable stability over time whereas revolutionary strategies encourages keeping the strategist attached to the strategy-led approach throughout the project implementation.

6.5.2 Stakeholder Involvement

Stakeholder management is rated as the second most frequent strategy focus (22% of the conceptual strategies; 25% of e strategies merging at the implementation stage; 45% of sub-strategy focus) in the responses given by the NZIOB award recipients after strategies focused on 'planning related development (section 5.3.6). In section, 5.3.9.2, construction project managers and clients are rated with 'very high' importance whereas the lowest importance is labours that the construction project managers consider as 'neutrally' important. Other stakeholders were of 'high' importance to implement construction projects through the strategy-led approach according to the statistical analysis done for H14 at 95% confidence interval.

The SMEs asked about the importance of the stakeholders into the strategy-led approach.

About the importance of themselves toward the strategy-led approach, they all have similar perception that the construction project managers are the centre of construction project strategies. Having said that, they explained to which extent other stakeholders are important. SME 1 said: "every stakeholder is important; for different purpose, they have important roles". Similar perception was held by SME 2, but further added that client and consultant are more important to craft main strategies than others, because their agreement and approval could become vital. In SME 2's words, "sub-contractors and suppliers come into some strategies; project team is important to carry out strategies". SME 3 added that stakeholders outside the own organization and who were client, consultant and sub-contractors should be integrated before implementation. "Different organizations come together with diverse contract obligations" he described. According to SME 3 it is "easier to control people at lower hierarchy levels; at different levels, they are taken into project strategies. Better to communicate with sub-contractors, site managers and engineers on available opportunities and better construction methods; their suggestions are important, but should be comprehensively analysed for consequences". SME 3 opined that transaction with stakeholders could result in increasing motivation of other stakeholders although their suggestion may be impracticable.

Since labours are rated as neutrally important in the questionnaire survey at α=0.05 significance level, SME 3 was requested to comment on their importance in strategy crafting and implementation. He opined: "labours are important; they implement plans, but under supervision: use hard-nosed lieutenants as deputies' model while charismatic-colonel leadership is followed". According to his opinions, labours' influence is neutral although they are important to construct the project physically. Low level of authority, i.e. they are bound to work under their contract obligations, is considered as the reason to make them neutral toward the strategy-led approach.

Therefore, the findings of the primary analysis are considered as a validated by the SMEs' perception.

Integration of other Stakeholders to the Strategy Context

Through the review of literature, this research study uses six integrations methods, which construction project managers use to incorporate other stakeholders into the strategy crafting. In the primary investigation, the construction project managers' agreements to use them are evaluated at α=0.05 and these six methods are 'vision' (very high to high), 'mission' (very high to high), 'transact with stakeholders' (high), 'learning and improving' (high), 'responsibility for performance benchmarks' (high) and, 'experimenting and risk taking' (neutral).

The SMEs were asked for their perception on using these six methods to integrate other stakeholders into the strategy-led approach.

In responses to the questions on stakeholder importance, it emerged that 'transaction with stakeholders' was important in strategy crafting. Further, they were asked to provide their perceptions on how vision and mission were used to integrate stakeholders into construction project strategies.

The three SMEs had similar perceptions about vision and mission as well their importance toward strategy context in terms of stakeholder integration. Vision and mission seem to be the closest criteria toward strategies among the six policies used in the questionnaire survey. It is the way of communicating strategies in simple terms or in detail, as described by SME 2 and SME 3, respectively. Therefore, vision and mission are one after another as the top-most policies to integrate strategies could be considered as valid.

Further, the three SMEs agreed to the fact that responsibilities should be shared between stakeholders according to their positions. SME 3 said: "performance milestones are goals which divide final objectives over time". SME 2 described why 'learning and improving' should be allowed under implementation of construction project strategies. He said: "we cannot expect that similar strategies have previously been experienced by the project team; learning and improving should be allowed for novel strategies at the beginning". Therefore, five out of six policies that had been rated as advantageous under the questionnaire are validated through the SMEs' statements.

SME 1 disagreed to allow 'experimenting and risk taking' as an integration method in the strategy content. Indeed, SME 1 described that strategies have their own risk, but that risk taking should be distributed among all; at least among top-most authorities. SME 2 opined that stakeholders should be integrated into strategies: "no matter how it is done. Some are involved in crafting and some in implementation. When all are linked together, there is no risk taking limited to one party". However, the third SME opined that there would be risk taking which would be allowed even for labours. According to SME 3, it seemed that site engineers and labours were allowed to take risk for minor strategies which are relevant on lower levels than the overall project level. SME 3 opined: "labours may use easier and faster construction; if there is no impact on quality of construction, there is any need to take that risk beyond supervisory level". Therefore, ability of risk taking should be considered by considering minor levels of strategies according to SME 3's opinions.

Therefore, the findings of the primary investigation are considered as validated. Extracts of the SMEs' perceptions are as follow:

> "People in a construction project come from different backgrounds; vision can give common identity to all. It describes what we are going to achieve by a strategy. Mission clarifies how that strategy can make differences compared to normal practice: all strategies may not contain necessarily vision and mission in a formal way, but major strategies usually do" [SME 1].

> "We cannot wait until things happen as expected. Opportunities should be identified and strategized. Strategies come out as vision, mission and objectives; once a strategy is decided, usually, these things are clarified in simple terms, verbally or as statements. This inspires others and they feel they are involved and important" [SME 2].

> "Vision describes ultimate goals of a strategy. It is described in-detail in a mission statement; what should be done by each person and why!!! These two come together. Vision is more stable than mission; mission will be changed during implementation, based on feedback, but still vision can be the same as long as strategy is not changed" [SME 3].

6.6 Conclusion

This chapter collects synthesizing as well as anesthetizing facts through dialectical information towards the findings which have been shaped through both preliminary and primary investigations. The current study is based on post-positivism, consequently methodological multiplism, which encourages validating findings through triangulation, is followed. Therefore, the validation exercise was considered as important. Attempts were made in this chapter to validate the findings under three major areas: scope of construction project planning, complementary role of strategies and finally some dimensions of strategies.

Section 6.3.1 explains SMEs agreements towards the research findings of this research study on primary success measures and hence the verification exercise is in line with objective 1 of this research study. The SMEs' perceptions mentioned above have indicated important criteria to verify the current study's research postulation that cost, time, quality and client satisfaction are the primary measures of success in construction projects.

To validate the research finding that complexity, dynamism, uncertainty and uniqueness, which are the characteristics of construction projects, are highly challenging for construction project planning and implementation, the SMEs' opinions were analysed in section 6.3.2. Construction project planning is challengeable due to these four characteristics and the SMEs further have articulated the necessity of dealing with these four characteristics to deliver construction projects successfully. Therefore, this finding validates the current study's postulation that reliable planning approaches should be developed for the construction industry to effectively handle challenges related to these characteristics. It constructs significance to the current study which develops the strategy-led approach to handle complex and uncertain situations.

Section 6.3.3 focuses on the nature of issues related to these four characteristics by using distinctiveness of TR and RP. SMEs' opinions show that problems related to construction planning and to implementation are mostly interrelated with each other, and hence agree with the research findings that reductionist considerations in the traditional planning algorithms should be replaced with holistic considerations, which is one of the purposes of developing the strategy-led approach. Further, SMEs' opinions validate the findings that experience and artistry is more important than engineering theories to identify issues related to construction project planning and implementation, although both explicit and tacit knowledge are important. These findings verified through the SMEs indicate that construction project planning and implementation is characterized more towards RP natures. Therefore, the strategy-led approach is considered to eliminate the identified drawbacks of TR in traditional planning algorithms, which are identified through literature review to achieve the third objective of this study.

The fourth objective of this study is to propose a strategy-led approach for adoption by project managers in the form of a suitable practice to deliver construction projects with successful outcomes. To verify the research findings related to this objective, sections 6.4 and 6.5 describe opinions of the SMEs.

In section 6.4, the use of construction project strategies are identified related to their focus that emerged during the preliminary and primary investigations. It is verified that construction project strategies are used to improve schedules and ensure cash flow in addition to selecting the most appropriate construction methodologies by integrating the context of the projects into planning. Further, section 6.4 describes how the SMEs use both tacit and explicit knowledge to craft suitable strategies, and therefore the strategy-led approach is dominant with the characteristics of RP, which makes it suitable to plan construction projects along with traditional planning algorithms such as CPM, PERT, CCPM and EVM.

Section 6.5.1 verifies the finding on the typologies, which is considered as another way of describing the strategy-led approach to achieve the fourth objective of this study.

From the opinions of the SMEs, it is verified that generative typology is used more than rational typology while other four typologies, spontaneous, deliberate, transformational and revolutionary, are equally used.

Section 6.5.2 verifies the finding of this research study that the construction project manager is the focal point of the strategy-led approach, and hence the finding is in line with the second objective of this study to recognize the contributory role of the construction project manager in achieving an outcome (be it success or failure). In addition, this verification exercise could expand the know-how of using different integration methods effectively to incorporate other stakeholders into the strategy-led approach effectively.

The validation exercise can be considered as a piece of work to comprehend the discussion in the next chapter.

Chapter 7. General Discussion

7.1 Introduction

The main points of synthesis of the whole research findings are explained in this chapter. The chapter includes the points that have been shaped through the preliminary stage that are literature review and the archival analysis of CMYA award statements. Further, discussions on the primary investigation stage, which are the questionnaire survey and the validation exercise, bring the findings in line with the preliminary points outlined. The chapter can be considered as the triangulation exercise of the current study merging the findings of both quantitative and qualitative methods to evaluate the reality under the roots of post-positivism.

The literature reviewed and mentioned in Chapter 2 provides direction toward understanding the issues related to construction project planning and implementation. Through identification of current conditions, the chapter provides solutions to manage problematic situations by using construction project implementation strategies to complement the current planning methods. The focus was to identify deficiencies of the current planning tools because addressing those drawbacks is essentially the purpose of strategies. The drawbacks of traditional planning tools and the purpose of construction project strategies include:

- Project planning and implementation fail to deliver desired outcomes to the industry in terms of productivity.
- Current planning techniques are not capable of handling increasing complexity, dynamism, uncertainty and uniqueness of construction projects.
- Planning tools are underpinned by the TR paradigm, but the real world is complex and uncertain, consequently RP becomes the only viable alternative paradigm to solve uncertain and complex situations successfully.
- A suitable construction project planning approach needs both rational and generative planning and therefore a combination of TR and RP paradigms.
- By using strategies as a complementary planning method, current planning tools can be used to achieve successful ultimate outcomes.

These identified key points were evaluated in the preliminary investigation of the current study. Thereafter, the above set of issues was resolved into knowledge gaps, which were further investigated in the subsequent stages of the research study. These knowledge gaps include:

- Extent of the characteristics of construction projects that challenge construction project planning and implementation
- Governing natures of TR and RP in actual problems related to construction project planning
- Impact of strategies and the characteristics of construction projects toward project success
- Dominant natures of TR and RP in the strategy-led approach
- What is strategy-led approach in terms of the three dimensions: process, content and context?

The knowledge gaps identified at the problem identification stage of the research (through literature and archival analysis) were used to prepare the questionnaires and interviews for the data collection and analysis stage. The interviews at this stage of the research were designed as validation interviews to verify the research findings and extend knowledge where necessary. The interviews were undertaken with subject matter experts (SME) that were carefully selected to meet the objectives of the research.

The main themes achieved by the research investigations are discussed under the following sub headings.

7.2 Synthesis of Findings

The synthesis of the research findings is discussed under two headings, which are 'scope of construction project planning' and 'construction project strategies'. Under these two key headings, there are sub-headings addressing themes covered by the research investigation.

7.2.1 Scope of Construction Project Planning & Implementation

Syntheses based on the scope of construction project planning and implementation is discussed under three sub-headings which are 'measures of success', 'characteristics of construction projects' and 'nature of issues in construction projects'.

Measures of Success

Under the current study, there were two postulations made about industry's primary demands on success. The first postulation is that cost, time, quality and client satisfaction are the most commonly used success measures for construction projects. The other postulation is that overruns in terms of time and cost may or may not be necessarily considered as failures (section 3.2). Based on these assumptions, project success is calculated in this research investigation to be used in regression analysis.

Although there are no exact ways to determine construction project success (Belassi & Tukel, 1996), among the measures which past scholars have used in their studies, cost, time, quality and client satisfaction are usually considered to indicate construction project success. From the studies outlined by Chan, Scott and Lam (2002), most scholars mention cost, time and quality (75% for each) as concerns of their research focus. These three measures are followed by client satisfaction (35%). With this observation as an indication of industry's demand, expectations of the industry were evaluated under the archival analysis (section 5.2.4).

The archival information provided by the CIOB, UK, provided an opportunity to investigate the industry's perception about success as an overall trend, because award selection was done by representatives from the entire industry (CIOB, 2010). The performed frequency count showed that around 75% of awarded projects had concerned time and cost whereas 65% and 45% of the award statements had mentioned quality and client satisfaction, respectively. By considering the archival analysis and past literature, it was possible to decide that cost, time, quality and client satisfaction are the primary concerns of construction project delivery.

Apart from the above facts, the primary data collection allowed the participants to mention other criteria that they considered as measures of construction project success. Among the 40 responses, 7.5 % mentioned that they had other concerns in addition to the four criteria given to rate. Their concerns under 'other' were similar and generally to satisfy neighbourhood of the construction sites. However, when this success criterion was reviewed with their open-ended responses, the current study considered that the emerging criterion would be more suitable to consider as a challenge for construction project implementation rather than a measure of project success: satisfying the local community ultimately worked as a strategy to cope with public protest against some projects. Thus, satisfying the local community is a critical factor that governs ultimate success of a construction project.

The SMEs perceptions were used further to rationalize the four concerns as primary measures of construction project success (section 6.3.1). Other criteria such as sustainability of the projects are required to be considered under construction project implementation. However, cost, time, quality and client satisfaction are the top most concerns according to the SMEs. According to the opinions of SMEs, it is unusual to have construction projects that consider reducing life-time cost through applying energy efficient concepts while allowing cost overruns at the construction stage. Further, mostly, sustainability concerns can be considered under the contexts of the four primary concerns. For example, sustainability criteria such as green buildings can be considered under the context of client satisfaction. Therefore, the SMEs further validated cost, time, quality and client satisfaction as the most commonly used criteria to measure construction project success.

The current study set measures of success in the primary investigation such that time and cost overruns due to variations are not considered as failures. The archival analysis on the award statements of CIOB, UK, showed that the industry has allocations for extensions under variations of scope according to the causes for these variations to occur(section 5.2.2), i.e. changes to client's desires and unforeseen ground conditions as well as urgency to complete the project on time (Chartered Institute of Building, 2010a). Past scholars (Belassi & Tukel, 1996; Gardiner & Stewart, 2000) are of the opinion that no stakeholder in the construction project environment expects any longer to deliver construction projects within the initial budget and time line. The SMEs opine that variations outside project scope could be claimed while variations within scope should be minimized by using value adding techniques. By considering these facts together, it can be concluded that success measures set for the research study, cost (variations considered), time (variations considered), quality and client satisfaction are generally valid in any construction project delivery.

Characteristics of Construction Projects

Literature shows that complexity, dynamism, uncertainty and uniqueness are the key project characteristics that make construction project planning and implementation difficult and unpredictable if using only traditional planning algorithms (Sriprasert &

Dawood, 2002; Wong & Ng, 2010). In other words the project characteristics influence whatever strategy is to be applied to any construction project.

The archival analysis of the UK award statements showed that complexity was among the four project characteristics that were most widely mentioned as a challenge posed to projects (section 5.2.2). By testing the hypotheses H1-H4, a similar observation was found in the primary data analysis by having the highest severity at $\alpha=0.05$ significance level (> 7.5 out of 10) for complexity among the four project characteristics (section 5.3.4.3). Therefore, the findings agree with the findings in literature that construction projects are complicated, and hence difficult to understand. Complexity is followed by uniqueness of construction projects (> 7 out of 10) according to the primary investigation although the content analysis on the CMYA award statements could not find issues related to uniqueness, frequently. However, the SMEs agree that complexity and uniqueness are usually interrelated and hence reasonable to rank one after another. The SMEs articulate that unique natures related to design, construction methodologies, stakeholder involvement and site conditions could make construction projects difficult to visualize (complex) and hence to plan accurately (section 6.3.2). Based on literature findings (Clough, Sears, & Sears, 2008; Long & Ohsato, 2007), uniqueness is considered by the current study as one of the major reasons that nomothetic theories fail to achieve desired results in construction project delivery. Hence, the findings and the SMEs explanations together imply the requirement of developing idiographic planning approaches to the construction industry, which is one of the major reasons to investigate the strategy-led approach in this research study.

According to the testing of related hypotheses of the characteristics of construction projects at 95% confidence, dynamism and uncertainties are ranked after complexity and uniqueness in the primary investigation, but these two factors highly influence the construction project planning and implementation (> 6.5 and > 6 out of 10, respectively). The SMEs agree that these two contingencies could usually influence construction projects. They further explain that issues related to dynamism and uniqueness can be mostly solved locally, compared to complexity and uniqueness, which usually would need global understanding about the construction project under implementation (section 6.3.2). Therefore, when the project delivery strategy model is crafted at the conceptual stage, more attention is paid toward complexity and uniqueness, which need more global understanding compared to dynamism and uniqueness.

Considering these facts, construction project planning and implementation can be considered to be largely influenced by the characteristics of construction projects, which are complexity, dynamism, uncertainty and uniqueness. The conclusion can be taken as agreeable with the evolvement of project management theories which have been shaped up through nearly a century from rational ‘classical approach’ to more innovative ‘dynamic’ engagement (Fryer, 2004). Therefore, the aim of this study, which is to develop a strategy-led approach complementary to traditional planning algorithms to cope with characteristics of construction projects effectively, can be considered as significant to improve construction project implementation.

Nature of Issues in Construction Projects: Technical Rationality versus Reflective Practice

Dias and Blockley (1995) articulate that parts of an issue can never duplicate the whole if the interrelations between the parts are not considered, which is one of the opinions to hypothesize conceptual inequality through H6. The reductionist approaches (a nature of TR) underpinning traditional planning algorithms solve problems by dividing the whole into parts, and consequently, those conventional planning methodologies cannot deliver intended outputs in construction project implementation.

The current study’s primary investigation found that both reductionist and holistic procedures can be used to diagnose issues of construction project implementation. However, according to the research findings, most issues related to construction project implementation cannot be considered isolated from other issues that are applicable to the same project. The questionnaire survey showed that the ratio between reductionism and holism is 35:65 at 95% confidence (testing of H6). Further, frequency count of archival information provided by the CIOB, UK, showed that 72% of issues were likely to be interrelated with other issues (section 5.2.3). Therefore, holistic considerations should be integrated into construction project planning, instead trying to solve issues related to construction project implementation through traditional planning algorithms which are underpinned by reductionist principles.

The subject matter experts agree (section 6.3.3). According to them, only in some situations is it possible to provide solutions to issues related to a construction activity without considering consequences for other activities of the project; mostly interactions should be considered. Minimizing negative consequences among activities associated with construction project issues and related solutions, and prioritizing between several project implementation issues that need strategic considerations can be given as two example for the need of construction project managers for holistic considerations. Further clarifications of the SMEs revealed that, more important project implementation issues and opportunities can become hindered if construction project managers do not understand them in a holistic manner, and hence, planning methodologies have to be underpinned by RP (Wong & Ng, 2010).

The preliminary archival investigation has shown how stakeholder responsibilities should be considered in a holistic manner. For example, variations outside scope can be claimed (the SMEs agree, too), but when contractors try to lock in the original budget by adapting value adding techniques, there are benefits such as ensuring smooth cash-flow into the project in addition to the cooperation of clients to implement projects successfully, which lead to a successful project delivery at the end (Chartered Institute of Building, 2010a). Considering these arguments, the postulation made is a foundation to develop the strategy-led approach, i.e. traditional planning methodologies are not adequate to clarify issues of project implementation successfully. Providing solutions by dividing the whole into parts is the approach of mathematics which is now recognized as inadequate to handle practical situations due to inherent complexity (Dias, 2002). Lu and Lam (2008) describe the consequences of mathematical rigours based on reductionism in CPM by using conflicts between early start time adjustments and timely achievements, and hence the requirements to consider issues in a holistic manner, which should be reflected by new advancements in planning methodologies.

In addition, Rand (2000) opines that the most critical concerns of construction that govern success cannot be explained through theoretical backgrounds. The archival analysis provided credence for this statement. 97% of challenges which are mentioned in the CMYA award statements as challenges towards project implementation indicated that contribution of tacit knowledge is essentially required in addition to theoretical knowledge to identify them comprehensively (section 5.2.3). Thus, an inequality was considered through testing H5 at the primary investigation through statistical inference in the population.

The participants in the questionnaire survey further clarified problems they faced as predominantly clarified through reflective interaction as opposed to theoretical formulations. The ratio between using theoretical formations and reflective interaction was 45:55 at 95% confidence level according to the preliminary investigation (testing of H5 in section 5.3.7.1).

The SMEs opine that theoretical knowledge is important, but tacit knowledge dominates explicit knowledge. Further, both types of knowledge together can make construction project implementation realistic under complex and uncertain situations (section 6.3.3). The SMEs' clarifications are similar to the Soft System Methodology (SSM) which believes that real world problems are complex and difficult to be clarified only through theoretical formations (Dias, 2002). Thus, the suggestion that construction project managers should become reflective practitioners from inception to completion of their projects (Winch, 2010) has been reinforced through the current study by the findings of both, qualitative and quantitative, methodologies. Since traditional planning algorithms are based on rigours of mathematics (Fallah, Ashtiani, & Aryanezhad, 2010; Kaka & Price, 1993), complementary approaches are required to improve traditional planning tools by enhancing the capability of problem identification through reflective interaction and hence, this is a similar concluding remark to the aim of this research study.

7.2.2 Construction Projects Strategies

This section describes the influence of construction project strategies on cost, time, quality and client satisfaction that are synthesized as primary measures of success in section 7.2.1. Further considerations are given under this synthesizing exercise to validate its complementary role with the traditional planning algorithms. The nature of the strategy-led approach is described in addition to these considerations.

7.2.2.1 Influence of Construction Project Strategies on Project Implementation

The primary investigation of this research study showed statistically that construction project strategies can significantly influence the primary measures of success except in the case of client satisfaction (section 5.3.13.5). At 95% confidence level, 46% of variance related to achievements of cost is governed by influence of strategies to improve project implementation. For time and quality, the amounts of variances governed by construction project strategies are about 37% and 20%, respectively. Further, at $\alpha=0.05$ significance level, 39% of variance related to overall success, which includes client satisfaction in addition to cost, time and quality, is governed by construction project strategies. Therefore, the current study's postulation, which was developed out of suggestions within literature (Abeysekara, 2007; Wong & Ng, 2010), that strategic considerations can significantly contribute to the primary measures of construction projects is validated through statistical tests belonging to H17.

Construction project success is strongly impeded by the four characteristics which are complexity, dynamism, uncertainty and uniqueness(Sawhney, Mund, & Chaitavatputtiporn, 2003). Development of strategies can enhance construction project managers' ability to handle these challenges effectively (Fryer, 2004). The correlation analysis done in the primary investigation to test H16 showed that there are significant positive correlations between the four project characteristics and influences of strategies on critical success factors at $\alpha=0.05$. Thus, the ability of the strategy-led approach to cope with complex and uncertain situations, which is not a feature of traditional planning algorithms (Long & Ohsato, 2007; Schon, 2001), is considered as a reason to accomplish the above achievements in terms of cost, time, quality and overall success in the past successful projects planned and implemented based on construction project strategies.

Supporting the statistical testing mentioned above, the content analysis that is done on the responses obtained from open-ended questions found that these four characteristics are major reasons to craft strategies by construction project managers. In 35% of projects, productivity issues are mentioned as one of the reasons to make construction project strategies while 60% of the reasons could be considered under the four characteristics of construction projects (section 5.3.6.2). Thus, construction project strategies are capable of influencing the primary measures of construction project success by handling challenges related to the four characteristics effectively. Supporting these findings, there are 136 issues related to the four project characteristics along with strategic solutions provided to cope with them in the archives of the CIOB award statements (section 5.2.5).

Two of the SMEs opine that strategies would be more important than traditional planning algorithms to achieve successful outcomes in construction projects while one SME opines that strategies are of the same importance as CPM, PERT, CCPM and EVM (section 6.4). By considering these findings shaped throughout this research investigation, the study could achieve one of its objectives, which is that strategy-led approaches can be used to improve plans and schedules under highly challenging project environments to achieve desired outcomes in terms of cost, time, quality and overall success.

Under overall success, this study considered client satisfaction, in addition to cost, time and quality. However, under the scope of this study, the research could not model the behaviour of client satisfaction under the influence of the strategy-led approach.

7.2.2.2 Complementary Role of the Strategy-led Approach to the Traditional Planning Algorithms

The current study's intention is to develop the strategy-led approach to work complementary with traditional planning algorithms. Regardless of pros and cons developed around the traditional planning methodologies, this study takes the position that they benefit successful planning and implementing construction project. The purpose of the strategy-led approach is to improve the reliability of schedules and plans made with traditional planning algorithms.

CPM, PERT, CCPM and EVM are widely used traditional planning algorithms in the industry (Mensi, 2010). The questionnaire survey provided evidence of this. The primary investigation found that the CPM was used in 75% of projects alone or with other scheduling tools by the NZIOB award recipients (section 5.3.1). 97.5% of projects used at least one of the tools among CPM, PERT, CCPM and EVM. In addition these four tools, main and sub-strategies (sub-strategies are the supportive strategies for main strategies) are used to plan and implement construction projects by the NZIOB award recipients.

Similarly, the archival analysis showed that strategies are used at the implementation level of construction projects (section 5.2.5). Therefore, the past scholars' suggestion to use strategies as a complementary approach to work with scheduling techniques (Kumar, 2002) seems to be valid. Further, the SMEs articulate that both strategies and scheduling tools are of high importance to achieving desired end results of a construction project. This study believes that the strategy-led approach can influence construction project planning and implementation as a whole. To represent the scope of construction project planning and implementation as a whole, this study used critical success factors by considering the perceptions of past scholars (Belassi & Tukel, 1996; Kumaraswamy & Chan, 1998).

From the statistical testing for H15, the study has found that the influence of construction project strategies toward the 35 critical success factors are high (> 7.5 out of 10) at $\alpha=0.05$ significance (section 5.3.11). These 35 critical success factors include suggestions of past scholars as well as the industrial perception gained through the content analysis of the CMYA award statements (section 5.2.5). Only one critical success factor, which was ‘coping with plant break-down’, had neutral impact from construction project implementation strategies at $\alpha=0.05$ significance level.

The SMEs mentioned versatile activities that strategies can be applied, including making flexible schedules, calculate activity durations according to project contexts, cope with variations, cash-flow management, team building, knowledge sharing, and ensuring feedback and monitoring (section 6.4).

Thus, this study considers that the strategy-led approach developed under this research investigation is capable of improving construction project planning and implementation as a whole. Therefore, construction project managers have more flexibility to use the strategy-led approach to handle any circumstances within the scope of construction project planning and implementation.

Although the strategy-led approach can influence each and every critical success factor positively according to these findings, there are variations among the influences of strategies toward the 35 critical success factors. From all the critical factors, this study considered only a few factors for the validation and to extend knowledge further by interviewing the SMEs.

In the regression analysis of the primary investigation, there are some variables that are significantly and mathematically correlated with the achievements of cost, time, quality and overall success at $\alpha=0.05$. These factors are: ‘planning related development’, ‘minimizing delays and errors in design documents’, ‘coping with site conditions’ and ‘coping with complexities’.

Among these factors, ‘planning related development’ is the only variable that significantly influences all the success measures at $\alpha=0.05$ significance level except in the case of the client satisfaction that is suggested for further studies (section 5.3.13.5). The quantitative analysis under the primary investigation has determined that construction projects accomplish only around 90% of the initial expectations of achievements in terms of cost, time, quality and overall success, when the influence of construction strategies is moderate (5 out of 10) toward ‘planning related development’. When the influence of construction project strategies is very high toward ‘planning related development’ (10 out of 10), achievements of cost, time, quality and overall success are increased significantly at $\alpha=0.05$ as mentioned below (section 5.3.13.5).

- Achievements of cost toward the initial expectations can be increased from 90% to 134%.
- Accomplishment toward initial expectations on timely completions can be achieved from 90% to 105%.
- Initial quality expectations can be realized from 90% to 114%.
- Achievements on overall success toward initial expectations can be increased from 90% to 108%.

Thus, in statistical point of views, this study is certain that influence of construction project strategies toward 'planning related development' can significantly influence project success.

'Planning related development' is a component factor, which is transformed under the primary investigation to make the original variables normally distributed (section 5.3.13.4). The original factors that comprised in 'planning related development' are:

- Coping with variations
- Improving schedules and plans
- Ensuring feedback and monitoring of progress
- Effectively using technology, and
- Ensuring contractor's cash-flow

In the archival analysis of the CIOB award statements, improving schedules and plans, coping with variations and effectively using technology are among the top-most frequently mentioned strategy foci by the CMYA award winners, which means that construction project managers consider the factors related to 'planning related development' as a major focus of construction project strategies to improve project implementation (section 5.2.5).

Further, from the content analysis of the qualitative information within the open-ended questions, the primary investigation of this study has determined that the above factors related to 'planning related development' is the most frequent concern of the NZIOB award recipients when they craft construction project implementation strategies.

Among the construction project strategies mentioned by the participants of the primary investigation, 50% of the conceptual strategies are related to improve schedules and cope with variations. Further, 25% of main strategies emerged at the implementation stage, and 27% of sub-strategy strategies are related to financial management and ensuring feedback and monitoring of progress which are related to the items of the component factor ‘planning related development’ (section 5.3.6). Altogether, ‘planning related’ strategies in the content analysis of the responses to the open-ended enquiries count for 35.5% of total construction project strategies. In addition, another 7% of construction project strategies are related to design alternatives, which essentially influence schedules and plans. There are 16% of construction project strategies, which are related to the effective use of technology in the responses given by the NZIOB award recipients (section 5.3.6.1). Therefore, according to the content analysis of the responses to the open-ended questions in the primary investigations, nearly 60% of them are related to the five critical success factors considered under the component factor ‘planning related development’. Thus, the decision taken under this study to develop the strategy-led approach by focusing on ‘planning related development’ is considered rationale.

To confirm that ‘planning related development’ is one of the most important concerns of the strategy-led approach, the SMEs mention their strategy focus toward improving schedules, handling variations, securing smooth cash-flow and using value-adding techniques to achieve successful outcomes in terms of cost, time and quality.

The Strategy-led Approach around ‘Planning Related Development’

Through the discussion provided in this section, there are five steps belonging to the strategy-led approach:

1) Identify opportunities and threats at the conceptual stage
2) Craft suitable project delivery strategies at the conceptual stage
3) Improve schedules and plans
4) Ensure feedback and monitoring at the implementation stage
5) Craft suitable project delivery strategies at the implementation stage

‘Improve schedules and plans’ becomes the focal point of the strategy-led approach. By the focal point, this study means the connection between the other four steps of the strategy-led approach and the step ‘improve schedules and plans’.

The first two steps belonging to the conceptual stage of a construction project where all (100%) of the participants of the primary investigation craft suitable strategies (section 5.3.10). The probability to retain these strategies made at the conceptual stage as the major project delivery strategy model is between 80-99% at 95% confidence level. The last two steps are related to the implementation stage of a construction projects, and there is a 24-53% probability of emerging main strategies at $\alpha=0.05$ according to the responses provided by the NZIOB award recipients. Under both stages, there is a 100% possibility to craft or adopt emerging sub-strategies which support the main strategies of a construction project. These steps are described according to the findings of this study as follow:

1) Identify Opportunities and Threats at the Conceptual Stage

Improvement toward 'schedules and plans' is a major concern to ensure ultimate project success (Sawhney et al., 2003). Living through a project in advance to make planning related strategies is required to make construction projects less complex (Abeysekara, 2007; Kumar, 2002). In the responses from the SMEs, the NZIOB award recipients empathized that identifying opportunities and threats at the conceptual stage provides opportunities to act in a proactive manner toward uncertainties that may appear in schedules and plans at the implementation stage (section 6.4).

According to the perceptions of the NZIOB awardees, identifying constraints and opportunities serves as a pre-condition for the schedules made at the end of the conceptual stage. Early identification of opportunities and threats helps to employ the most appropriate design solutions and construction methodologies as describe in the next step.

The SMEs believe that involvement in the construction project at the conceptual stage secures more understanding about the project and, hence, less surprises (section 6.4). The SMEs believe that feedback of the past projects that could experience similar contexts is an advantage to identify constraints and opportunities better. To visualize complex design involved in construction projects, the use of 3D visualization is sometimes used by the participants of the primary investigation (section 5.3.6).

Thus, in this study, the beginning of the strategy-led approach considers the project context through limitations and opportunities at the conceptual stage to develop the most appropriate strategy delivery method.

2) Craft Suitable Project Delivery Strategies at the Conceptual Stage

According to the scope of a construction project, project managers identify constraints and opportunities as described under the first step, which ultimately allows them to craft suitable construction project delivery strategies to minimize the consequences of limitations, and to enhance productivity by using opportunities effectively. Under value-adding strategies at the conceptual stage, use of design alternatives and construction methodologies were mentioned by the participants of the primary investigation (section 5.3.6.1) and validation interviews (section 6.4).

Effectively using 'construction technology', which is a critical success factor given under the component factor 'planning related development' by the primary investigation (section 5.3.13.2), is a prominent strategy focus either to remove constraints or benefits opportunities among the information used in both, preliminary and primary, investigations of this research study.

This strategy focus emerged from the content analysis of the preliminary investigation in the award statements of CIOB, UK. For the 66 award statements, the use of effective construction methods was mentioned in 67% of the projects which could make the most frequent strategy focus of the CMYA award recipients (section 5.2.5). This strategy focus was rated by the NZIOB awardees as 'very high' (8 out of 10) among their construction project implementation strategies (section 5.3.11). However, under the preliminary and primary investigations, this research study did not consider if those strategies were made at the conceptual stage or implementation stage. The qualitative information given to the open-ended questions at the primary investigation and the validation interviews provided information to verify that crafting strategies on construction methodologies is applicable to both conceptual and implementation levels (sections 5.3.6 and 6.4).

The SMEs' perceptions about the procedures to use strategies on selecting the most appropriate construction methodologies have helped this research study to understand how cost, time and quality can be integrated at the conceptual stage in plans and schedules (section 6.4). For example, considerations on quality work as a precondition to separate suitable construction methodologies from all possible construction methods by considering the context of a construction project. Through consideration of workmanship, the SMEs focus on possible construction methods for the particular project context by comparing the quality specifications of the project at the conceptual stage. In this way, construction project managers can bring the context of a project (specific to quality) into plans and schedules.

To consider productivity (in terms of cost) into construction project planning, the SMEs use analytical knowledge coupled with tacit knowledge, which comes from their experience and qualities, by taking economies of scale into account (section 6.4). The validation interviews have revealed that economies of scales are done to the construction methods that are selected after considering quality requirements. According to the explanations given by the SMEs, work study is used to determine the potential cost that are associated with each construction methodology including the preliminary cost that should be spent on new plant requirements and specialist involvements. According to the SMEs explanation on selecting the most suitable construction methodologies, economies of scale are a thorough analysis of preliminary cost, implementation cost and construction volumes.

According to the SMEs opinions, construction methods selected at the end of these considerations are not always the cheapest, but the most economical method of construction that could satisfy the requirements to build structures within the given duration (section 6.4). Construction project managers use alternative design solutions similarly to the strategies that are focused on value-adding through the use of construction technology to cope with constraints and benefit opportunities according to the award statements given by the CIOB, UK (Chartered Institute of Building, 2009, 2010b, 2011).

To eliminate constraints and benefit opportunities (the first step described under the strategy-led approach of this study), use of effective construction methodologies and alternative design solutions are the top most strategies that this study identified from the content analysis of the open-ended responses given by the NZIOB award recipients (section 5.3.6.2). This study believes that there could be other strategy models which work as the main project delivery method, but the strategies discussed under ‘planning related development’ are beneficial to any construction project environment.

Based on limitations and opportunities identified under ‘planning related development’ (step 1), construction project managers prepare schedules and plans with the assistance of traditional planning algorithms (step 3) for the construction methodologies and design solutions selected under step 2.

3) Improve Schedules and Plans through the Strategy-led Approach

The preparation of plans and schedules that would be implemented is the third step that comprises the strategy-led approach developed by considering 'planning related development' under this research study. For the selected construction methods under the second step, scheduling and planning is considered in terms of time, cost and quality at this stage of the strategy-led approach. The procedure of this is described under this section.

In literature, there are many advancements discussed around developing better schedules and plans to enhance productivity in construction project delivery by applying changes to existing traditional planning algorithms (Belassi & Tukel, 1996). Criticizing these advancements as ineffective due to underpinning mathematical rigours, scholars suggest to replace tactical considerations of those traditional planning algorithms in the contexts of strategic concerns to improve schedules and plans (Kumar, 2002; Wong & Ng, 2010). In the primary investigation of this study, the industry experts of NZ rated that the influence of construction project strategies on 'schedules and plans' is very high (9 out of 10) (section 5.3.11), which supports past scholars' propositions that emphasize the development of strategies in the realm of construction project planning.

The similarities and differences between the suggestion given in past studies and the strategy-led approach this study developed are described under this section by mainly focusing on estimates of activity durations, use of critical path, use of software packages, uncertainty management and financial planning. This exercise explains why the strategy-led approach is suggested before other traditional planning algorithms to be a viable planning approach.

Some scholars suggest to manage uncertainties in schedules of CPM by adding buffers (Hegazy & Menesi, 2010), which conflicts with achievements in terms of productivity (Fallah et al., 2010). In simplified PERT, Cottrell (1999) suggests the analysis of historical data through probabilistic rigours to handle uncertainties, which is also debatable due to the unique nature of construction projects (Long & Ohsato, 2007). From the information provided by the industry practitioners on construction project scheduling and planning, these suggestions did not emerge as the practice of construction project managers either in the research investigations (both the preliminary and primary stages) or validation exercise. Indeed, the current study finds that the integration of project context and practitioners' subjective interpretations are the key factors that make schedules and plans more reliable.

To estimate activity durations, the participants of the validation exercise encourage the use of construction projects that have been implemented in the past (section 6.4). Unlike probabilistic developments, the SMEs articulated that one or a few construction projects are adequate to estimate activity durations to near accuracy since the context of that past projects (such as uncertainties and barriers faced under the implementation, and their impacts toward the accuracy of estimates) is well known. When, there is no previous experience, the SMEs recommend integrating other stakeholders' experience to make reliable estimates. Thus, the approaches given by the SMEs and the traditional planning algorithm of PERT are different, as further described below.

In PERT, historical data is used with an assumption of a certain probabilistic distribution, but with not much consideration given to the contextual variables that past historical data is based on (section 2.3.3.2). Since the primary investigation of this study has found that uniqueness of construction activities is high (7.7 out of 10 at $\alpha=0.05$ significance) in construction projects (section 5.3.4.3), having adequate sample of historical data is arguable for probabilistic calculations encouraged in traditional planning algorithms like PERT where usually more than 30 data entities are required to satisfy the assumptions to base estimates on. For example, Cottrell's (1999) simplified PERT algorithm assumes a normal distribution to derive equations of estimates, but finally has realized that actual durations of a project can vary by up to 35% compared to the calculations based on the simplified PERT. The data distributions related to actual activity durations of the projects that Cottrell (1999) used for this comparison showed considerable deviations from normality which becomes the reason of variations between estimates and actual values (section 2.3.3.2).

By using the strategy-led approach, the SMEs use subjective interpretation that is based on past experience over the mathematical operations, which are underpinned by probabilistic assumptions. This study believes that the consideration given to similar contexts of past projects under the strategy-led approach is the reason to develop more reliable estimates.

In addition to estimates, allocation for variations is another major concern in scheduling (Mensi, 2010).

This study has found that variations are common to construction projects that are planned through the strategy-led approach. According to the responses given by the SMEs and the NZIOB awardees, typical variations in terms of cost and time are between 10-20% for the projects that are planned and implemented by using the strategy-led approach. This study considers that having 10-20% variations is reasonable because the projects that have been delivered by the NZIOB awardees through the strategy-led approach are rated as dynamic to the extent of 47-98% at $\alpha=0.05$ significance (section 5.3.4.3). Dynamism is used in this study as an indication of variations to the scope of a construction project (section 3.3).

The content analysis of the SMEs' interview transcripts show some strategies that can be used at the conceptual stage to cope with variations at the implementation stage. One strategy that emerged from the analysis is to use different project calendars. Preparing of schedules by using a 5-day project calendar and work for 6 days is considered a viable strategy (section 6.4) because in this way construction project managers can cope with 20% of variation in terms of time. According to the SMEs' perceptions and the quantitative information of the NZIOB award recipients, within-scope variations are usually below 20% if projects are comprehensively planned through the strategy-led approach at the conceptual stage. When variations are more than 20%, usually there are variations outside the scope of the projects which the SMEs prefer to claim in terms of time and cost if the variations cannot be handled within the allocation made to the schedules (section 6.4).

Adding safety time through the strategy-led approach seems different than the methods suggested in traditional planning algorithms. According to the information provided by the SME on using two different project calendars, non-working days are used only when it is required. However, buffers suggested by CCPM and the development on CPM are a different approach to create schedules. In-built buffers suggested to cope with variations in the CPM algorithm hinder the productivity of construction activities due to 'student syndrome', which is a tendency of workers to do the most of work by using the safe time added (Fallah et al., 2010; Rand, 2000). When the algorithm of CCPM is used to add buffers, 'student syndrome' is not applicable (section 2.3.3.2), but adding 50% project buffer as the safety time to the end of a project is an unnecessary protection for projects, which are in low uncertainties (Rand, 2000). Thus, this study prefers the use of different calendars as described above under the strategy-led approach over traditional planning algorithms (both CPM and CCPM) to handle variations in construction project implementation.

After these concerns of the strategy-led approach (selecting activity durations from historical data of similar projects and applying strategies to cope with potential variations), the SMEs opine that the traditional planning algorithm can be used to assist preparing schedules and plans (section 6.4). These traditional planning tools can assist the construction project managers to decide the critical path of a project in addition to monitoring that is described as the next step (Lu & Lam, 2008). Supporting the use of traditional planning algorithms along with the strategy-led approach, 92.5% of the participants of the primary investigation have used at least one of the planning algorithms suggested in CPM, PERT, CCPM and EVM (section 5.3.1). Among the NZIOB award recipients, CPM is the most widely used traditional planning algorithm which has been used alone in 16% of the projects and coupled with other planning tools in another 58% of the projects to assist making schedules and plans under the strategy-led approach.

Ensuring contractor’s cash-flow is another critical success factor that is considered under the strategy-led approach through ‘planning related development’. In the archival analysis, there was no single situation that any issues or related strategic concern mentioned related to contractor’s cash-flow (section 5.2.5). However, the participants of the primary investigation rated the influence of strategies to ensure contractor’s cash-flow as ‘very high’ (8 out of 10). Considering both facts, confidentiality related to the contractor is considered as one of the reasons to hinder issues related to contractor’s cash-flow in the CIOB award statements.

In the open-ended responses of the NZIOB awardees, financial planning is stressed as a supportive strategic concern toward main strategies to implement construction projects successfully (section 5.3.6.1). Thus, ensuring contractor’s cash-flow is considered as another focus of the strategy-led approach to making plans and schedules.

An S-curve is usually used in the industry at the conceptual stage to plan construction projects as a general rule (Kaka & Price, 1993). To modify the S-curve to the project context SMEs explained how contractor’s cash-flow could be strategized. Using the S-curve as an initial trend line, the SMEs bring the project context into financial management by using front-end loading, tail-end loading or middle duration loading (section 6.4). Client's financial capabilities are considered mainly for these adjustments.

The SMEs explain that the economy of the country should be considered to apply safety time for uncertainties in financial management (section 6.4). In the primary investigation (section 5.3.11), influence of strategies toward minimizing economic issues is rated as high (8 out of 10), while showing a correlation of 0.512 (at $\alpha=0.05$ significance level) between the influence of strategies to minimizing the influence of economic issues and uncertainties (section 5.3.12). These facts together provide credence to support that a country's economy should be considered under financial planning of construction projects. According to uncertainties in any country's economy, strategies are set in financial management such that early completion is possible and therefore having deficit of money can happen rarely during implementation (section 6.4).

These contextual considerations under financial planning (client's financial capabilities and country's economy) give supporting facts toward this study's decision to reject Abeysekara's (2007) 'rate and rhythm' planning as a generally applicable strategy to any construction project (section 2.3.2.2).

The SMEs' perceptions toward making plans to secure quality are straightforward. Since the specifications and workmanship is considered before schedules are made under selecting the most appropriate construction methodology as described under the second step of 'planning related development', at this stage of planning, the construction managers' strategic considerations are to prepare a check-list to secure the quality required under the implementation stage (section 6.4).

After schedules and plans are made in terms of cost, time and quality under the third step, the strategy-led approach related to 'planning related development' is continued in the implementation stage.

4) Ensure Feedback and Monitoring of progress at the Implementation Stage

The fourth and fifth steps of the strategy-led approach related to 'planning related development' integrate the stakeholders into scheduling and planning throughout the life span of a construction project. Similarly to the requirement given in traditional planning tools, this study has found feedback and monitoring of progress as an essential part of the strategy-led approach.

Schedules and plans, which are made before construction is started, can go wrong in the implementation stage (Rand, 2000). In 10% of the CIOB award statements, feedback and monitoring is mentioned as a strategy focus at the implementation stage (section 5.2.5). The findings of the primary investigation of this research study (section 5.3.11) have evaluated the influence of strategies towards ensuring feedback and monitoring as ‘very high’ (8 out of 10).

According to the qualitative information, which is the responses from the open-ended questions and to the validation interviews, feedback and monitoring assists the construction project manager to find opportunities and limitations which have not emerged at the conceptual stage. In addition, strategies focused on feedback and monitoring help to ensure the effectiveness of the strategies that were crafted at the conceptual stage (section 5.3.6 in the primary investigation & section 6.4 in the validation interviews).

Strategies are trials, and hence there may occur strategy-to-implementation gaps (Thompson, Strickland, & Gamble, 2007) and creating the risk of failure (De Wit & Meyer, 2004). In the primary investigation, this research study has determined that influence of some strategies, which are set to minimize consequences of uncertainties in estimates, ground conditions and legal and statutory requirements, negatively affected achievement targets set in terms of time (section 5.3.13.5). At 95% confidence interval, the component factor (‘coping with complexities’) that these strategies are focused on had B values between 0.004 and -0.020. Thus, the findings of this research study have implied that ensuring feedback and monitoring is an essential element of the strategy-led approach.

The SMEs prefer to integrate others stakeholders into feedback and monitoring of the strategy-led approach (section 6.4). Quality is a measure of success and concern for every stakeholder in a project environment. Thus, the SMEs’ perceptions have rated quality over other measures of success to be improved through clients, consultants and sub-contractors’ participation in feedback and monitoring.

To ensure the achievements of cost and time, construction project managers can use traditional planning algorithms. From the reviews of perceptions of past literature, this study finds that the use of multiple tools can increase the reliability of the feedback and reviews that come from traditional planning tools (section 2.3.3.2). In the primary investigation of this research study, 18% of the participants have used EVM and CPM together when they plan their construction projects through the strategy-led approach. EVM parameters can give independent estimates about completion time that can be compared with CPM to predict the accuracy of each prediction (Jones, Meyer, & Flanagan, 2009).

Under feedback and monitoring, diagnosing reasons that cause variations is an important criterion. The SMEs articulate in this study that the precautions of variations largely depend on the cause of those variations (section 6.4). The algorithm of CPM does not reflect the causes of variations (Mensi, 2010). Thus, this study realizes that the critical path segment (CPS) method (Hegazy & Menesi, 2010) is more advantageous and effective than CPM as a tool to assist feedback and monitoring (section 2.3.3.2) under the strategy-led approach that this section discusses by focusing on ‘planning related development’.

5) Craft Suitable Project Delivery Strategies at the Implementation Stage

Construction project managers craft both main and sub-strategies to implement construction projects under the strategy-led approach according to the responses of the participants of the primary investigation (section 5.3.6.1) and validation interviews (section 6.4). The similar procedure described under the second step of this section can be used to craft strategies to eliminate limitations and benefit opportunities that emerge during the implementation stage.

In addition to limitations and opportunities, the SMEs emphasize to craft strategies at the implementation stage to ‘minimize the influence of variations’ to the scope of projects.

Coping with variation has emerged in 44% of the award statements of the CIOB award winners under the deductive analysis done in the archival analysis (section 5.2.5). In the primary investigation, the factor was rates as ‘very highly’ influenced (9 out of 10) through construction project strategies (section 5.3.11). The SMEs describe that the nature and cause of variation largely determines the strategic path towards coping with variations (section 6.4).

Under the strategy-led approach, allowances are made at the conceptual stage to cope with uncertainties (like using different project calendars). When those allowances are inadequate to cope with variations under the implementation stage, the SMEs consider the nature of variations in terms of the influence toward the critical path and if the variations are within or outside the scope.

Handling variations related to non-critical activities would be easier, while variations outside the project scope can be claimed (section 6.4). When there are variations related to client's demands outside of the scope, the SMEs emphasize the client's financial capabilities and client's urging to complete the project on time. Further, in the award statements of CIOB award recipients, use of value-adding techniques is usually mentioned to minimize consequences from variations outside the scope (section 5.2.6). It could secure smooth cash-flow into projects. Further, client satisfaction under such circumstances causes to integrate the client into project planning and implementation. Under the primary investigation, the client is found as similarly important to the construction project as the manager in the strategy-led approach (section 5.3.9.2). Thus, by considering these facts, this research investigation believes that value adding-techniques for outside-scope variations are required where it is possible.

In the above discussions, the strategy-led approach related to 'planning related development' is described using the five steps recognized under this research study. By using the strategy-led approach, construction project managers integrate project context into planning by using tacit knowledge that comes from practitioner's experience coupled with qualities (skills and characteristics). This study believes context dependency and practitioner dependency are the foremost features of the strategy-led approach to deliver successful outcomes in terms of cost, time, quality and overall success.

Context Dependency

CPM as well as other planning tools have been criticized because these tools do not consider context of a construction projects (Mensi, 2010; Wong & Ng, 2010), which is a characteristic of TR approaches (Schon, 2001). For example, to cope with uncertainties in estimates of activity durations, PERT encourages to use optimistic, most probably and pessimistic durations with weighting factors by using historical data (Cottrell, 1999). Critiques are developed by saying that estimates can vary from actual realizations, considerably (up to 35% in total duration), according to contexts particular to a project (Cottrell, 1999; Long & Ohsato, 2007). Scholars' suggestion is to introduce some of the RP natures, i.e. context dependency in this case, to minimize deficiencies of TR. The current study hence considered the possibility to include contextual variables in planning by using strategies.

In addition to the contextual considerations mentioned under the strategy-led approach above, the frequency count done on the archival analysis showed that most of the strategies (97%) are crafted after the contextual variables, like project value, duration, project type, design, scope, procurement type and site conditions, are considered (section 5.2.6). As example, some project managers use integration strategies to avoid public protest in different ways: in urban areas, noisy construction is limited for off-peak time, while neighbours are given advantages from the projects in rural areas. Using these two strategies in other ways will not work to avoid public protest of locals.

There are strategies, such as use of 3D visualization to understand projects better, which can be used in any project, and hence considered as context-dependent (section 5.2.6). However, still the strategy cannot be considered as purely context-independent because the reason to use 3D visualization is a complicated associated design. The primary investigation is a step forward to perceive the context-dependency of the strategy-led approach thorough quantification.

In the quantitative analysis of the primary investigation (testing of H7 in section 5.3.7), except legitimacy that is rated as 'moderately important', all the contextual variables (project value, duration, project type, design, scope, procurement type and site conditions) are rated by the NZIOB awardees as 'highly' important at least (4 out of 5 at α=0.05). According to the perceptions of the SMEs, the purpose of the strategy-led approach is to improve schedules and plans through flexibility because the context of construction projects is volatile (section 6.3.2).

By considering these facts coupled with the descriptions given under the five steps of the strategy-led approach, context dependency is considered one of the features through which the strategy-led approach becomes a suitable planning approach to plan and implement construction projects.

Practitioner Dependency

In addition to context independency, traditional planning algorithms are criticized for their limitations due to the underpinnings such as strong theoretical rigours (Fallah et al., 2010). To align them with practical considerations, incorporation of practitioner artistry, that is developed through experience and qualities, should be encouraged in planning and implementation (Bourne & Walker, 2005). Thus, the current study made its supposition that reliable planning tools must include RP natures, which in this case is practitioner dependency, in addition to practitioner-independent TR natures (section 3.6).

The archival analysis has shown that construction project strategies are made usually by using practitioners' experience and qualities (section 5.2.6). The questionnaire survey focused on quantification that is to find out contributions from education, experience and qualities separately. Experience and qualities are 'very highly to highly' important (4.5 out of 5) whereas engineering theories are 'moderately to highly' important (3.5 out of 5) for the strategy-led approach at $\alpha=0.05$ significance. While education, experience and qualities are important to the strategy-led approach, the primary investigation has shown at the 95% confidence level that the use of experience and qualities are more important than engineering theories to the strategy-led approach (testing of H7). These findings indicate that the strategy-led approach is practitioner-dependent according to the operational definitions set in section 3.6.

The SMEs emphasize that engineering theories have a major role, but subjective interpretation is required to decide the most appropriate delivery path under the strategy-led approach (section 6.5.1). By using tacit knowledge together with engineering theoretical formulations, the strategy-led approach provides more reliable schedules and plans.

These findings related to the context dependency and practitioner dependencies encourage the researcher to consider methodologies of RP when planning algorithms are developed for the construction industry.

7.2.2.3 Strategy Making Typologies

The current study has used strategy making methodologies or typologies as another way of describing strategy content. Since typologies are selected according to the context of interest (Alison & Zelikow, 1999), under this investigation, rational versus generative, spontaneous versus deliberate and transformational versus revolutionary are used as the appropriate typologies in the context of construction project implementation (Abeysekara, 2007; Price & Newson, 2003). Throughout the study, operational definitions given in section 3.7 are used to measure these typologies.

More recent literature perceives strategy making is a combination of rational and generative methodologies (Abeysekara, 2007) and which is different from earlier studies whose belief is in a single extreme: either rational (Andrews, 1987) or generative (Ohmae, 1982). Lee et al. (2006) articulated that effectiveness of strategies is increased when they tend towards the generative from rational typology. Statistical testing of H9 under the primary investigation of this research study has determined that the ratio between rational and generative typologies is 1:1.5 at α=0.05 (section 5.3.8.2). The SMEs use both generative and rational approaches, but generative typology is predominant in construction project strategies. Since traditional planning tools, i.e. CPM, PERT, CCPM, EVM and S-curve, lean more towards theories, strategies need to counterbalance theories by being more generative' (section 6.5.1).

Being more generative, the strategy-led approach can be treated as a suitable way to bring practitioners' tacit knowledge into construction project implementation which is a requirement of RP to minimize drawbacks of TR-based traditional planning algorithms (Dias, 2002).

Spontaneous versus deliberate typologies indicate the extent of early preparedness required to craft strategies (section 3.7). The content analysis of the responses to the open-ended questions in the primary investigation has shown that 100% of the construction project managers deliberately craft strategies at the conceptual stage (section 5.6.6.1). This finding indicates that early preparedness is a must, which is a similar observation to past scholars (Abeysekara, 2007; Kumar, 2002) who emphasize the necessity of early development of strategies. The quantitative analysis aimed at testing H10 under the primary investigation shows that the use of spontaneous and deliberate typologies in construction project strategies is 50:50 at 95% confidence level (section 5.3.8). The SMEs opine that both pre-planning and taking emergency actions are important equally to achieve desired end results, although one can go over another slightly.

According to the primary investigation, the use of transformational and revolutionary typologies is 50:50 at 95% confidence level (testing of H11 in section 5.3.8). Some established strategies remain unchanged or change incrementally with time while some strategies developed change and modify frequently. The SMEs articulate that both typologies are important for the strategy-led approach; transformational typology encourages crafting strategies through comprehensive analysis to increase their stability whereas revolutionary typology keeps the strategist attached to the development process of construction project strategies throughout the project implementation (section 6.5.1). The third SME's articulation is biased towards a transformational nature as such main strategic rigours remain stable, although little changes can happen day-by-day.

According to these findings, the strategy-led approach in construction project implementation is a combination of the six typologies which are generative, rational, spontaneous, deliberate, transformational and revolutionary. This research study has found that generative typology is more important than rational typology.

7.2.2.4 Stakeholders in the Strategy Context

Stakeholder management is the second most frequent strategy focus after 'planning related development' in the strategies that the NZIOB award winners mentioned as the key to success (5.3.6.1). The construction industry is a labour-oriented industry (Fryer, 2004), which makes stakeholders an important asset to achieve success (Bourne & Walker, 2005).

Reviews of past literature (Bourne, 2007) indicate that the focal point of construction project planning and implementation is the construction project manager. Thus, this research study is in a position to develop the strategy-led approach by gathering information from construction project managers on their successful planning and implementation strategies.

In the archival analysis of the CMYA award statements, both bottom-up and individual strategy making methodologies are commonly used to craft construction project strategies. From the quantitative analysis done to test H12 in section 5.3.9.1, the ratio between bottom-up and individual strategy making is 1.5:1 at $\alpha=0.05$ significance. Thus, this research has investigated that construction project managers craft strategies by integrating other stakeholders into the strategy-led approach more than crafting suitable strategies alone. Although, bottom-up strategy making is rated as more important than individual strategy making, the construction project manager is considered as the most important stakeholder because in both methodologies, the construction project manager involves; bottom-up strategy making seeks other stakeholders' involvement, but still the project manager is the focal point to develop the strategies that are proposed by other stakeholders (section 3.8).

In the questionnaire survey, both construction project managers and clients are found as the most important stakeholders in a strategy context and similarly important as found through the quantitative analysis at 95% confidence (section 5.3.9.2). Therefore, future studies that will investigate the strategy-led approach by gathering data from the client may comprehend the findings of this study. Supporting this finding, in the open-ended responses, the client is the most predominantly mentioned stakeholder under the conceptual strategy focus of stakeholder management strategies (section 5.3.6.1). The SMEs emphasize that the client is important for main strategies because of the level of authority; the client adds strategies to implement construction project strategies while his/her approval is required to carry out construction project strategies in an effective way (section 6.5.2).

All other stakeholders are less important than the construction project manager and the client, as found in the primary investigation (testing of H13 in section 5.3.9.2). At $\alpha=0.05$, labours are rated as 'moderately important' (3 out of 5), but all other stakeholders considered under the analysis are 'moderately to highly' important (3.5-4 out of 5) to shape the strategy-led approach in the realm of construction project implementation. In the open-ended responses given by the NZIOB awardees, under stakeholder management strategies, sub-contractors and the own team were mentioned mostly at the implementation stage (section 5.3.6.1). Communicating with sub-contractors, site managers and engineers on available opportunities and better construction methods is important. Other stakeholders' suggestions should be comprehensively analysed for consequences, according to the SMEs articulations (section 6.5.2).

The SMEs perceived that every stakeholder is important for different purposes. Therefore, integration strategies that construction project managers use to incorporate other stakeholders are important to understand the strategy-led approach.

Integration Strategy

The above section has described that all stakeholders are important for construction project implementation at some stages. Labours who are 'moderately' important to the strategy-led approach at 95% confidence level have contribution to implement the strategies by constructing the physical structures according to the explanation of the SMEs.

Based on the reviews of literature (Cheunga, Ngb, Shek-Pui Wonga, & Suena, 2003; Fryer, 2004), this research investigation has evaluated the use of six integration methods under the primary investigation, which are vision, mission, transaction with stakeholders, learn and improve, responsibility for performance benchmarking, and experiment and risk taking (section 3.8).

According to the quantitative analysis done at 95% confidence level to the responses given by the NZIOB award winners (testing of H14 in section 5.3.9.3), five of the six integration methods are recognized as advantageous towards the strategy-led approach, except 'experiment and risk taking' which the participants are neutral to use at $\alpha=0.05$ significance level.

Mission and vision are the most important ways to integrate stakeholders into the strategy-led approach and rated between 'agree' to 'highly agree' (4.5 out of 5). At $\alpha=0.05$ significance level, there is no significant difference between the use of vision and mission. The SMEs emphasize that vision gives common identity to the stakeholders who come from different organizational backgrounds; mission tells what should be done by each person and why it should be done (section 6.5.2).

All other methods, except 'experiment and risk taking', are less important compared to vision and mission, but are rated at 4 out of 5 (section 5.3.9.3). The SMEs use performance milestones as goals which divide the objectives of the strategy-led approach over time. Thus, stakeholders are assigned with responsibilities against performance benchmarked to implement strategies effectively. According to the SMEs' opinions 'learn and improve' is allowed for novel strategies at the beginning although productivity can go down at the beginning (section 6.5.2).

Experiment and risk taking is the only method, which based on the sample data of the primary investigation, had perceptions (17.5%) of 'disagree' to be integrative. Apart from these negative perceptions, there were 35% of the NZIOB awardees who agreed or highly agreed to use experiment and risk taking. The SMEs articulate that risk taking should be distributed at least among the top most authorities rather than assigning a single stakeholder. Labours may use means of easier and faster construction; if there is no impact toward quality of construction, no need to take that risk beyond supervisory level. Therefore, risk taking and experiment may allow for labours at the activity level which comes below the hierarchical level of project level strategies.

7.3 General Discussion

From the above discussion, this research investigation has articulated that strategies can bring contextual background into practice, while encouraging construction project managers to use their tacit knowledge in addition to theoretical rigours. The articulation given in Table 7.1 is based on the study's findings and describes how strategies can bring these RP natures to improve traditional planning algorithms in which the characteristics of TR are prominent.

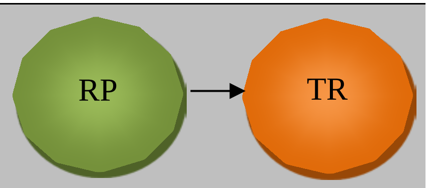
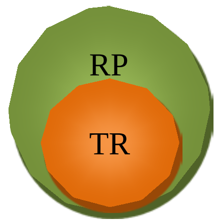
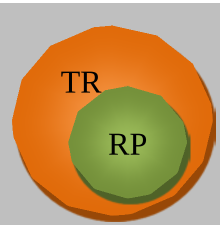
Making project schedules in terms of time, cost and quality is given as the first clarification to illustrate that RP can become a pre-condition to TR (Table 7.1). Under scheduling, the CIOB awardees, NZIOB award winners as well as SMEs recommended to identify constraints and opportunities to select the most appropriate construction methods, predict amount of uncertainty and sequencing of activities (section 5.3.6.1) before conservative scheduling tools are used (considerations under RP). Use of past experience, visualization and information handling skills were emphasized by the participants of the current study as a must. After those things are analysed comprehensively, the construction project manager is in a position to select and modify norms according to the particular project contexts. Then, subsequent calculations such as construction volume and duration can be calculated by using basic mathematical operations, and finally the critical path can be calculated by using CPM algorithm (i.e. TR considerations).

The second example given in Table 7.1 is to illustrate a situation of where TR becomes the context of RP. To cope with variations, the participants have stressed throughout the study that amount of variation and influence on the critical path should be considered. Use of EVM and GANTT chart methods can support identifying these considerations. The current study perceives these considerations as TR. However, according to the participants' articulations, these TR considerations are only a few factors among many criteria, which the construction project managers should consider before necessary actions are taken. Finding causes of variations, client's financial capacity and use of different construction methods are some other salient concerns that the traditional planning tools cannot describe effectively. In these considerations, the construction project manager needs information handling skills, analytical skills and experience.

In the last example of Table 7.1, RP becomes a constraint to TR. To select the most appropriate construction method, the construction project manager considers cost optimization where cost-benefit analysis comes into practice. However, before the construction project manager uses these TR analyses, he/she needs to think of noise, vibration, interruption and space requirements, which each construction method requires (section 5.2.6). After, reflecting on these considerations, practitioners can select the alternative construction methods that should be used under the cost-benefit analysis. Therefore, considerations under RP become constraints for TR in this situation.

In the above three examples, RP considerations bring the project context along with traditional planning tools to make planning more reliable. Use of RP can provide solutions to problems, which cannot be described through theoretical formations. Traditional planning algorithms can be used alone without strategic considerations when the context of a project is certain. Under that kind of certainty, only, TR alone can provide adequate solution. Therefore, planning through TR is a specific situation of general construction project planning, which is essentially done through the right combination of a TR and RP. This is similar conclusion to Al-zahrani (n.d) who opines Hard System Methodology as a specific case of general Soft System Methodology. Hard System Methodology which is the approach of TR methodologies can provide solutions only when problems and solutions are well-define, but the general Soft System Methodology that is the base of RP can provide resolutions to any case through reflective interaction (Dias & Blockley, 1995).

Table 7.1: Relationships between TR and RP related to construction project planning

Industry	Reflective Interaction	RP Procedure	Focus of Attention	TR Approach	
Making project schedules	Identifying constraints and opportunities to select the best construction methods, predict amount of uncertainty, sequencing of activities	Use past experience of similar projects; visualization; information handling skills	Use norms; calculate volume and subsequently duration; add % for variation; find the critical path	Mathematical operations such as multiplication, addition and division: use of scheduling tools such as CPM	 RP is a pre-condition to TR
Cope with necessary variations	Finding causes (within scope or outside scope) and nature of variations (critical or non-critical); client's financial capacity; use of different construction methods	Information handling skills; analytical skills; experience	Amount of variation; effect on critical path	Use GANTT charts; EVM	 TR within the context of RP
Choice of a construction method	Noise, vibration, interruption, space requirements	Experience; considering project context; information handling skills	Cost optimization	Cost-benefit analysis	 RP is a constraint for TR

Chapter 8. Conclusion and Recommendations

8.1 Introduction

This chapter describes the original contribution to construction project planning and implementation by pursuing this research study. It reflects on the objectives set for the study including how these objectives have been achieved. Then a list of recommendations is given to enable the adoption of the strategy-led approach thus improving current sub-optimal planning approaches. Finally, the chapter describes recommendations relevant to future investigations to complement the findings of the current study.

8.2 Original Contribution

This section outlines the contribution of the study to enhance effectiveness of construction project planning and implementation so that planning activities ultimately achieve successful outcomes.

This research can be taken as a reinforcing exercise to past propositions which have articulated over time that current sub-optimal tools are not sufficient to cope with increasingly complex and uncertain situations on construction projects. It is clear that planners must reinforce tactical considerations by being more strategic. By adopting a post-positivist approach, the current study has gone beyond hypothetical constructions to verify that there is a strong link between strategies and project characteristics. The study has found that construction projects are complex, dynamic, uncertain and to a high extent unique. Thus, there cannot be simplicity, which is described in literature as the reason to impede strategic development, in the construction industry at the project implementation level. Therefore, the findings of the current study strengthen the requirements to focus on strategies in academic discourses.

Some information gained from reviews of literature criticizes academic discourses that are focused on improving construction project implementation through developing better scheduling techniques. Traditional planning tools are recognized by some scholars as limited to presentation purposes, only. Despite that, the systematic investigation procedure of this study determined that scheduling tools can contribute to successful outcomes in construction project delivery. This research study has evaluated that past scholars' suggestions given to improve schedules (such as estimate activity durations using probabilistic methods and adding buffers) are occasionally realized in the industry. This study realized that the development of strategies is the way to improve construction project planning and implementation as a whole including developing schedules. This study has determined that the strategy-led approach is context-dependent and through the tacit knowledge of the practitioners the approach can improve traditional planning algorithms to make more reliable schedules and plans.

Strategies are suggested to improve construction project implementation by some past scholars and this research study has gone beyond these suggestions by evaluating the applicability of construction project strategies to improve achievements on cost, time, quality and overall success. The study was able to quantify the cause and effects of construction project strategies toward cost, time, quality and overall success as 46%, 37%, 20% and 39%, correspondingly. In addition, this research study evaluated the critical success factors that could significantly influence each success parameter if projects are planned using the strategy-led approach.

The strategy-led approach is suggested to be a combination of RP and TR paradigms. The study has found that the strategy-led approach encourages the practitioners to diagnose problems related to construction project management through ‘reflective interaction’. Thus, the strategy-led approach investigated in this study is different from the traditional planning approaches, which are characterized by ‘selective inattention’ (a characteristic of TR that represents the incapability to diagnose problems that cannot be described through theoretical formations). The finding could be used to reinforce the perception of literature that construction project managers should be reflective practitioners.

The strategy-led approach determined throughout this study is a combination of both generative and rational methods. Thus, this finding can be used to minimize controversial opinions of scholars saying that strategies are either rational or generative. There are some scholars who opine that the strategy-led approach is a combination of both, rational and generative, methods. This study determines this combination as 60:40 between generative and rational methods of the strategy-led approach. Therefore, the findings can help future researchers to develop strategic solutions to the industry by focusing more on generative methodologies.

In addition, this study found that solutions that are viable to the construction industry are not nomothetic theories. This study’s findings encourage scholars to develop more flexible planning methodologies where tolerance to project context can be made within the approach given. Traditional planning algorithms are nomothetic rules that believe problem clarification and the selection of the solutions are straightforward (characteristics of hard systems methodology). The strategy-led approach, which this research study has found as a viable planning approach, is developed by construction project managers as a heuristic procedure by using RP. Thus, this study encourages researchers to develop reliable solutions to construction project planning and implementation by using the principles of RP. This finding reinforces past scholars' suggestion that research advancement towards real world problems should be based on the soft systems methodology (system approach for RP) as opposed to the hard systems methodology that traditional planning tools are based on.

8.3 Review of Objectives

The primary focus of this research study is to propose the strategy-led approach as a tool for successful construction project planning and execution by construction project managers. The study evaluated current project management practices for their drawbacks in project delivery, and then investigated the suitability of the strategy-led approach to improve project planning and implementation to achieve successful outcomes. Since this research study is based on methodological multiplism to investigate the relevant research enquiries, a mixed methods approach was used and the findings were triangulated to construct the validity of the findings. This section provides a conclusion to the five objectives outlined in section 1.3 on how the objectives were achieved by using several research methods.

Objective 1: To identify what constitutes success and failure on construction projects. This objective assists the research study to identify areas of interests that a suitable planning approach should focus on.

To perceive what was meant by success and what constitutes project success, this research study followed a systematic approach from the review of literature until the validation exercise of this study.

Firstly, the study used perceptions of past scholars to identify the most important measures of success in the ambit of construction project implementation. Through the reviews of information in literature, this study identified several measures as well as the frequency of their usage as was shown in Table 2.11. From the reviews, cost, time, quality and client satisfaction were recognized as the primary measures of success in construction projects. In addition to success measures, reviews of information in literature helped in the establishment of 32 critical success factors on construction projects. A list of these 32 critical success factors is provided in Table 2.4.

Secondly, the study investigated the industry's perceptions of success by using the archival information which is provided by the Chartered Institute of Building (CIOB), UK, on the recipients of Construction Manager of the Year Award (CMYA). The archival analysis showed that the most frequently mentioned success measures in the review of literature are the top most considerations of success among the industry practitioners (Table 5.4). Further, this archival analysis could inductively determine three critical success factors, which could help in the achievement of success in construction project implementation, that were not mentioned in the reviews of literature (Table 5.5).

In the primary investigation of this study, those success measures (cost, time, quality and client satisfaction) and the 35 critical success factors, which are shaped through the reviews of literature and the preliminary investigation, were used to gather information on the projects that are recognized as successful by the New Zealand Institute of Building (NZIOB). The participants' achievements on cost, time, quality and client satisfaction are above the initially expected outcomes according to the inferential statistics of the population, which indicates that these four measures are primary measures of construction project success. A few of the participants mentioned 'satisfying neighbourhood' as another measure of success, but through the review of responses to the open-ended questions, the research investigation determined that 'satisfying neighbourhood' is rather to be considered as a barrier for construction project implementation than as a measure of project success. There were no other critical success factors given by the participants in addition to the 35 critical success factors that this study found through the reviews of literature and the preliminary investigation as could help in the achievements of success in construction project implementation.

Finally, this research study investigated the perceptions of project success and factors that help in the achievement of construction project success by using the dialectical information, which are provided by the subject matter experts (SMEs) who are the award recipients of NZIOB (section 6.3 and 6.4). From their responses, it could be found that cost, time, quality and client satisfaction are the primary measures of construction project success. In section 6.3.1, it is mentioned that other measure of success like sustainability can be considered under the context of these four primary measures.

These four success measures (cost, time, quality and client satisfaction) and the 35 critical success factors are hence considered as the constituents of construction project success. These success measures and critical success factors were used as variables in multiple regression analyses (section 5.3.13.5) to determine the suitability of the strategy-led approach to implement construction project planning as described under the fifth objective of this study.

Objective 2: To determine the contributory role of the construction project manager in achieving either outcome (success or failure). This objective investigates the suitability of the construction project manager to be the most important stakeholder for crafting and implementing construction project strategies.

Similar to the first objective, the first step to achieve this objective was to review information in literature in the realm of construction project management and strategies where perceptions of past researchers on strategists could be determined. Recognition of the construction project manager as the strategist of construction project strategies is described in section 2.3.2.1.

In the second step, archival information on the CMYA awardees was analysed using content analysis to assess construction project manager's role in crafting and implementing construction project strategies (section 5.2.7). Under the analysis, it was recognized that the construction project manager contributes mainly to crafting of strategies both under individual and bottom-up strategy making methodologies.

Having recognized the construction project managers as the most suitable person to provide information on construction project strategies, this study then collected information from the construction project managers, who were recognized by NZIOB for their excellence, to provide information on the different construction project strategies they had used. In this primary investigation, the study used the opportunity to gather perception of the construction project managers in their roles of crafting and implementing construction project strategies. This assessment included comparison of roles that each stakeholder plays in the strategy-led approach (section 5.3.9). From the comparison done on the stakeholder contributions, both construction project manager and client were rated as the most important stakeholders to plan and implement construction projects under the strategy-led approach.

The SMEs believe that the construction project manager is the most responsible person for the achievement of project success as well as to integrate other stakeholders into the context of project planning and implementation. The analysis is described in detail in section 6.5.2.

From all these investigations, the construction project manager is recognized as the most responsible person to achieve successful outcomes in construction project implementation. The construction project manager is the strategist for the strategy-led approach, which this study investigates under the fifth objective of this study. The role of the construction project manager is to craft construction project strategies by themselves or integrating other stakeholders while working as the focal point of the development of the strategy-led approach.

Objective 3: To investigate the drawbacks of traditional planning practices related to construction project planning and implementation.

Since the current inquiry focuses on developing a complementary planning methodology to existing planning approaches focusing on the use of tools and algorithms, the strategy-led approach should be able to provide solutions to drawbacks of current approaches. Therefore, this objective evaluates the purpose of such a complementary approach.

In this objective, the drawbacks of traditional planning tools that are used to plan and implement construction projects were completely investigated by reviewing past literature. In addition to critics developed around traditional planning tools, this research study reviewed information provided by past scholars on decision making and problem solving using both, TR and RP, paradigms. Through this review, it was recognized that inadequacy to cope with the characteristics of construction projects (complexity, dynamism, uncertainty and uniqueness) and strong TR underpinnings (reductionism, selective inattention, context independency and practitioner independency) are the major drawbacks of traditional planning algorithms.

The possibility of construction project strategies to cope with the identified drawbacks is evaluated through the preliminary and primary investigations of this study. From the preliminary investigation, this study found that strategies were used to cope with the characteristics of construction projects while integrating context dependency and practitioner dependency in planning and implementation of construction projects (section 5.2.6). In section 5.3.12, significant Spearman correlations at $\alpha=0.05$ were found between the characteristics of construction projects and the influence of strategies towards construction project planning and implementation, which implied that strategies and project characteristics are interrelated. In section 5.3.6.2, the content analysis of the open-ended responses of the questionnaire survey showed that 60% of the reasons given for the use of strategies are related to the characteristics of construction projects. Further, in section 5.3.7.1, inferential statistical analyses showed that the strategy-led approach tends to show more context dependency and practitioner dependency as opposed to TR natures of context independency and practitioner independency. These findings suggest that the strategy-led approach minimizes the drawbacks of traditional planning algorithms, effectively.

Having recognized the drawbacks of traditional planning algorithms and the possibility of strategies to minimize those drawbacks, the SMEs articulations were used to construct validity of the findings related to objective 3(section 6.3). From all the findings, inadequacies to cope with the characteristics of construction projects (complexity, dynamism, uncertainty and uniqueness) and integrate reflective practice into problem solving and decision making are considered as the drawbacks of traditional planning algorithms. Since this objective found that the strategy-led approach can minimize those drawbacks, this objective could be considered under the context of the fifth objective which describes the suitability of the strategy-led approach to construction project planning and implementation.

Objective 4: To develop a theoretical framework that represents the conceptual relationships between the characteristics of construction projects, nature of issues in project implementation, construction project strategies, nature of those strategies and success measures.

The problem identification of this study was done through the reviews of literature and the findings of the preliminary investigation. After aim, objectives and research questions were identified, a theoretical framework was developed to illustrate the relationships between the major variables in this study. This objective is described in detail throughout Chapter 3.

Creating the theoretical framework assists in having a coherent perception about the variables and their relationships to other variables before the study commenced with the field investigation. Development of hypotheses, H1-H4, is the hypothetical constructs to assess the characteristics of construction projects under the field investigation. In the primary investigation, H5 and H6 are used to determine the nature of issues related to construction projects in terms of TR and RP. To assess the nature of the strategies under TR and RP, H7 and H8 are the hypotheses that were made based on the achievements of objective 4. In addition to assessing the strategies by using content analysis, the framework was made through the achievement of this objective. To explain the strategies in terms of typologies, conceptual inequalities were made between opposite typologies using H9 (generative versus rational), H10 (deliberate versus spontaneous) and H11 (transformational versus revolutionary). Under the achievement of objective 4, this study developed operational definitions for the variables under consideration such as the four project characteristics, typologies, and TR and RP natures which helped during the primary study to set suitable scales.

To construct hypotheses assessing the strategy-led approach in terms of stakeholder contributions is another achievement under this objective. Since construction project managers are recognized as the strategist of the strategy-led approach, these hypothetical constructs (H12, H13 and H14) are made under the objective 4 by considering the construction project manager as the focal point.

Under objective 4, another accomplishment is the ability of establishing the relationships among the main variables of this study, which are the characteristics of construction projects, construction project strategies and success. To find the influence of strategies on the critical success factors, H15 was made under this objective whereas H16 was developed to measure the relationships between the characteristics of construction projects and the influence of project strategies. Under the achievement of objective 4, finally, conceptual relationships were established by the development of H17 and H18 to assess the behaviour of the strategy-led approach under the characteristics of construction projects if projects are planned through the strategy-led approach, the achievement of which helped reaching objective 5 that is described next.

Objective 5: To propose the strategy-led approach for adoption by project managers in the form of a suitable practice to deliver construction projects with successful outcomes.

Under the fifth objective, this research study investigates the influence of strategies towards construction project implementation and determines dimensions of strategies within the context of construction projects to define what a strategy-led approach is.

As the first step toward achieving this objective, literature was reviewed in the scope of construction project implementation and strategies, which ultimately could assist in reviewing postulations made on the applicability of construction project strategies to improve project planning and implementation (section 2.3). Through the reviews of literature, information could be found to construct the hypothetical constructions, which are described related to the strategy-led approach throughout the achievements of objective 4.

As the subsequent step, this research study used the preliminary investigation to evaluate whether the construction project strategies are in practice in successful project implementation (section 5.2.5). In this analysis, there were 136 issues of construction project implementations and the related strategic solutions to mitigate those issues identified. Through this analysis, the applicability of strategies and the suitability of the operational definition used under this study for strategies were determined.

To propose the strategy-led approach as a suitable planning approach, the primary investigation was done mainly by focusing on the theoretical framework made under the fourth objective. In the primary investigation of this study, both, qualitative and quantitative, approaches were used to achieve this objective. To achieve this objective there were two main considerations: to find out the suitability of the strategy led approach and to evaluate what the strategy-led approach is.

As described under objective 3 of this section, the ability of the strategy-led approach to minimize the drawbacks of traditional planning approaches is one way of determining the suitability of construction project strategies to plan and implement construction projects. Under section 5.3.1, it was found that the strategy-led approach is a complementary method of planning and implementing construction projects together with traditional planning algorithms. Further, inferential statistical analyses were done to determine the influence of strategies towards success measures.

To determine the suitability of the strategy-led approach, the primary investigation used mathematical modelling (testing of H17 and H18 of the theoretical framework), as one of the steps, by using the characteristics of projects (extent of complexity, dynamism, uncertainty and uniqueness) and strategies' influences on critical success factors as the independent variables. In this way, this research study could quantify the influence of strategies on success as 48%, 37%, 20% and 39% of the variances towards cost, time, quality and overall success, respectively (section 5.3.13.5).

The final step to find the suitability of the strategy-led approach was to conduct the SME interviews to construct validity of the findings of the preliminary and primary investigation of this research study (section 6.4). From the SMEs, construction project strategies are found to be more or, at least, equally important as traditional planning algorithms to achieve construction project success which implies the suitability of the strategy-led approach to become a viable planning methodology.

In addition to determine the suitability of the strategy-led approach, there were some analyses done to describe what the strategy-led approach is. As found under the primary investigation of this study, traditional planning approaches are used under the strategy-led approach, and construction project strategies are used to improve reliability of scheduling and planning. The use of traditional planning algorithms along with construction project strategies is described under section 5.3.1. Therefore, under the achievements of objective five, the strategy-led approach is found as a combination of construction project strategies and traditional planning tools. The SMEs have the same perception as to the investigation of this research study about the strategy-led approach (section 6.4).

By the regression analysis, this study identified critical success factors on which construction project strategies depend to support the achievement of construction project success. The open-ended responses of the primary investigation were analysed to find the major focus of the strategy-led approach (section 5.3.6.1). The findings could help to determine the areas that should be focused under the validation exercise to extend knowledge on describing the strategy-led approach. With the aid of the validation exercise, this study found how the strategy-led approach can be used with traditional planning tools to improve scheduling and planning which is another achievement of the fifth objective.

The analysis of testing H9-11 under the primary investigation helped the achievement of the fifth objective by describing the properties of construction project strategies using typologies. Construction project strategies, that the strategy-led approach is comprised of, are found to be a combination of generative versus rational (60:40), spontaneous versus deliberate (50:50) and transformational versus revolutionary (50:50) strategy making typologies (section 5.3.8). The findings were validated through the participation of the SMEs (section 6.5.1).

Another achievement of the fifth objective is to describe the strategy-led approach in terms of stakeholder involvement. The conceptual relationships made under the hypotheses, H12-14, were tested under the primary investigation to determine the stakeholder contributions (section 5.9.9). The findings of this analysis could assist this study to propose the strategy-led approach as a combination of individual and bottom-up strategy making methodologies where construction project managers alone or with other stakeholders craft construction project strategies, correspondingly. The finding is validated through the SMEs (section 6.5.2). This achievement is used to describe the strategy-led approach as a planning methodology, in which all the stakeholders are integrated to shape the strategic direction of the project planning and implementation.

Another sub-objective of the fifth objective is to describe the strategy-led approach through the construction project managers’ behaviours under the conceptual and implementation stages. From the primary investigation under section 5.3.10, the strategy-led approach is determined as a planning methodology that should be stretched from the conceptual stage to the implementation stage. The study found that for 80-99% of the projects, the delivery model made in the conceptual stage of construction projects remains the major strategy until the completion of a construction projects. The findings of this sub-objective are used to describe the effort that should be given under the conceptual and implementation stages to develop the strategy-led approach. Under section 6.4, the perceptions of the SMEs are described to construct the validity of these findings.

Through the step-by-step procedure described in this section, this research study achieved the fifth objective which is to determine the suitability of the strategy-led approach and evaluate what the strategy-led approach is in the realm of construction project planning and implementation. After the fifth objective is achieved, the study could specify useful recommendations to plan and implement construction projects under the strategy-led approach.

8.4 Limitations

The current study used only successful projects to develop the strategy-led approach that can be used to plan and implement construction projects. Therefore, failures that could happen due to the use of strategies were not discovered under the scope of this study. Strategies are trials and therefore there is a potential of failure to achieve desired outcomes. Further, the study found from its quantitative analysis that influence of strategies can deliver negative outcomes towards timely achievements sometimes (section 5.3.13.5). Thus, the findings of this study could be extended if failure of the use of strategies is investigate under future research.

This research study considered complexity, dynamism, uncertainty and uniqueness as major characteristics of construction projects that make planning and implementation difficult. Thus, other factors such as responsiveness or susceptibility of projects to environemental dynamics that can influence project planning and implementation were not considered.

Another limitation of this study under the questionnaire survey is the response rate achieved. Although several strategies were implemented to get the required sample size, which is 69 to generalize the findings under 95% confidence, only 40 responses were received. However, the findings of this research study are generalized through the aid of other research methods such as the archival analysis and SME interviews. Therefore, the findings of this study are still generalizable.

In this study, under the SME interviews, only a few among the all critical success factors that significantly influence the regression models were selected. Thus, future studies are required to extend knowledge on how other critical success factors (such as coping with complexities, coping with site conditions, and minimizing delays and errors in design documents) can be influenced by the use of the strategy-led approach.

8.5 Recommendations

The recommendations of this research study are given in line with the findings of the reviews of past literature, archival analysis of CIOB awardees, questionnaire survey in which the NZIOB awardees participated, and finally the verification exercise using the SMEs.

There are three major areas that the recommendations cover: specific and general recommendations for construction project managers, and recommendations for future studies.

8.5.1 Specific Recommendations

The aim of this study is to propose a strategy-led approach as a suitable planning tool for successful construction project planning and execution by construction project managers. The recommendations are given to improve decision making under complex and uncertain situations by using construction project strategies along with traditional planning tools to achieve ultimately successful outcomes in terms of cost, time, quality and overall success.

Planning and Implementing Construction Projects through the Strategy-led Approach

- The study recommends the strategy-led approach to plan and implement construction projects. This study finds that the strategy-led approach can cope with the key project characteristics, which are complexity, dynamism, uncertainty and uniqueness, effectively, and thus enhances the desired successful outcomes. The strategy-led approach contributes to 48%, 37%, 20% and 39% of achievements in terms of cost, time, quality and overall success, respectively.

- Construction project managers may use several strategy models as the main delivery strategy to achieve potential successful outcomes as described above. However, by considering the influences toward success, this study recommends to develop the strategy-led approach around ‘planning related development’ which contained five critical success factors: ‘improve plans and schedules’, ‘effective use of technology and design alternatives’, ‘ensure monitoring and feedback’, ‘cope with necessary variations’ and ‘ensuring contractor’s cash flow’. When the influence of construction project strategies increases towards these five critical success factors from ‘moderate’ to ‘very high’, the study finds that achievements of cost, time, quality and client satisfaction are increased up to 134%, 105%, 114% and 108% in terms of cost, time, quality and overall success, respectively. On how to influence these critical success factors through the strategy-led approach, general recommendations are provided later under section 7.4.2.

- Under the strategy-led approach, construction project managers are encouraged to diagnose problems and create solutions by being reflective practitioners. This study finds that both tacit knowledge and engineering theories can be integrated effectively in the strategy-led approach by being reflective practitioners. Through reflective practice, the strategy-led approach can minimize the drawbacks of traditional planning algorithms as follows:

    - As this study finds, there is only 35% of chance that numerous issues encountered in construction projects can be dealt with in isolation. As the study determines, 65% of issues should be diagnosed while considering the interrelationships of other issues. Traditional planning algorithms (theoretical knowledge related to construction project planning) do not provide methodologies for holistic considerations. Thus, construction project managers need to use their experience and personal attributes in addition to theoretical knowledge to identify issues comprehensively with their interrelationships and create suitable strategies for planning and implementation of construction projects.

    - This study finds that the strategy-led approach can influence any critical success factor helping the achievements of success, including social issues, which traditional planning algorithms cannot effectively provide solutions for. According to the findings of this study, the use of reflective interaction and theoretical knowledge to diagnosed issues in construction project implementation is 55:45.

    - The strategy-led approach is a combination of generative and rational strategy making typologies, but generative typology is predominant over rational typology in the ration 60:40. Thus, through adopting the strategy-led approach, construction project managers can use their tacit knowledge effectively toward construction project scheduling and planning.

- This research study recommends construction project managers to craft suitable project delivery strategy models at the conceptual level comprehensively. Although construction projects are dynamic and uncertain in nature, this study finds that there is 80% to 99% possibility of the project delivery strategies that are made at the conceptual stage to remain the major project delivery strategy throughout a construction project. After crafting main strategies at the conceptual stage, there is still a possibility of 24% to 53% of emerging main strategies at the implementation stage although these emerging strategies rarely replace the strategy model made at the conceptual stage. After selecting the major project delivery strategy for a project, construction project managers need to emphasize the crafting of sub-strategies that provide assistance to achieving the desired goals of the main strategies.

Suitable Direction for Future Studies: Use of Soft Systems Methodology (SSM)

This study recommends considering the contextual background of construction projects into reflection when planning tools are developed for construction projects. This study has investigated past construction projects which were implemented successfully and found that nomothetic algorithms suggested in traditional planning tools work occasionally in construction project planning and implementation. Problem identification as well as creating proactive solutions is not straightforward. Thus, the current study recommends encouraging heuristic procedures to plan and implement construction projects. This is the characteristic of soft systems methodology, (SSM) that problem solving and decision making is encouraged through reflection in and on actions. The study has found that construction practice is a combination of technical rationality and reflective practice, but reflective practice is more important. Therefore, when solutions are created for the industry, this study recommends the development of practices based on SSM (Dias & Blockley, 1995). There are developments related to decision making and problem solving through SSM where Gödel's incompleteness theorems and Heisenberg’s uncertainty principle are used to minimize inadequacy of mathematics to handle complex and uncertain situations (Dias & Blockley, 1995; Dias, 2002). Traditional planning algorithms in the construction industry and suggested complementary advancements for them seem to be lacking in integrating these principles.

8.5.2 General Recommendations

The following general recommendations are made to describe how the strategy-led approach given under the specific recommendations can be used effectively with traditional planning algorithms to plan and implement construction projects.

2. Strategies are context-dependent. Therefore, the study does not recommend using the same strategies over and over without considering the project context for which the strategy-led approach is applicable.
3. This study recommends considering potential risk of failure associated with strategies. This study finds that there are negative consequences sometimes on timely achievements from strategies used to handle unforeseen ground conditions, cope with estimation errors and minimize effects of legal and statutory requirements.
4. Use of deliberate and spontaneous methods to craft construction project strategies is 50:50. Hence, construction project managers need to craft strategies with or without much early preparation, accordingly.
5. There is a 50% chance that established strategies remain unchanged or change incrementally with time (transformational strategies). Thus, there is a 50% chance that established strategies change frequently (revolutionary strategies). This study recommends using both revolutionary and transformational strategies advantageous for construction project planning and implementation.

- To estimate activity durations, the study recommends using subjective interpretations rather than using algorithms suggested in PERT. PERT encourages the elimination of uncertainties of estimates through probabilistic rigours, but those assumptions are valid only when a data set used for estimates have adequate number of entities (usually more than 30 data entities). This study finds construction projects rated unique to a high extent. Due to unique characteristics of construction projects, having an adequate number of data entities to satisfy probabilistic assumptions under similar contextual backgrounds is somewhat debatable.
- CPM can be used to make schedules in terms of time and to identify the critical path. This study discouraged considering the assumptions of CPM, which are unlimited duration and infinite resource availability, as reliable. The constraints based on these assumptions should be identified and suitable strategies (different construction methods and alternative design solutions) should be crafted before schedules are made.
- Adding 50% of the critical path duration as project buffer, which is the procedure of CCPM, is strongly discouraged. Rather, construction project managers are recommended to assess risk and uncertainty within the scope of a project comprehensively by using their subjective interpretations along with engineering knowledge.

- The strategy-led approach does not remove uncertainties and complexities in schedules and plans completely. Thus, in the implementation stage, this study strongly recommends to set suitable methods to get feedback through monitoring to evaluate efficiency of schedules and plans made under the strategy-led approach.
- To measure schedule and cost variances, the study recommends using traditional planning tools such as EVM and CPM. The study recommends using multiple approaches to track progress and estimate project completion. EVM parameters can give independent estimates about completion time which can be compared with the critical path of CPM to predict planning accuracy.
- As well as tracking progress, the study strongly recommends recording causes for and effects of variations. Representing an activity through segments (as similar to critical path segment (CPS) method) can allow practitioners to identify and illustrate causes for and effect of variations more effectively compared to CPM where an activity is represented as a continuous block.
- When variations are related to the non-critical path, those non-critical activities may appear later in the critical path due to variations. Construction project managers should consider those possibilities under coping with variations of non-critical activities.
- Both strategies, which are craft by the construction project managers alone or by integrating other stakeholders, are recommended for planning and implementing construction projects. However, experimenting and risk taking is discouraged to be allowed under the strategy-led approach. Rather, risk is recommended to be distributed at least among the top most authorities for project level strategies.

8.5.3 Recommendations for Future Studies

This section provides a list of recommendation for future studies to comprehend the investigations of this research study and to minimize the limitations.

- There are a few critical success factors that are found under the regression analysis (section 5.3.13.5) as statistically significant for achievements of cost, time and overall success, but which the SME interviews did not focus on. Only the critical success factors related to 'planning related development' were further evaluated to clarify how the factors influence planning and implementation of construction projects. For the factors that were not validated through the dialectical information of the SMEs interviews, future studies are recommended as follows to develop strategy models:

1. How can strategies be used to improve achievements on cost through ‘minimizing delays and errors in documents’?
2. In the similar way, how can strategies be used to enhance achievements of ‘overall success’ through crafting strategies to ‘minimize delays and errors in documents’?
3. Why could influences of strategies toward ‘coping with complexities’ cause either positive or negative consequences on timely achievements? ‘Coping with complexity’ includes several critical success factors: handling unforeseen ground condition, coping with legal/statutory requirements, communication, handling design complexities and coping with estimation errors.

- Future studies are recommended to investigate the extent of the strategy-to-implement gap as well as factors contributing to this gap. In reviews of literature, it is emphasized that strategy has risk of failure. The strategy-to-implement gap can limit the achievements of strategies in marketing to 60% only, and hence this gap should be evaluated in the context of construction project planning strategies (Thompson, Strickland, & Gamble, 2007). The factors that create strategy-to-implement gaps in the marketing sector include communication and resource unavailability which can also be critical for construction project strategies.
- This research study has investigated that the client has similar importance towards the strategy-led approach. This study is mainly based on the responses given from construction project manager’s perspectives. The study recommends investigating the strategy-led approach from the perspective of the client, similar to this study, to uncover the client’s views of what the strategy-led approach is.

8.6 Conclusion

This research has added to literature on strategy and its development in the construction industry.

The evaluation of issues related to construction project planning has helped to establish that problem clarification in construction projects should be done through reflective interaction, where theoretical knowledge and tacit knowledge should be used effectively. Further, this study emphasized the importance of considering issues in a holistic manner where construction project practitioners are encouraged to consider issues both, in parts and as a whole. While crafting solutions, construction project managers are encouraged to consider the context of projects from the conceptual stage until completion. This research has shown that strategies should include a combination of traditional planning tools and experiential knowledge of construction planners (construction project managers) to achieve success in planning and implementation of projects.

The strategy-led approach is determined as a planning methodology that can effectively influence any critical concern that would help in achievements of success in construction projects. The in depth investigation that is done under this study was on 'planning related development' which includes 'improve plans and schedules', 'cope with variations', 'effective use of technology and design solutions', 'ensure feedback and monitoring' and 'ensure contractor's cash-flow'. The investigation helped to describe how traditional planning tools and construction project strategies can be used together under the strategy-led approach.

This research study has used the construction projects that are recognized as successful by a wide range of industry practitioners. Further, the projects used in this research were considerably challenged by complexity, dynamism, uncertainty and uniqueness. Thus, study believes that the strategy-led approach, which is formulated in this research study, can be used to handle complex and uncertain situations effectively and to ultimately achieve success in construction projects.

References

Abeysekara, S. (2000). Quantitative Analysis Approaches to Qualitative Data: Why, When and How. www.reading.ac.uk

Abeysekera, V. (2007). Living through a Project: A Strategy-Led Approach for Project Success. *Construction information quarterly, 9*(4), 186-191.

Akintoye, A. S., MacLeod, M. J. (1997). Risk analysis and management in construction. *International Journal of Project Management, 15*(1), 31-38.

Al-Momani, A. H. (2000). Construction delay: a quantitative analysis. *International Journal of Project Management, 18*(1), 51-59.

Al-zahrani, s. (n.d). *The systems approach*. Retrieved 26/07, 2012, from http://www.google.co.nz/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved =0CGAQFjAA&url=http%3A%2F%2Fwww.dr-s

Alfers, D., & Dinges, H. (1984). A normal approximation for beta and gamma tail probabilities. *Wahrscheinlichkeitstheorie 65*(3), 399-420.

Alison, G., & Zelikow, P. (1999). *Essence of Decisions: Explaining the Cuban Missile Crisis* (2 ed.). NY: Longman.

Amanda, N., & Enders, C. K. (2010). An introduction to modern missing data analyses. *Journal of School Psychology, 48*(1), 5-37.

Amaratunga, D., Baldry, D., Sarshar, M., & Newton, R. . (2002). Quantitative and qualitative research in the built environment: Application of 'mixed method' research approach. *Work Study, 51*(1), 17-31.

Andrews, K. R. (1987). *The concept of corporate strategy*. Homewood: Irwin.

Assaf, S. A., & Al-Hejji, S. (2006). Causes of delay in large construction projects. *International Journal of Project Management, 24,* 349-357.

Atlantic Yards Report. (2012). *Construction monitor: arena still ahead of schedule* Retrieved 03/08, 2012,

Baccarini, D. (1996). The concept of project complexity-a review. *International Journal of Project Management, 14*(4), 201-204.

Badiru, A. B. (1991). *A simulation approach to PERT network analysis*. Retrieved 6/3, 2012, from http://sim.sagepub.com/content/57/4/245.full.pdf

Bailey, C., A. (2007). *A Guide to qualitative field research*. Thousand Oaks, CA: SAGE.

Ballard, G., & Howell, G. (1998. *What kind of production is construction*. presented at the meeting of the International Group for Lean Construction (IGLC), Guaruja, Brazil.

Baloia, D., & Price, A. D. F. (2003). Modelling global risk factors affecting construction cost performance. *International Journal of Project Management 21*, 261-269.

Barribeau, P., Butler, B., Corney, J., Doney, M., Gault, J., Gordon, J., ... Palmquist, M. (2012). *Pretesting the Questionnaire*. Retrieved 02/03, 2012, from http://writing.colostate.edu/guides/research/survey/com4a3.cfm

Bartlett, J. E., Kotrlik, J. W., Higgins, C. C. (2001a). Organizational research: Determining appropriate sample size in survey research. *Information Technology, Learning and Performance 19*(1), 43-50.

Bartlett, J. E., Kotrlik, J. W., Higgins, C. C. (2001b). Organizational Research: Determining Appropriate Sample Size in Survey Research. *Information Technology, Learning and Performance 19*(1), 43-50.

Baruch, Y. (1999). Response rate in academic studies: a comparative analysis *Human Relations, 52*(4), 421-438.

Belassi, W., & Tukel, O. I. (1996). A new framework for determining critical success/failure factors in projects. *International journal of project management, 14*(03), 141-151.

Bennett, J. (1991). *International construction Project Management: General theory and Practice*. Oxford: Butterworth-Heinemann.

Betts, M., & Ofori, G. (1992). Strategic planning for competitive advantage in construction. *Construction Management and Economics, 10*, 511-532.

Black, M., Guy, M., & McLellan, N. (2003). *Productivity in NZ 1998 to 2002*. Wellington NZ Treasury.

Blaxter, L., Hughes, C., & Tight, M. (2001). *How to research* (2 ed.). Buckingham: Open University Press.

Bordon, R. C., & Biklen, S. K. (1998). *Qualitative Research in Education: An introduction to theory and methods* (3 ed.). Boston: Allyn & Bacon.

Bourne, L. (2007). *Avoiding the successful failure*. Retrieved 2/3, 2011 from http://www.mosaicproject.com.au/PDF_Papers/P046_Successful_Failure.pdf

Bourne, L., & Walker, D. (2005). The Paradox of project Control. *Team Performance Management Journal, 11*(5), 157-187.

Boussabaine, A. H. (1996). The use of artificial neural networks in construction management: a review. *Construction Management and Economics, 14*, 427-436.

Burke, R. (2006). *Project Management. Planning and Control Techniques (5th Ed.)*. London: Burke Publishing.

Chaffee, E., E. (1985). Three models of Strategy. *The academy of Management Review, 10*(1), 89-98.

Chan, A. P. C., Chan, D. W. M., Chiang, Y. H., Tang, B. S., Chan, E. H. W., & K., a. S. (2004). Exploring Critical Success Factors for Partnering in Construction Projects. *Journal of Construction Engineering and Management, 130*(2), 188-198.

Chan, A. P. C., Scott, D., & Chan, A. P. L. (2004). Factors Affecting the Success of a Construction Project. *Journal of Construction Engineering and Management, 130*(1), 153-155.

Chan, A. P. C., Scott, D., & Lam, E. W. M. (2002). Framework of Success Criteria for Design/Build Projects. *Journal of Management in Engineering, 18*(3), 120-128.

Chan, D. W. M., & Kumarswamy, M. M. (1997). A comparative study of causes of time overruns in Hong Kong construction projects. *International journal of project management, 15*(01), 55-63.

Chandler, A. D. (1962). *Strategy and structure*. Cambridge: Massachusetts Institute of Technology.

Charles, C. M. (1995). *Introduction to Educational Research* (2 ed.). San Diego: Longman.

Chartered Institute of Building. (2009a). *GOLD: Housing / Accommodation Projects Under £12M*. Retrieved 1/2, 2012, from http://www.cmya.co.uk/Winner/2010/448

Chartered Institute of Building. (2009b). *GOLD: New Build / Refurbishment Projects £2M and below*. Retrieved 10/02, 2012, from http://www.cmya.co.uk/Winner/2009/330

Chartered Institute of Building. (2009c). *GOLD: New Build / Refurbishment Projects £2M and below*. Retrieved 1/2, 2012, from http://www.cmya.co.uk/Winner/2009/330

Chartered Institute of Building. (2009d). *Silver: Residential projects under 14M*. Retrieved 2011, 01/12, from http://www.cmya.co.uk/Winner/2009/310

Chartered Institute of Building. (2010a). *The Construction Manager of the Year 2010 and GOLD: New Build / Refurbishment Projects Over £40M to £60M*. Retrieved 1/2, 2012, from http://www.cmya.co.uk/Winner/2010/538

Chartered Institute of Building. (2010b). *GOLD: New Build / Refurbishment Projects Over £26M to £40M*. Retrieved 01/02, 2012, from http://www.cmya.co.uk/Winner/2010/529

Chartered Institute of Building. (2010c). *SILVER: Housing / Accommodation Projects Over £6M*. Retrieved 1/2, 2012, from http://www.cmya.co.uk/Winner/570

Chartered Institute of Building. (2010d). *SILVER: New Build / Refurbishment Projects £4M to £7M*. Retrieved 1/2, 2012, from http://www.cmya.co.uk/Winner/603

Chartered Institute of Building. (2011a). *Gold: Housing/ accommodation projects under 6M*. Retrieved 2012, 01/02, from http://www.cmya.co.uk/Winner/566

Chartered Institute of Building. (2011b). *GOLD: New Build / Refurbishment Projects £11M to £17M*. Retrieved 1/2, 2010, from http://www.cmya.co.uk/Winner/616

Chartered Institute of Building. (2011c). *Gold: New Build/refurbishment projects over 8M to 14M*. Retrieved 01/02, 2012, from http://www.cmya.co.uk/Winner/2010/492

Checkland, P. B. (1981). *System Thinking, System Practice*. Chichester John Wiley & Sons.

Checkland, P. B. (1999). *System Thinking, System Practice, a 30-Year Retrospective.* Chichester John Wiley & Sons.

Checkland, P. B., & Scholes, J. (1990). *Soft System Methodology in Action*. Chichester John Wiley & Sons.

Chen, C.-H., Ling, S. F., & Chen, W. (2003). Project scheduling for collaborative product development using DSM. *International Journal of Project Management, 21*, 291-299.

Cheunga, S.-O., Ngb, T. S. T., Shek-Pui Wonga, & Suena, H. C. H. (2003). Behavioural aspects in construction partnering. *Engineering, Construction and Architectural Management, 21*(5), 333-343.

CIOB. (2002). *Code of practice for project management for construction and development* (3 ed.). Oxford, UK: Blackwell Publishing.

Clealand, D. I., & King, W. R. (1983). *System analysis and project management* NY: McGrow Hill.

Clegg, R., S. (1992). Contracts cause conflicts In P. Fenn & R. Gameson (Eds.), *Conflict management and resolution* (pp. 128-144). London, UK: E $ FN Spon.

Clough, R. H., Sears, G. A., & Sears, S. K. (2008). *Construction project management (5th edition)*. NJ: John Wiley & Sons.

Construction Manager of the Year Award. (2009a). *Gold: New Build / Refurbishment Projects Over £20M to £45M*. Retrieved 08/15, 2010, from http://www.cmya.co.uk/Winner/2009/406

Construction Manager of the Year Award. (2009b). *Silver: New Build / Refurbishment Projects Over £7M to £10M*. Retrieved 08/15, 2010, from http://www.cmya.co.uk/Winner/2009/433

Construction Manager of the Year Award. (2009c). *Silver: Residential Projects Under £14M*. Retrieved 02/05, 2012, from http://www.cmya.co.uk/Winner/2009/310

Construction Manager of the Year Award. (2010a). *The Construction Manger of the Year award*. Retrieved 28/11, 2011, from http://www.cmya.co.uk/Winner/2010/529

Construction Manager of the Year Award. (2010b). *GOLD: New Build / Refurbishment Projects £14M to £20M*. Retrieved 19/3, 2012, from http://www.cmya.co.uk/Winner/2010/499

Construction Manager of the Year Award. (2010c). *GOLD: New Build / Refurbishment Projects Over £26M to £40M*. Retrieved 19/3, 2012, from http://www.cmya.co.uk/Winner/2010/529

Construction Manager of the Year Award. (2010d). *GOLD: New Build / Refurbishment Projects Over £60M* Retrieved 19/3, 2012, from http://www.cmya.co.uk/Winner/2010/548

Construction Manager of the Year Award. (2011). *GOLD: New Build / Refurbishment Projects Over £60M*. Retrieved 03/05, 2011, from http://www.cmya.co.uk/Winner/2011/663

Construction Manager of the Year Award Entry Form. (2012). *Construction Manager of the Year Awards Entry Form* Retrieved 26/03, 2012, from http://www.cmya.co.uk/uploads/CMYA%202012%20Entry%20Form.pdf

Cottrell, W. D. (1999). Simplified Program Evaluation and Review Technique. *Journal of Construction Engineering and Management, 125*(1), 16-22.

Cunningham, P. (2010). *Constructing Excellence in New Zealand: International Building & Construction Industry Productivity Reform Programmes* Retrieved 8/3, 2012, from http://www.constructing.co.nz/files/Knowledge%20Library/CENZProductivityReportFinalAug10.pdf

Davis, N. (2007). *Construction Sector Productivity-Scoping Report*. Wellington: Martin-Jenkins.

De Wit, B., & Meyer, R. (2004). *Strategy: Process, Content, Context* (3 ed.). London: Thomas Learning.

Denzin, N. K., & Lincoln, Y. S. (2003). *The landscape of qualitative Research: theories and issues*. CA: SAGE Publication.

Denzin, N. K., & Lincoln, Y. S. (2005). Introduction. In N. K. Denzin & Y. S. Lincoln (Eds.), *The Sage Handbook of Qualitative Research* (3 ed., pp. 1-32). Thousand Oaks: CA: Sage.

Dias, W., P., S. (2002). Reflective practice, artificial intelligence, and engineering design: Common trends and interrelationships. *Artificial Intelligence for Engineering Design, Analysis and manufacturing, 16*, 261-271.

Dias, W., P., S., & Blockley, D., I. . (1995). Reflective practice in engineering design *ICE Proceedings on Civil Engineering, 108*, 160–168.

Egan, J. (1998). *Rethinking Construction*. London: Department of the Environment, Transport and the Regions.

Egbu, C. O. (2004). Managing knowledge and intellectual capital in the construction industry. *Engineering, Construction and Architectural Management 11*(5), 301-315.

Fahey, M. (2010). *NZIOB Annual Report - Presidents' Report*: New Zealand Institute of Building.

Fairclough, J. (2002). *Rethinking Construction Innovation and Research: A review of Government R & D Policies and Practices*. London: Department for Transport and Local Government Regions (DTLR).

Fallah, M., Ashtiani, B., & Aryanezhad, M. B. (2010). Critical Chain Project Scheduling: Utilizing uncertainty for Buffer Sizing. *International Journal of Research and Review for Applied Science, 3*(3), 280-283.

Feinberg, F. M., Kinnear, T. C., & Taylor, J. R. (2008). *Modern Marketing research: Concepts, Methods and Cases*. Mason, OH: Thomson Corporation.

Fellows, R., & Liu, A. (2003). *Research methods for construction* (2 ed.). Oxford: Blackwell Publishing.

Fewings, P. (2005). *Construction project management – An integrated approach*. Abingdon, UK: Taylor & Francis Group.

Field, A. (2005). *Factor Analysis Using SPSS*. Retrieved 5/6, 2012, from http://www.google.co.nz/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&sqi=

2&ved=0CE8QFjAE&url=http%3A%2F%2Fwww.statisticshell.com%2Fdocs%2Ffactor.pdf&ei=nfuBUaOWPOWjiAew1ICQDg&usg=AFQjCNGZN_Dmos0zRJ6bykzInXOWFXQZzQ&sig2=Td7SkRy31vhG-UIBCi5_vg

Fleming, Q. W., & Koppelman, J. M. (2002). Earned Value management: Mitigating the risk associated with construction projects *Risk Management* 90-95.

Fryer, B. (2004). *The practice of construction management*. Oxford, UK: Blackwell publishing.

Ganaway, N. (2006). *Construction Business Management* (1st ed.). Oxford: Butterworth-Heinemann.

Gardiner, P. D., & Stewart, K. (2000). Revisiting the golden triangle of cost, time and quality: the role of NPV in project control, success and failure. *International Journal of Project Management 18*, 251-256.

Gidado, K. I. (1994). Project complexity: The focal point of construction production planning. *Construction Management and Economics, 14*, 213-225.

Glenwright, E. T. (2004). *Let's Scrap the Precedence Diagramming Method*. Retrieved 21/06, 2012, from www.asapm.org/asapmag/articles/ps08_earl.pdf

Glesne, C., & Peshkin, P. (1992). *Becoming Qualitative Researchers: An introduction*. New York: Longman.

Golafshani, N. (2003). Understanding the Reliability and Validity in Qualitative Research. *The Qualitative Report, 8*(4), 597-607.

Grant, M., G., & Giddings, L., S. (2002). Making sense of methodologies: A paradigm framework for the novice researcher. *Contemporary Nurse, 13*(1), 10-28.

Guba, E. G. (1990). The Alternative Paradigm Dialog. In E. G. Guba (Ed.), *The paradigm dialog* (pp. 17-30). CA: SAGE Publication.

Guba, E. G., & Lincoln, Y., S. (1994). Competing paradigms in qualitative research. In N.K. Denzin, & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105-117). Thousand Oaks, CA: SAGE.

Guba, E. G., & Lincoln, Y. S. (2005). Paradigmatic controversies, contradictions, and emerging confluences. In N.K. Denzin, & Y. S. Lincoln (Eds.), *The Sage handbook of qualitative research* (pp. 191-216). Thousand Oaks, CA: SAGE.

Hambrick, D., C. (1983). Some tests of the effectiveness and functional attributes of Miles and Snow's strategic type. *Academy of Management Journal, 26*(5-25).

Hardy, J. V. (1970). *Cash flow forecasting for the construction industry*. Lough-borough University of Technology, Lough-borough.

Hart, S., & Banbury, C. (1994). how Strategy Making Process Can Make A Difference. *Strategic Management Journal, 15*, 251-269

Hegazy, T., & Menesi, W. (2010). Critical Path Segments Scheduling Technique. *Journal of Construction Engineering and Management, 136*(10), 1078-1085.

Hsieh, H. F., & Shannon, S. E. (2005). Three Approaches to Qualitative Content Analysis. *Qualitative Health Research, 15*(9), 1277-1288.

Hyari, K., & El-Rayes, K. (2006). Optimal Planning and Scheduling for Repetitive Construction Projects. *Journal of Management in Engineering, 22*(1), 11-19.

Jaafari, A. (1984). Criticism of CPM for Project Planning Analysis. *Journal of Construction Engineering Management, 110*(2), 222-233.

Janssen, J., & McLoughlin, S. (2008). *NZ's Productivity Performance*. Wellington NZ Treasury.

Jha, K. N., & Iyer, K. C. (2006). Critical factors affecting quality performance in construction projects. *Total Quality Management, 17*(9), 1155-1170.

Jiang, J., & Klein, G. (1999). Risk to different aspects of system success. *Information and Management, 36*(5), 263-271.

Jick, T. D. (1979). Mixing Qualitative and Quantitative Methods: Triangulation in Action. *Administrative science quarterly 24*, 602-611.

Johnson, G., & Scholes, K. (2002). *Exploring corporate strategy (6th Ed.)*. London: Prentice-Hall.

Johnson, G., Scholes, K., Whittington, R. . (2005). *Exploring Corporate Strategy: Text & Cases* (7 ed.). Harlow: Financial Times Prentice Hall

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed method research: a research paradigm whose time has come. *Educational Researcher 33*(7), 14-26.

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research, 1*(2), 112-133.

Jones, M., Meyer, J., & Flanagan, D. (2009). *Emerging Earned Value Management Technique: Earned Schedule*. Retrieved 15/08, 2011, from http://www.earnedschedule.com/Docs/Emerging%20EVM%20Technique,%20Earned%20Schedule.pdf

Kaka, A. P., & Price, A. D. F. (1993). Modelling standard cost commitment curves for contractors' cash flow forecasting. *Construction Management and Economics, 11*, 271-283.

Kaming, P. F., Olomolaiye, P. O., Holt, G. D., & Harris, F. C. (1997). Factors influencing construction time and cost overruns on high-rise projects in Indonesia. *Construction Management and Economics, 15*, 83-94.

Kassab, M., Hegazy, T., & Hipel, K. (2010). Computerized DSS for Construction Conflict Resolution under Uncertainty. *Journal of Construction Engineering and Management, 136*(12), 1049-1057.

Kazaz, A., Ulubeyli, S. (2009). Strategic Management Practices in Turkish Construction Firms. *Journal of Management in Engineering, 25*(4), 185-194.

Kerzner, H. (2006). *Project Management*. NJ: John Wiley & Sons.

Ketchen, D. J., Thomas, J. B., & McDaniel, R. R. (1996). Process, Content and Context: Synergistic Effects on Organizational Performance. *Journal of management 22*(2), 231-257.

Kinsella, E. A. (2007). Technical rationality in Schön's reflective practice: dichotomous or non-dualistic epistemological position. *Nursing Philosophy, 8,* 102–113.

Kirk, J., & Miller, M. L. (1986). *Reliability and validity in Qualitative Research*. Newbury Park, California: Sage Publications.

Kuhn, A. J. (2006). CPM not working well on small projects. *AACE International Transactions*, PS21.21-PS21.23.

Kuhn, T., S. (n.d). *The structure of scientific revolution*. Retrieved 23/01, 2012, from http://des.emory.edu/mfp/kuhnsyn.html

Kumar, D. (2002). Developing strategies and philosophies early for successful project implementation. *International Journal of Project Management*, *7*(3), 164-171

Kumaraswamy, M. M., & Chan, W. M. (1998). Contributors to construction delays. *Construction Management and Economics*, *16*, 17-29.

Lancaster University Management School. (n.d). *What is Operational Research?* Retrieved 23/04, 2012, from http://www.lums.lancs.ac.uk/masters/management-science/msc-operational-research-management-science/what-is-operational-research/

Lau, A. H.-L., Lau, H.-S., & Zhang, Y. (1996). A simple and logical alternative for making PERT time estimates *IIE Transactions*, *28*(3), 183-192.

Laufer, A., & Tucker, R. L. (1987). Is construction project planning really doing its job? A critical examination of focus, role and process. *Construction Management and Economics, 5*, 243-266.

Lee, S., Peña-Mora, F., & Park, M. (2006). Reliability and Stability Buffering Approach: Focusing on the Issues of Errors and Changes in Concurrent Design and Construction Projects. *Journal of Construction Engineering and Management, 132*(5), 452-464.

Letourneau, N., & Allen, M. (1999). Post-positivistic critical multiplism: a beginning dialogue. *Journal of Advanced Learning, 30*(3), 623-630.

Lewis, J. P. *The project manager's desk reference: project planning, scheduling, evaluation, control, systems* (3 ed.). NY: McGraw-Hill Professional.

Lim, C. S., Mohamed, M. Z. (1999). Criteria of project success: an exploratory re-examination. *International Journal of Project Management, 17*(4), 243-248.

Lock, D. (2007). *Project Management* (9 ed.). Hampshire: Gower publishing Limited.

Long, L. D., & Ohsato, A. (2007). Fuzzy critical chain method for project scheduling under resource constraints and uncertainty *International Journal of Project Management, 26*, 688-698.

Lu, M., & Lam, H.-C. (2008). Critical path Scheduling under Resource Calendar Constraints. *Journal of Construction Engineering and Management, 134*(1), 25-30.

Lynch, S. M. (2007). *Introduction to Applied Bayesian Statistics and Estimation for Social Scientists*: Springer. Retrieved 2/2, 2012 from http://books.google.co.nz/books?id=D41tTXCiRtgC

Lynch, S. M. (2007). *Introduction to Applied Bayesian Statistics and Estimation for Social Scientists*. NY: Springer.

Malhotra, N., Hall, J., Shaw, M., & Oppenheim, P. (2002). *market research: An applied orientation* (2 ed.). NSW: Prentice Hall.

Masurier, J. L. (2001). *Developing the observational method as a systematic approach to uncertainty management* The University of Bristol, Bristol.

McDonald, D., & Schneberger, S. (2006). Scientific Inquiry-Theory Construction: A Primer Symposium conducted at the meeting of the Proceedings of the Information Systems Education Conference Dallas, Texas. Retrieved 3/8, 2011from http://proc.isecon.org/2006/2544/index.html

Mensi, W. (2010). *Construction Scheduling Using Critical Path Analysis with Separate Time Segments*. University of Waterloo, Ontario.

Mingers, J., & White, L. (2010). A review of the recent contribution of systems thinking to operational research and management science. *European Journal of Operational Research 207*, 1147–1161.

Mintzberg, H., Quinn, J. B., & Ahlstrand, B. (1998). *The strategy safari*. San Francisco: Jossey-Bass.

Moder, J. J., Phillips, C. R., & Davis, E. W. (1983). *Project Management with CPM, PERT and Precedence Diagramming* (3 ed.). NY: Van Nostrand Reinhold.

Mouchi, G. (2010). *Project Managers Skills for managing Complex projects*. Auckland University of Technology, Auckland

Muller, R., & Turner, J. R. (2007). Matching the project manager's leadership style to project type. *International Journal of Project Management, 25*, 21-32.

Munns, A. K., & Bjeirmi, B. F. (1996). The role of project management in achieving project success. *International Journal of Project Management, 14*(2), 81-87.

Nelson, C. (2010). *Deterministic and Stochastic Models*. Retrieved 18/05, 2012, from http://www.futuretoolkit.com/detstoch.htm

New Zealand Institute of Building. (2011a). Retrieved 10/12, 2011, from http://www.nziob.org.nz/page/nziob-awards

New Zealand Institute of Building. (2011b). *Entry form*. Retrieved 10/12, 2011, from http://www.nziob.org.nz/gib-entry

Norton, B., & Irving, R. (1999). *Understanding strategy in a week: Successful business in a week*. London: Hodder & Stoughton General Division.

Oder, N. (2012). *Atlantic Yards Report*. Retrieved 12/3, 2012, from http://atlanticyardsreport.blogspot.co.nz/2012/01/new-report-for-three-months-arena-has.html

Ofori, G. (1990). *The construction industry: Aspects of its economics and management*. Singapore: Singapore University Press.

Ohmae, K. (1982). *The mind of the strategist: The art of Japanese business*. New York: McGraw-Hill.

Oliver, J. C. (1984). *Modelling cash flow projections using a standard micro-computer spreadsheet programs* Loughborough University of Technology, Loughborough.

Oloufa, A. A., Hosni, Y. A., Fayez, M., & Axelesson, P. (2004). Using DSM for modulling information flow in construction design projects. *Civil Engineering and Environmental System, 21*(2), 105-125.

Parashos, P., Morgan, M., & Messer, H. (2005). Response rate and non-response bias in a questionnaire survey of dentists. *Community Dent Oral Epidemiology, 33*, 9-16.

Parfitt, M., & Sanvido, V. (1993). Checklist of Critical Success Factors for Building Projects. *Journal of Management in Engineering, 9*(3), 243-249.

Parsons, G. L. (1983). Information Technology: A New Competitive Weapon. *Sloan. Management Review, 25*(1), 3-14.

Passer, R. (2011). *What Project Strategies are needed for successful implementation of construction projects?* Auckland University of Technology Auckland.

Patrick, F. (2004). *Software for critical chain project management* Retrieved 15/03, 2012, from http://www.focusedperformance.com/2004/04/software-for-critical-chain-project.html

Petit, T., A. (1967). *The moral crisis in management*. NY: McGraw-Hill.

Pettigrew, A. (1992). The character and Significance of Strategy Process Research. *strategic management 13*, 5-16.

Pinto, J. K., & Covin, J. G. (1989). Critical factors in project implementation: A comparison of construction and R&D projects. *Technovation, 9*(1), 49-62.

Pinto, J. K., & Mantel, S. J. (1990). The Causes of Project Failure. *IEEE Transactions on Engineering Management, 37*(4), 269-276.

Pinto, J. K., Slevin, D. P. (1987). Balancing strategy and tactics in project implementation. *Sloan management review*, 33-41.

Pope, J. L. (1993). *Practical Marketing Research*. NY: AMACOM.

Popper, K. R. (2002). *Conjectures and refutation: the growth of scientific knowledge* London, UK: Routledge Classics.

Porter, M. E. (1985). *Competitive Advantage*. NY: Free Press.

Porter, M. E. (1997). *Rethinking Competition: Rethinking the Future*. London Nicholas Brealey Publishing.

Porter, M. E. (1998). *Competitive advantage: Creating and sustaining superior performance* New York: The Free press.

Price, A. D. F., & Newson, E. (2003). Strategic Management: Consideration of Paradoxes, Processes, and Associated Concepts as Applied to Construction. *Journal of Management in Engineering, 19*(4), 183-192.

Ramanayaka, C., & Rotimi, J. (2011, 5-7 September). Strategy: Towards its applicability for successful project delivery. In C. Egbu & E. C. W. Lou, Symposium conducted at the meeting of the Association of Researchers in Construction Management (ARCOM) 27th Annual Conference, University of the West of England, Bristol.

Ramanayaka, C., & Rotimi, J. (2012, July 4, 2012 – July 6, 2012). Strategy-led Construction: Success Thorugh a Human-Centred Approach. In I. Kamardeen, S. Newton, B. Lim, & M. Loosemore, *AUBEA.* Symposium conducted at the meeting of the 37th Annual Conference of Australasian University Building Educators Association (AUBEA), University of New South Wales.

Ramanayaka, C., & Rotimi, J. (2012, 10-13 September). Reflective Practice: Scoping its applicability for successful construction project delivery. In D. Kashiwagi & K. Sullivan, Symposium conducted at the meeting of the RICS COBRA 2012, Construction, Building and Real Estate Annual Conference, Las Vegas, Nevada

Rand, G. K. (2000). Critical chain: the theory of constraints applied to project management. *International Journal of Project Management 18*, 173-177.

Razali, N. M., & Wah, Y. B. (2011). Power comparisons of Shapiro-Wilk, Kolmogrov-Smirnov, Lilliefors and Anderson-Darling test. *Journal of statistical modelling and Analytics 2*(1), 21-33.

Reynolds, P. D. (1971). *A premier in theory construction*. Indiana Bobbs-Merrill.

Riva, M. (2009). *What was the business strategy adopted by a residential developer in Auckland to help it survive during the economic downturn*. Unitec, Auckland.

Rodríguez, J. O., Prieto, S. E., Correa, C., Bernal, P. A., Puerta, G. E., Vitery, S., ... Muñoz, D. (2010). Theoretical generalization of normal and sick coronary arteries with fractal dimensions and the arterial intrinsic mathematical harmony. *Journal of Experimental and Clinical Cancer Research, 10*(1), 1-6.

Rogelberg, S., & Stanton, J. (2007). Understanding and dealing with organizational survey responses *Organizational Research Methods, 10*(2), 195-209.

Rotimi, J. (2010). *An examination of improvements required to legislative provisions for post disaster reconstruction in New Zealand* University of Canterbury, Canterbury.

Saliya, C., A. (2009). *Role of Bank Lending in Sustaining Income/Wealth Inequality in Sri Lanka*. Auckland University of Technology, Auckland

Sambasivan, M., & Soon, Y. W. (2007). Causes and effects of delays in Malaysian construction industry. *International journal of project management, 25*, 517-526.

Sandelowski, M. (2000). Combining qualitative and quantitative sampling, data collection and analysis techniques in mixed-method approach *Research in nursing and health, 23,* 246-255.

Saunders, M., Lewis, P., & Thronhill, A. (2007). *Research methods for business students* (6th ed.). Harlow: Pearson Education.

Sawhney, A., Mund, A., & Chaitavatputtiporn, T. (2003). Petri net-based scheduling of construction projects *Civil Engineering and Environmental System, 20*(4), 255-271.

Schlomer, G. L., Bauman, S., & Card, N. A. (2010). Best Practices for Missing Data Management in Counselling Psychology. *Journal of Counselling Psychology 57*(1), 1-10.

Schon, D. (1992). The Theory of Inquiry: Dewey's Legazy to Education. *Curriculum Inquiry, 22*(2), 119-139.

Schon, D. (2001). The Crisis of Professional Knowledge and the Pursuit of an Epistemology of Practice. In J. Raven & J. Stephenson (Eds.), *Competence in the Learning Society* (pp. 185-207). NY: Peter Lang. Retrieved 14/11, 2010 from http://www-new1.heacademy.ac.uk/assets/documents/resources/heca/heca_cl13.pdf

Shadish, W. R. (1993). Critical multiplism: a research strategy and its attendant tactics. *New Directions for Program Evolution, 60* 13-57.

Shim, E., & Kim, S. (2011, October 26-29). The Cash-flow Simulation Game: Introduction. In M. El-Gafy (Chair), *Michigan State University*. Symposium conducted at the meeting of the Proceedings of the 2011 ASC Region III Conference, Downers Grove, Illinois.

Silverman, D. (2004). Research and social theory. In C. Seale (Ed.), *Researching society and culture*. London SAGE Publications.

Slevin, D. P., Pinto, J. K. (1987). Balancing strategy and tactics in project implementation. *Sloan management review*, 33-41.

Smith, M., & Hodkinson, G. (2005). Relativism, Criteria and Politics. In N.K. Denzin, & Y. S. Lincoln (Eds.), *The sage Handbook of Qualitative Research* (pp. 915-932). Thousand Oaks, CA: Sage.

Smith, N. J., Merna, T., & Jobling, P. (1999). *Managing Risk in Construction Projects*. Oxford: Blackwell Publishing.

Smith, T. E. (2012). *A Suggested Procedure for Multiple Regression Analysis*. Retrieved 10/09, 2012, from http://www.seas.upenn.edu/~ese302/extra_mtls/Multiple_Regression.pdf

Sommerville, J., Craig, N., & Hendry, J. (2010). The role of the project manager: all things to all people? *Structural Survey, 28*(2), 131-142.

Sowers, G., F. (1991). The Human Factors in Failures. *American Society of civil Engineers, 61*(3), 72-74.

Sriprasert, E., & Dawood, N. (2002, 10, August). Next generation of construction planning and control system: The LEWIS approach Symposium conducted at the meeting of the International Group for Lean Construction, Gramado, Brazil.

stattrek.com. (2012). *Statistical Inference* Retrieved 25/08, 2012, from http://stattrek.com/estimation/estimation-in-statistics.aspx?Tutorial=AP

Stevens, J. W. (2009). *What is Bayesian statistics*. Retrieved 03/02, 2012, from http://www.medicine.ox.ac.uk/bandolier/painres/download/whatis/What_is_Bay_stats.pdf

Stoner, J., Freeman, A., & Gilbert, D. (1995). *Management (6th Ed.)*. Englewood Cliffs, NJ: Prentice Hall.

Taylor, G. R. (2005). Introduction and overview of the research process. In G. R. Taylor (Ed.), *Integrating quantitative and qualitative methods in research* (2 ed.). Lanham, Maryland: University Press of America.

Thamhain, H. J., & Wilcmon, D. W. (1975). Conflict management in project life cycles. *Sloan Management Review, 17*(2), 31-50.

Thompson, A. A., Strickland, A. J., & Gamble, J. E. (2007). *Crafting and executing strategy: The quest for competitive advantage*. Boston: McGraw-Hill/Irwin.

Thompson, A. A., Strickland, A. J., Gamble, J. E. (2004). *Strategy: Winning in the market place: core concepts, analytical tools, cases*. Boston, Mass: McGraw-Hill.

Tobias, S., & Calson, J. E. (1969). Brief report: Bartlett's test of Sphericity and chance findings in factor analysis. *Multivariate Behavioural Research, 4*(3), 375-377.

Tran, V. D., & Tookey, J. E. (2012). Productivity in the NZ Construction Industry: Albatross Around the Neck of Growth or Victim of Circumstances Retrieved 2/4, 2012 from http://www.msd.unimelb.edu.au/events/conferences/aubea2010/conference-papers/pdf/A013-Tran-Tookey.pdf

Triantaphyllou, E. (2000). *Multi-criteria decision making methods: A comparative study*. Dordretcht, The Netherlands Kluwer Academic Publishers.

Turner, J. R., & Muller, R. (2005). The project manager's leadership style as a success factor on projects: A literature review. *Project Management Journal 36*(1), 49-61.

Twain, M. (1996). *Chapters from My Autobiography*. Oxford: Oxford University Press.

Underhill, L. G. (1994). Optimal and suboptimal reserve selection algorithms *Biological Conversation, 70*, 85-87.

University of Maryland. (2012). *Random vs. Systematic Error*. Retrieved 06/05, 2012, from http://www.physics.umd.edu/courses/Phys276/Hill/Information/Notes/ErrorAnalysis.html

University of the West of England. (2012). *Paired t-tests*. Retrieved 12/11, 2012, from http://hsc.uwe.ac.uk/dataanalysis/quantinfdifpair.asp

USAID. (n.d). *Earned Value Management* Retrieved 7/3, 2012, from http://www.usaid.gov/our_work/economic_growth_and_trade/info_technology/tech_series/EVM_508.pdf

Verreynne, M.-L. (2005). *Strategy-Making Process and Firm Performance in Small Firms*. Auckland: Auckland University of Technology.

Wainer, H., & Braun, H., I. (1988). *Test validity*. Hillsdale, NJ: Lawrence Earlbaum Associates.

Walker, A. (2007). *Project Management in Construction* (5 ed.). Oxford: Blackwell Publishing.

Walliman, N. (2005). *Your Research Project: a step-by-step guide for the first-time researcher* (2 ed.). Thousand Oaks:CA: SAGE Publication.

White, C. M. (2004). *Strategic management*. New York: Palgrave Macmillan.

White, M. (2008). *Perceived factors of delays on Office/Warehouse Projects, Constructed by a Specific Auckland Contracting Company* Auckland Unitec.

Williams, B., Onsman, A., & Brown, T. (2010). Exploratory factor analysis: A five-step guide for novices. *Journal of Emergency Primary Health Care 8*(3), 1-13.

Willock, J., Deary, I. J., Edwards-Jones, G., Gibson, G. J., McGregor, M. J., Sutherland, A., ... Grieve, R. (1999). The Role of Attitudes and Objectives in Farmer Decision Making: Business and Environmentally-Oriented Behaviour in Scotland. *Journal ofAgrincUura1 Economics 50*(2), 286-303.

Winch, G. M. (2010). *Managing Construction Projects* (2 ed.). Singapore: Blackwell publishing.

Winter, G. (2000). A comparative discussion of the of validity in qualitative and quantitative research. *The qualitative Report, 4*(3).

Wong, J. M. W., & Ng, T. S. (2010, 11-16 April). *Company Failure in the Construction Industry: A Critical Review and a Future Research Agenda*. presented at the meeting of the FIG Congress Sydney, Australia.

Woodward, J. (1965). *Industrial Organization*. NY: Oxford University Press.

Yang, J.-B. (n.d). *Applying the theory of constraints to construction scheduling*. Retrieved 13/07, 2012, from http://140.126.6.125/new/Portals/6/Faculty/Jyh-Bin_Yang/PDF/2003-ISEC2-1.pdf

Yang, J. B. (2003). Applying the Theory of Constraints to Construction Scheduling. *System Based Vision for Strategic and Creative Design*, *13*, 175-180.

Yin, R. K. (2003). Introduction. In *Case study research: Design and methods* (pp. 1-15). CA: SAGE Publications.

Zhao, Z. Y., You, W. Y., & Zuo, J. (2010). Application of Innovative Critical Chain Method for Project Planning and Control under Resource Constraints and Uncertainty. *Journal of Construction Engineering and Management, 136*(9), 1056-1060.

Zheng, S. (2007). *Factors Associated With Construction Delays in Auckland Commercial Construction Projects*. Unitec, Auckland

Glossary

RP	Reflective Interaction
TR	Technical Rationality
NZIOB	New Zealand Institute of Building
CIOB	Chartered Institute of Building
CMYA	Construction Manager of The Year Award
CPM	Critical Path Method
PERT	Programme Evaluation & Review Technique
CCPM	Critical Chain Project Management
EVM	Earn Value Management Method
DSS	Decision Support System
AI	Artificial Intelligence
ANN	Artificial Neural Network
ICCM	Innovative Critical Chain Method
HSM	Hard Systems Methodology
SSM	Soft Systems Methodology
SME	Subject Matter Expert
UK	United Kingdom
NZ	New Zealand
MCAR	Missing Completely at Random
KMO	Kaiser-Meyer-Olkin
PM	Project Manager
AUT	Auckland University of Technology
AUTEC	Auckland University of Technology Ethics Committee

Appendix A: Publications

The Summary of Publications

Conference	Topic and the content
COBRA 2012	**Reflective practice: scoping its applicability for successful construction project delivery** Criticizing current practices for inadequacy due to TR natures. Recognizing the ability of strategies to employ the RP and TR paradigms. Identifying the characteristics of the TR and RP paradigms. Discussing document analysis findings regarding RP and TR.
37th AUBEA	**Strategy-led construction: success through a human-cantered approach** Identifying strategy-led approach as a complementary solution to work with current practices. Refining the reflection of literature survey with document analysis findings. Discussing natures of strategies emerged from the document analysis. Explaining future plans of the study.
27th ARCOM	**Strategy: towards its applicability for successful project delivery** Recognizing the need for new planning approaches for the industry. Defining 'strategy' to the construction industry context. Identifying strategy-led approach as a blend of the technical rationality (TR) and reflective practice (RP) paradigms. Reviewing the current status of innovations in strategies with respect to construction. Describing aim, objectives and research questions in the current study.

REFLECTIVE PRACTICE: SCOPING ITS APPLICABILITY FOR SUCCESSFUL CONSTRUCTION PROJECT DELIVERY

Chamila Ramanayaka[1] and James Olabode Bamidele Rotimi[1]

[1]*Construction Management Programme, School of Engineering, Auckland University of Technology, Auckland 1142, New Zealand*

ABSTRACT

This paper reports on an on-going initiative to determine the applicability of reflective practice for successful construction project delivery. There are evidences to suggest that technical rationality approaches in construction projects sometimes fail to yield desired objectives. Selective inattention, reductionism, context independency and practitioner independency are identified as major aspects of ineffectiveness in technical rationality techniques. The aim of this initiative is to introduce reflective practice as an alternative to technical rationality approaches in construction project planning. The approach is based on the belief that the complexities of construction project planning and execution sometimes require strategies that are both creative and generative. Reflective practice offers a bridge between theory and practice through practitioner engagement in a learning process that allows reflection from three different dimensions: reflection in-action, on-action and for-action. The formalization of reflective practice for project planning is based on a systematic approach which enhances the ability to interpret the interconnection of different entities connected with project planning. The study discusses how a document analysis is used to find the applicability of reflective practice and strategies on past successful projects.

Keywords: reflective practice, strategies, technical rationality.

INTRODUCTION

There is the need for philosophical changes to fill gaps between academic solutions and practical issues. According to Schon (2001, p. 186) “professionally designed solutions to public problems have had unanticipated consequences, sometimes worse than the problem they were intended to solve”. Further, Dias and Blockley (1995) explain that many engineering curricular describe most physical phenomena in terms of engineering science and mathematics which leads to scepticism and that those technical rationality (TR) approaches are inadequate to handle complex situations. Thus an alternative paradigm, ‘reflective practice’ (RP) was introduced by Schon (1992) for practitioners. Winch (2010) suggests that construction practitioners should be reflective practitioners that could apply disciplines holistically from the inception to the completion of construction projects. The current study aims at seeking the applicability of the RP

[1] cramanay@aut.ac.nz
[2] jrotimi@aut.ac.nz

STRATEGY-LED CONSTRUCTION: SUCCESS THROUGH A HUMAN-CENTERED APPROACH

Chamila Ramanayaka [1*] and James Olabode Bamidele Rotimi [2]

1. Construction Management Programme, School of Engineering, Auckland University of Technology, cramanay@aut.ac.nz *

2. Construction Management Programme, School of Engineering, Auckland University of Technology, jrotimi@aut.ac.nz

ABSTRACT

Performance statistics in the construction industry show that project and company failures have become widespread in the industry. Studies have recognized the need for new planning approaches, since existing approaches seem incapable to cope with increasing complexity, dynamism, uncertainties and uniqueness of construction projects. This doctoral study investigates a suitable complementary approach as a tool for construction project planning to achieve success in terms of time, cost, quality and client satisfaction. The paper discusses how a preliminary document analysis is used to seek a suitable pathway for subsequent phases of the doctoral programme. The preliminary study sought information on different strategies used by construction managers on past successful projects in the UK. The results are compared with past suggestions for successful project delivery. Different strategic approaches are reviewed for the feasibility of adopting a human-centered approach to for strategy in the construction industry. The latter part of the paper describes the limitation of the current study and presents a future research plan for a comprehensive understanding of strategy-led approaches in construction projects.

Keywords: Project success, Construction planning, Strategies

INTRODUCTION

Developing a human centered planning approach aims at providing solutions for issues that bother around construction project failures. The inabilities to cope with increasing complexities, dynamisms, uncertainties and unique nature of the construction industry are highlighted as deficiencies in current planning approaches that deserve attention (Wong & Ng, 2010). For example some authors ascribe philosophical reasons for these failures, saying that on-going practices are dominated by technical rationality that solves problems through reductionism (Dias, 2002). Therefore the current study aims at developing a holistic and complementary approach to current planning tools with the hope of achieving balance between cost, time, quality and client satisfaction under chaotic situations. Document analysis research technique was used as a preliminary scrutiny to determine different strategic solutions on past successful projects. Though strategy-led approaches could be recognized from the document analysis, there are limitations that emerged from the research approach which would be addressed in future studies. The current study is carried out under a larger doctoral study that uses both quantitative and qualitative research methods to complement the limitations of each of the two methodologies.

STRATEGY: TOWARDS ITS APPLICABILITY FOR SUCCESSFUL PROJECT DELIVERY

Chamila Ramanayaka[1] and James Rotimi

Auckland University of Technology, Auckland, New Zealand.

Successful project delivery is somewhat elusive because cost overruns, time extensions and quality failures have become common features on construction projects. Advanced database software packages and computer aided design, using nD modelling and artificial intelligence have been developed, but these solutions are inadequate to mitigate construction failures. Some studies suggest strategic approaches as the ideal alternative for successful construction project delivery. The pros and cons of this suggestion are reviewed in this paper. The key objective is to proffer strategy-led approaches as the best practice in construction project management, recognising the drawbacks in current project management practices. It is part of an on-going initiative to determine the applicability of a strategy-led approach to successful construction project delivery. The study on which this paper is based reviews different solutions available to planning for successful construction project delivery. The larger study aims to gather successful project delivery strategies that project managers use in project delivery. Successful project managers will be recruited and questionnaire surveys and structured interviews will be employed to evaluate their abilities to cope with project complexities, dynamisms, uniqueness and uncertainties. Contextual information on the larger study programme is provided while concluding with postulations for the adoption of a strategy-led approach to construction project planning. The strategy led approach is suggested as a root for the adoption of both reflective practice and technical rational paradigms. The authors believe there are benefits that could be derived from taking this conceptual approach to construction project delivery.

Keywords: project failures, project success, strategies.

INTRODUCTION

Project failures and corresponding company failures are a problem in the construction industry. Several factors are attributable to these, some of which relate to the interactions of stakeholders, poor planning and resource management and exogenous factors (Fryer, 2004; Kumar, 2002; Chan and Kumaraswamy, 1997; Belassi and Tukel, 1996). The complexity, dynamism, uncertainty and uniqueness of the construction industry make decision making and planning for their success particularly difficult (Ballard and Howell, 1998; Baccarini, 1996; Betts and Ofori, 1992). A notable solution to construction failures is the improvement of planning methods (Hegazy and Mensi, 2010; Kumar, 2002; Dias and Blockley, 1995; Schon, 1992). In this light, planning and decision tools e.g. micro-computer based design software were developed to improve decision making and for problem solving. Yet these costly solutions have not successfully curbed project failures in the construction industry (Kumar, 2002). Various attempts have been made to identify critical success

[1] cramanay@aut.ac.nz

Ramanayaka, C and Rotimi, J (2011) Strategy: Towards its applicability for successful project delivery *In:* Egbu, C. and Lou, E.C.W. (Eds.) *Procs 27th Annual ARCOM Conference,* 5-7 September 2011, Bristol, UK, Association of Researchers in Construction Management, 869-878.

Appendix B: Ethics

B1: Participant Information Sheet, The questionnaire survey

AUT UNIVERSITY
TE WĀNANGA ARONUI O TAMAKI MAKAU RAU

Date Information Sheet Produced:

20 July 2011

Project Title

Developing a strategy-led approach as a tool for construction project delivery.

An Invitation

My name is Chamila Ramanayaka, a PhD student at the Auckland University of Technology, supervised by Dr. James Rotimi and Associated Professor John Tookey. The research study aims at developing a strategy-led approach as a planning method for successful construction project delivery. This study is intended to develop this alternative planning approach to facilitate project managers to use their experience, education and qualities effectively.

I am looking for expert construction project stakeholders who are willing to participate in my research study. Therefore, I invite you to participate in the study by answering the questionnaire survey provided. Your participation in the survey is voluntary. By answering the questionnaire, you have indicated your consent to participate in the study. Your contribution and industry knowledge shared with this project is appreciated.

What is the purpose of this research?

The research, which aims at developing a strategy-led approach as a tool for successful construction project planning and execution by project managers, is funded by Fletcher Construction. The study will investigate current project management practices for their drawbacks in project delivery and then seek to proffer strategic approaches as the best practice in construction project management. The objectives are listed below.

- To identify what constitutes success and failure on construction projects and the contributory role of the project manager in achieving either outcome (success or failure)

- To investigate the drawbacks in current practices in construction project delivery. This objective is undertaken with a view to ascertaining the potential for alternative solutions to the planning and execution of projects

- Proposing a strategy-led approach for adoption by project managers in the form of best practice for delivering successful construction projects

How was I identified and why am I being invited to participate in this research?

Participants are selected from the members in the New Zealand Institute of Building.

What will happen in this research?

The data collected under the whole project will be used to determine the suitability of a strategy-led approach to achieve successful outcomes in construction projects. This part of the questionnaire is designed to investigate the project manager's involvement in achieving success/failure. The data collected will be analysed to find out the scope of project level strategies and company level strategies. In addition to the thesis report, the result could be used for publication in journals and conferences.

What are the discomforts and risks?

Potential discomfort and risk associated with this study is limited to confidentiality. The issue is mitigated by using an anonymous questionnaire as the only research instrument. There is no way to identify the participants. The researcher has not included any question relating to participants' personal information. There is no ability to track the participants from project details since the name or location of the project they handled is not required. A self-addressed envelope is provided to return the completed questionnaire.

The collected data will be kept highly confidential. The information collected will be presented in a coded system. There is no usage of the data beyond the purpose of the research. The participants can skip or stop the questionnaire survey at anytime if discomfort arises.

How will these discomforts and risks be alleviated?

No information is taken regarding to person

No information is taken regarding to personal details and project details. Therefore confidentiality is very secure.

What are the benefits?

The study will help construction contractors to keep a proper balance between project level strategies and corporate level strategies. Also, project stakeholders can identify their importance in achieving project success. The ultimate goal of this study is to improve the construction industry. The study will be the qualification for the researcher to fulfil the requirements for Doctor of Philosophy.

How will my privacy be protected?

All the participants are anonymous throughout the study. The collected data will be stored securely within the Auckland University of Technology. The researcher, the primary supervisor and the secondary supervisor will have access to the data. After six years, all the data will be destroyed permanently.

What are the costs of participating in this research?

The questionnaire survey will take 30 minutes to complete.

What opportunity do I have to consider this invitation?

Researcher would kindly appreciate if the responses to the invitation can be given within a few days. Participation in the questionnaire is voluntary.

How do I agree to participate in this research?

Completing the questionnaire survey will be the consent for the participation.

Will I receive feedback on the results of this research?

If the participants are interested they can access the summary of findings by visiting http://strategy-led.webs.com upon the completion of the project after 01/03/2013.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the primary supervisor, Dr. James Rotimi, Construction Management Programme, School of Engineering, Auckland University of Technology. Ph. (09) 921 9999 ext 6450, email: *jrotimi@aut.ac.nz*

The alternative contact is the secondary supervisor, Associate Professor John Tookey, Construction Management Programme, School of Engineering, Auckland University of Technology. Ph. (09) 921 9999 ext 9512, email: *john.tookey@aut.ac.nz*

Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTEC, Madeline Banda, *madeline.banda@aut.ac.nz*, 921 9999 ext 8044.

Whom do I contact for further information about this research?

Researcher Contact Details:

Chamila Ramanayaka, Construction Management Programme, School of Engineering, Auckland University of Technology. (09) 9219999 Ext 6635, email *cramanay@aut.ac.nz*

Project Supervisor Contact Details:

Primary supervisor, *Dr*. James Rotimi, Construction Management Programme, School of Engineering, Auckland University of Technology. Ph. (09) 921 9999 ext 6450, email: *jrotimi@aut.ac.nz*

Secondary supervisor Associate Professor John Tookey, Construction Management Programme, School of Engineering, Auckland University of Technology. Ph. (09) 921 9999 ext 9512, email: *john.tookey@aut.ac.nz*

Approved by the Auckland University of Technology Ethics Committee on 29 August 2011**, AUTEC Reference number *11/198*.**

Appendix B2: Consent form, The SME interviews

CONSENT FORM

Project title: ***Developing a strategy-led approach for a successful construction project delivery***

Project Supervisor: ***Dr. James Rotimi and Associate prof. John Tookey***

Researcher: ***Saputhanthirige Chamila Dilhan Dushantha Ramanayaka***

○ I have read and understood the information provided about this research project in the Information Sheet dated 20 July, 2011.

○ I have had an opportunity to ask questions and to have them answered.

○ I understand that notes will be taken during the interviews and that they will also be audio-taped and transcribed.

○ I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.

○ If I withdraw, I understand that all relevant information including tapes and transcripts, or parts thereof, will be destroyed.

○ I agree to take part in this research.

○ I wish to receive a copy of the report from the research (please tick one):

Yes○ No○

Participant signature:

....

Participant Name:

....

Date:………………………

Approved by the Auckland University of Technology Ethics Committee on 29 August 2011**,**
AUTEC Reference number *11/198*

Note: The Participant should retain a copy of this form.

Appendix B3: Ethics Approval

MEMORANDUM

Auckland University of Technology Ethics Committee (AUTEC)

To:	James Rotimi
From:	**Dr Rosemary Godbold** Executive Secretary, AUTEC
Date:	15 November 2011
Subject:	Ethics Application Number 11/198 **Developing a strategy-led approach as a tool for construction project planning.**

Dear James

Thank you for providing written evidence as requested. I am pleased to advise that it satisfies the points raised by the Auckland University of Technology Ethics Committee (AUTEC) at their meeting on 8 August 2011 and I have approved your ethics application. This delegated approval is made in accordance with section 5.3.2.3 of AUTEC's *Applying for Ethics Approval: Guidelines and Procedures* and is subject to endorsement at AUTEC's meeting on 28 November 2011.

Your ethics application is approved for a period of three years until 15 November 2014.

I advise that as part of the ethics approval process, you are required to submit the following to AUTEC:

- A brief annual progress report using form EA2, which is available online through http://www.aut.ac.nz/research/research-ethics/ethics. When necessary this form may also be used to request an extension of the approval at least one month prior to its expiry on 15 November 2014;
- A brief report on the status of the project using form EA3, which is available online through http://www.aut.ac.nz/research/research-ethics/ethics. This report is to be submitted either when the approval expires on 15 November 2014 or on completion of the project, whichever comes sooner;

It is a condition of approval that AUTEC is notified of any adverse events or if the research does not commence. AUTEC approval needs to be sought for any alteration to the research, including any alteration of or addition to any documents that are provided to participants. You are reminded that, as applicant, you are responsible for ensuring that research undertaken under this approval occurs within the parameters outlined in the approved application.

Please note that AUTEC grants ethical approval only. If you require management approval from an institution or organisation for your research, then you will need to make the arrangements necessary to obtain this.

When communicating with us about this application, we ask that you use the application number and study title to enable us to provide you with prompt service. Should you have any further enquiries regarding this matter, you are welcome to contact me by email at ethics@aut.ac.nz or by telephone on 921 9999 at extension 6902.

On behalf of AUTEC and myself, I wish you success with your research and look forward to reading about it in your reports.

Yours sincerely

Dr Rosemary Godbold
Executive Secretary
Auckland University of Technology Ethics Committee

Cc: Saputhanthirige Ramanayaka cramanay@aut.ac.nz

Appendix C: The Questionnaire

By completing this questionnaire you are indicating your consent to participate in this research.

AUT
UNIVERSITY
TE WĀNANGA ARONUI O TAMAKI MAKAU RAU

Section A

This section aims at evaluating a strategy (ies) used to achieve success on construction projects. Please think about a project that offered challenges apart from normal solutions and for which you eventually achieved successful outcomes in terms of cost, time, quality and client satisfaction.

In this research study, the following definition is adopted for 'strategy':

"Strategy is that which a construction manager employs in decision making and problem solving within the complexities, uncertainties, uniqueness and dynamisms of any construction process"

E.g. - Look-ahead plan to eliminate constraints; applying effective buffers between activities; using rate and rhythm planning such as constructing equal number of stories in a month ; effective team building, using alternative construction methods, changing the design requirements etc.

a) Could you say in few words, what are the strategies that you intended to use for project implementation at the conceptual stage in one (or the most) successful projects you have delivered?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

b) What were your reasons for using the above strategy?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

c) Please mention if there are any other main strategies that emerged as the project advanced from the conceptual phase (through workshops, option analysis etc)?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

d) Finally, what was the most suitable main project delivery pathway/strategy that you selected for the project? If this is the same strategy used in section (a) please go to section (f).

…………………………………………………………………………………………………
…………………………………………………………………………………………………

e) Can you please explain briefly why the strategy in section (d) was selected as the best among others?

…………………………………………………………………………………………
…………………………………………………………………………………………

f) Please mention if there are other sub-strategies used to support the main strategies for project implementation? And why?

Sub-strategy	Reasons
………………………………………………	………………………………………………
………………………………………………	………………………………………………
………………………………………………	………………………………………………

k) How do you rate the importance of main project strategy and sub-strategies for project implementation?

Main strategy	☐ Very High	☐ High	☐ Moderate	☐ Low	☐ Very Low
Sub-strategy	☐ Very High	☐ High	☐ Moderate	☐ Low	☐ Very Low

<u>Section B</u>

The following section aims at gathering data regarding the project implemented using the above strategies.

a) Which technique did you use for project planning and scheduling?(Multi selected)

☐ CPM ☐ PERT ☐ Critical Chain Project Management (CCPM) ☐ Earned Value Management (EVM)

☐ Other (Please specify)……………………………..

b) Please indicate the contract method used for that particular project.

☐ Traditional tender	☐ Traditional with traits of partnering	☐ Management contract
☐ Design and Build	☐ Pure partnering	☐ Alliance contract

☐ Other (Please specify) …………………………………………………………………………

c) What is the payment type?

☐ Lump sum	☐ Unit price	☐ Cost plus fee
☐ Percentage of construction fee	☐ Incentive contract	☐ Other (Please specify) …………………………

d) Please mention the project value and duration?

Value: NZ$.....................Million Duration: ………… Years

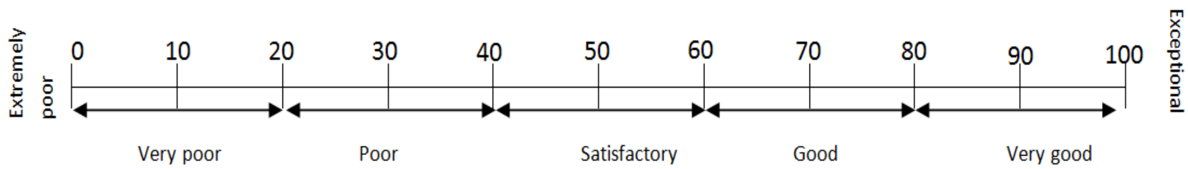
e) Please indicate the final performance levels achieved on the project using the measurement parameters defined in the table below.

<u>Final cost</u> x 100% Initial cost	☐ <70	☐ 75	☐ 80	☐ 85	☐ 90	☐ 95	☐ 100	☐ 105	☐ 110	☐ 115	☐ 120	☐ 125	☐ >130
<u>Final profit</u> x 100% Contractor’s margin	☐ <70	☐ 75	☐ 80	☐ 85	☐ 90	☐ 95	☐ 100	☐ 105	☐ 110	☐ 115	☐ 120	☐ 125	☐ >130
<u>Final duration</u> x 100% Initial duration	☐ <70	☐ 75	☐ 80	☐ 85	☐ 90	☐ 95	☐ 100	☐ 105	☐ 110	☐ 115	☐ 120	☐ 125	☐ >130

f) What are the amounts of variations compared to initial values due to changing client desires, unforeseen conditions etc.?

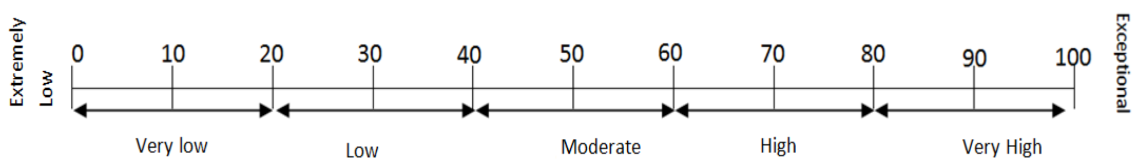
Cost variations	☐ <-50	☐ -40	☐ -30	☐ -20	☐ -10	☐ 0	☐ 10	☐ 20	☐ 30	☐ 40	☐ 50	☐ 60	☐ >70
Time variations	☐ <-50	☐ -40	☐ -30	☐ -20	☐ -10	☐ 0	☐ 10	☐ 20	☐ 30	☐ 40	☐ 50	☐ 60	☐ >70

g) Could you give an indication of the overall quality achieved and expected in the project? Please use the following scale to rate your perceptions.



Overall quality achieved (%)	☐ 0	☐ 10	☐ 20	☐ 30	☐ 40	☐ 50	☐ 60	☐ 70	☐ 80	☐ 90	☐ 100
Overall quality expected (%)	☐ 0	☐ 10	☐ 20	☐ 30	☐ 40	☐ 50	☐ 60	☐ 70	☐ 80	☐ 90	☐ 100

h) Could you please indicate owner satisfaction achieved and the importance of the client below? Please use the following scale to rate your perceptions.



Owner satisfaction achieved (%)	☐ 0	☐ 10	☐ 20	☐ 30	☐ 40	☐ 50	☐ 60	☐ 70	☐ 80	☐ 90	☐ 100
Importance of the client to get future opportunities for the company (%)	☐ 0	☐ 10	☐ 20	☐ 30	☐ 40	☐ 50	☐ 60	☐ 70	☐ 80	☐ 90	☐ 100

l) Could you indicate the level of consideration or priority given to the following competitive outcomes regarding that particular project? Please circle the most appropriate on a scale of 1 – 5 scale, **'5'** being **'Extremely Important'** and **'1'** being **'Not at all Important'**.

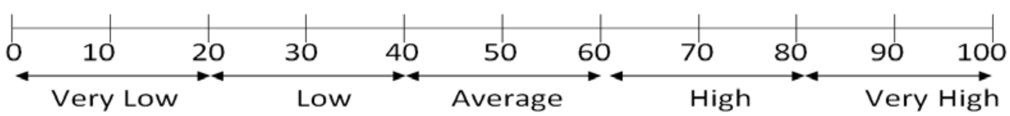
Criterion	**5**	**4**	**3**	**2**	**1**
Completing the project within the budget	☐	☐	☐	☐	☐
Completing the project on-time	☐	☐	☐	☐	☐
Completing the project according to the required quality	☐	☐	☐	☐	☐
Satisfying the client	☐	☐	☐	☐	☐
Other …………………………………………………..	☐	☐	☐	☐	☐

l) Construction projects are characterized in common by their complexity, dynamism, uncertainty and uniqueness. The meanings of those terms are taken as follows for this study.

Characteristics	Meaning	Examples
Complexity	Difficult to grasp due to its complicated nature.	Complex design, technology used, procurement methods, tough clientele
Dynamism	Sudden changes in work processes.	Client changing their desires from time-to-time, irregular weather changes
Uncertainty	Unpredicted or unexpected situations.	Unforeseen ground conditions, uncertainties in resource supply
Uniqueness	Novelty for things in the project.	Novelty in the use of construction methods, type of project, procurement type or type of stakeholders

How do you rate these characteristics in terms of their technical and managerial requirement/content for the successful project you have selected? Please use the following scale to rate your perceptions.

	0	10	20	30	40	50	60	70	80	90	100
Complexity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Dynamism	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Uncertainty	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Uniqueness	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐



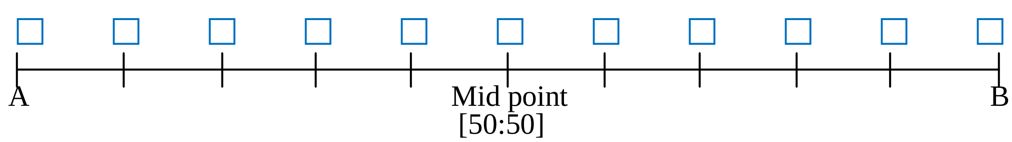
Section C

The section aims at evaluating strategy making styles.

a) Could you give an indication of where the nature of problems you faced on this project lie on the scale below?

Point A – Issues encountered on the project are interrelated with one another. Each issue could not be dealt with separately, without considering its interrelationship with other issues.

Point B – Issues encountered on the project are numerous but can be dealt with in isolation.



b) Could you give an indication of the nature of the strategies you used on the particular project on the scale below?

Point A – The strategy used deliberate, pre-conceived and ready to be implemented.

Pont B – The strategy making is a based on interaction and learning rather than the execution of pre-determined plan (spontaneous).

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

A Mid point [50:50] B

c) Could you give an indication of the stability of strategies you used on the particular project on the scale below?

Point A – Established strategies remain unchanged or changes incrementally with time.

Pont B – Developed strategies are changed and modified frequently.

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

A Mid point [50:50] B

d) To what extent do you agree with the statement relating to strategy crafting and implementation below?

Point A – The role of your employees is limited to the implementation of strategies articulated by you (project manager).

Point B – Employees are expected to participate in the strategy crafting process.

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

A Mid point [50:50] B

e) Could you indicate the level of contribution from logic and creativity to craft the strategies you used on the particular project?

Point A – Strategies are crafted in a logical manner by using engineering science.

Pont B – Strategies are crafted in a creative manner by using experience and personal skills

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

A Mid point [50:50] B

Section D

This section aims at measuring the performance of the strategies you used for the particular project.

a) Could you indicate the level of influence that your chosen strategies have on the following aspects of the particular successful project? N/A: Not Applicable

Project related

Very High ← → High ← → Satisfactory ← → Low ← → Very Low

Factor	10	9	8	7	6	5	4	3	2	1	N/A
Setting clear objectives											
Coping with necessary variations											
Improving communication											
Speeding up decision making											
Handling unforeseen ground conditions											
Improving project schedules and plans											
Coping with legal/statutory requirements											
Ensuring monitoring and feedback system											
Better Handling of design complexities											
Coping with estimation errors											
Effective use of technology											
Coping with site conditions											

Organizational factors

	10	9	8	7	6	5	4	3	2	1	N/A
Dealing with client's characteristics											
Improving project financing from client											
Ensuring contractors cash flow											
Minimizing delays & errors in design documents											
Reducing waiting time for test samples											
Improving site management and supervision											
Smoothly Working with sub-contractors											
Getting top management support											
Developing project organizational structure											
Getting lower cadres' support											

Resource supply

	10	9	8	7	6	5	4	3	2	1	N/A
Minimizing material shortages											
Coping with material changes											
Deciding on off-site prefabrication											
Handling labor shortages											
Coping with low skill levels											
Handling plant shortages											
Coping with low efficiency of plants											
Coping with plant breakdowns											
Avoiding wrong selections of plants											

External factors

	10	9	8	7	6	5	4	3	2	1	N/A
Helping to minimize political issues											
Helping to minimize economic issues											
Helping to minimize social issues											
Helping to minimize weather uncertainties											

Other issues that your strategies influenced, please specify

	10	9	8	7	6	5	4	3	2	1

………………………………………………..	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
………………………………………………..	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
………………………………………………..	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

<u>Section E</u>

This section aims at evaluating the context of the strategies you used for the particular project.

a) How do you rate the importance of following stakeholders toward strategy crafting and implementation using a scale of 1 – 5, **'5'** being **'Extremely Important'** and **'1'** being **'Not at all Important'**

	5	4	3	2	1		5	4	3	2	1
Yourself	☐	☐	☐	☐	☐	Site engineers	☐	☐	☐	☐	☐
Client/Project owner	☐	☐	☐	☐	☐	Foramens	☐	☐	☐	☐	☐
Consultant	☐	☐	☐	☐	☐	Sub-contractors	☐	☐	☐	☐	☐
Top management	☐	☐	☐	☐	☐	Labors	☐	☐	☐	☐	☐
Site managers	☐	☐	☐	☐	☐	Others ……………………....	☐	☐	☐	☐	☐

c) Could you please indicate the level of influence of your education, experience and skills/characteristics on the factors listed below?
Please circle the most appropriate on a scale of 1 - 5 scale, **'5'** being **'Very high'** and **'1'** being **'Very low'**

Factor	**Education**					**Experience**					**Skills Characteristics**				
	5	**4**	**3**	**2**	**1**	**5**	**4**	**3**	**2**	**1**	**5**	**4**	**3**	**2**	**1**
To identify problems	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Identifying needs to be addressed	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Know strength and weakness of the organization	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Crafting strategy (solution)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Setting scenarios	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Evaluation of solutions to find the best alternative	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Strategy implementation (including monitoring, feedback and adjustments)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

d) What is your opinion about employees' response to the strategies adopted for work execution on the particular project?

Opinion	**Highly**	**Agree**	**Neutral**	**Disagree**	**Highly**

	agree				disagree
Vision is created to give an identity for employees and project activities.	☐	☐	☐	☐	☐
Mission is given into specific targets to inspire employees to achieve high levels of performance.	☐	☐	☐	☐	☐
Transact with stakeholders and link outcomes overtime to decide strategic directions	☐	☐	☐	☐	☐
Employees are supposed to learn and improve	☐	☐	☐	☐	☐
Employees are encouraged for experimentation and risk taking	☐	☐	☐	☐	☐
Employees are responsible for performance benchmarked against the plan	☐	☐	☐	☐	☐
Other (please specify) ………………………………	☐	☐	☐	☐	☐

Section F

This section collects demographic information.

a) Years of total experience in the construction industry

☐ 0-5 years ☐ 6-10 years ☐ 11-15 years ☐ 16-20 years ☐ > 20 years

b) Years of experience as a construction project manager

☐ 0-5 years ☐ 6-10 years ☐ 11-15 years ☐ 16-20 years ☐ > 20 years

c) Highest educational level obtained

☐ Postgraduate ☐ Degree or equivalent ☐ Diploma/certificate ☐ On the job training

d) What is the project type for which you have used strategy successfully?

☐ Residential Building project ☐ Non-Residential Building project ☐ Infrastructure project

e) Would you please rate the influence from followings things on your strategy crafting procedure? Please circle the most appropriate on a scale of 1 - 5 scale, '5' being 'Very high' and '1' being 'Very low'

Factor	Main Strategy					Sub-strategies				
	5	4	3	2	1	5	4	3	2	1
Project value	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
project duration	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Project scheduling	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Project procurement	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Project scope	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Design	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Legal requirements	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Site conditions/restraints/limitation	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other (specify)…………………	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other (specify)…………………	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Thank you very much for your valued contribution.

Appendix D: The Verification Questionnaire (semi structured)

AUT UNIVERSITY
TE WĀNANGA ARONUI O TAMAKI MAKAU RAU

1. Can you please briefly mention your educational background and the experience in the construction industry? How long have you been working as a construction project manager?

2. Do you think that the consideration of cost, time, quality and client satisfaction as the measures of project success is reasonable? Are those the success measures that are commonly applicable to any construction project? Can you please explain?

3. Can you briefly explain the nature of challenges that construction project managers face during planning and implementation of construction projects?

4. Can you please explain one issue related to construction project planning and implementation with a brief clarification to your approach towards act on that issue?

5. How do you explain the contributions of theoretical and tacit knowledge toward construction project planning and implementation? What is more important?

6. Do you think that scheduling tools are important to achieve successful completion in construction projects?

7. How do you calculate activity durations to be reliable? How do you use past records to calculate activity durations? Please explain briefly?

8. Variations are prevailing problems in construction project planning. How do you recommend to use buffers to cope with variations if buffers are suitable to be added?

9. When resources are limited, how do you take precautions against that?

10. S-curve is used by practitioners for financial planning. How do you perceive the use of S-curve into finance planning in construction projects? If you recommend other methods, please mention briefly how you plan project finance through that tool.

11. Please mention how you use construction project strategies toward the following critical concerns in terms of cost, time and quality.

   i) To cope with variations
   ii) Improve schedules and plans
   iii) Ensure feedback and monitoring
   iv) Use of the most appropriate technology
   v) Ensure contractor's cash-flow

12. Are strategies generative or rational?

13. When you prepare construction project strategies, you act instantly or craft them deliberately?

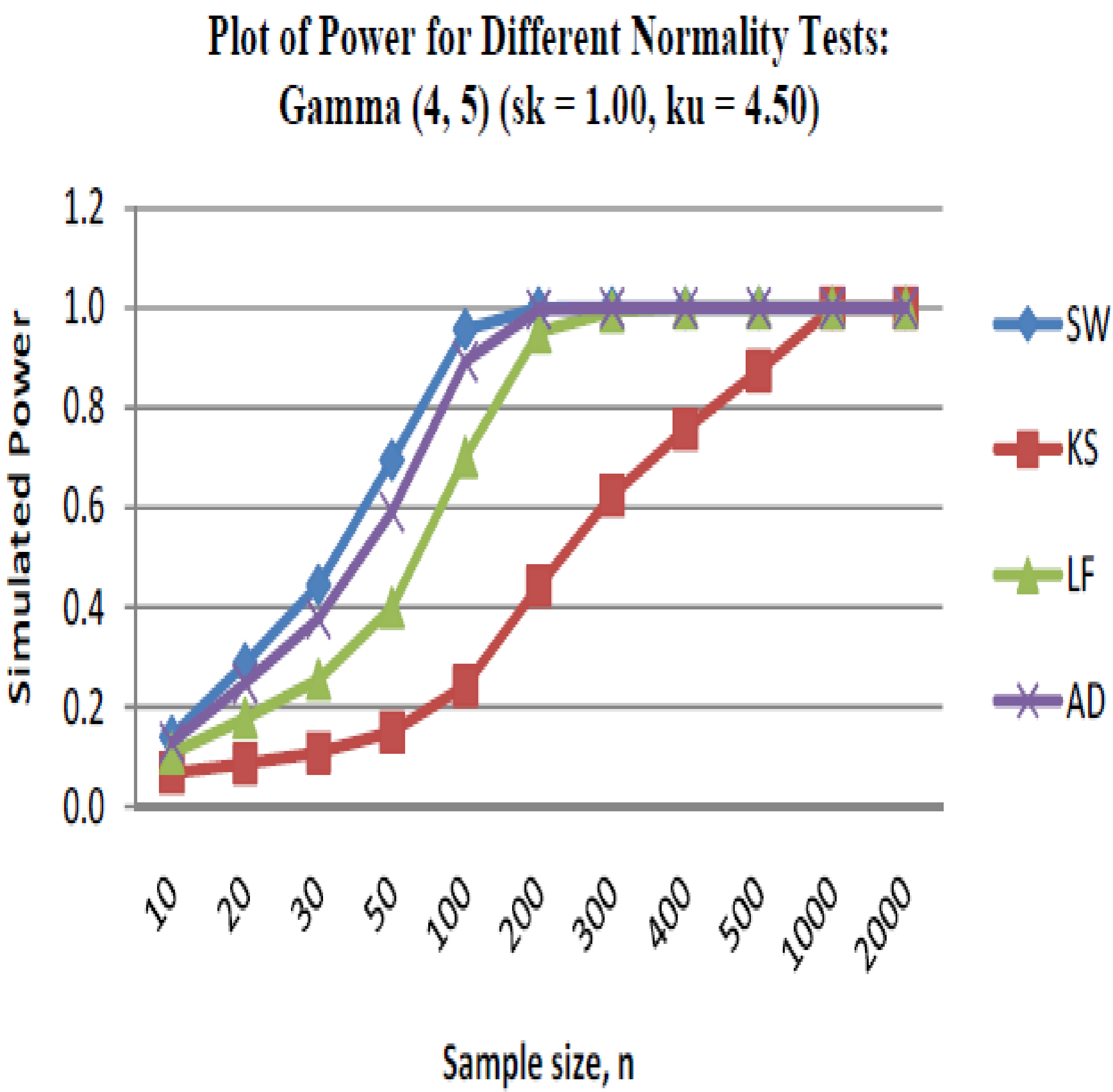
14. Do strategies remain unchanged over time? Please explain?

15. Do you think that construction project managers are the strategist for construction project implementation strategies?

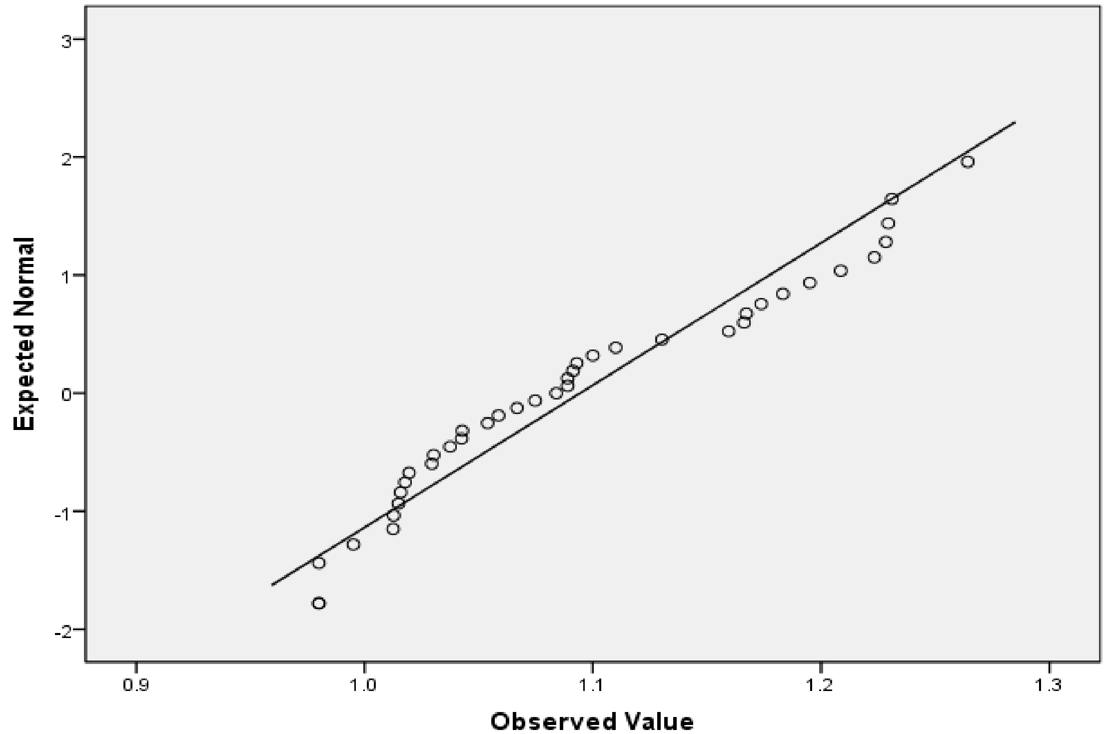
16. Can you please explain other stakeholders' contributions?

17. How do you integrate other stakeholders into strategy crafting and implementation?

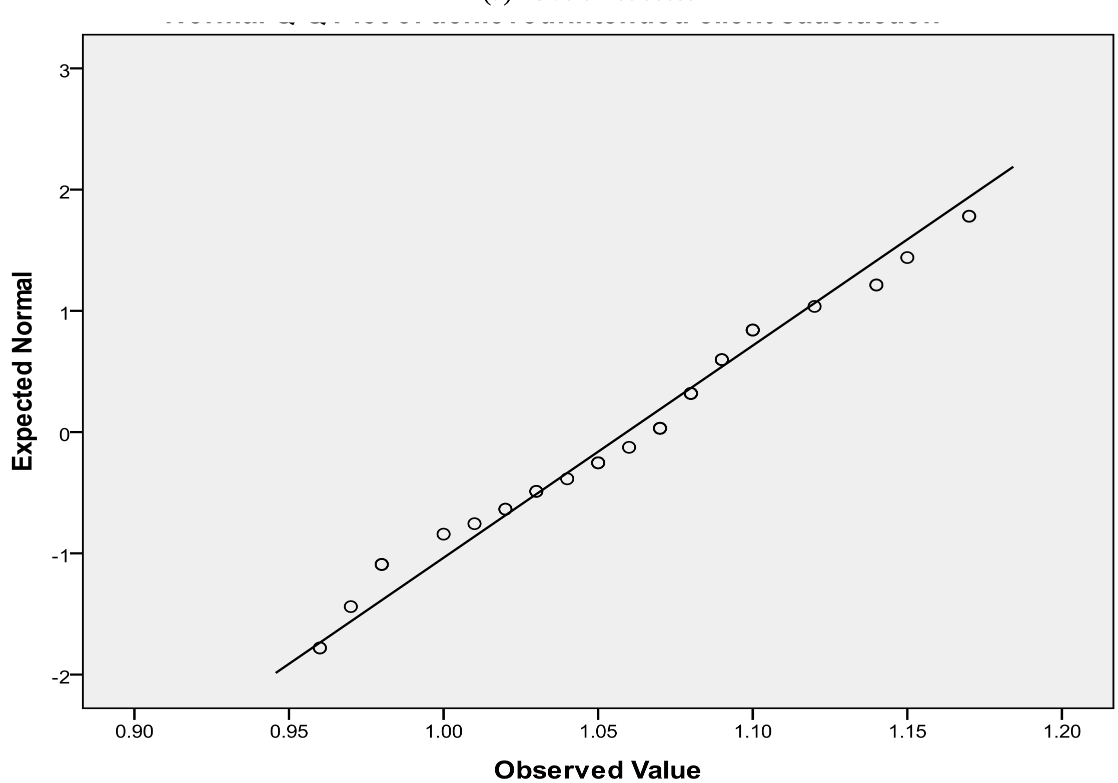
Appendix E: Statistical tests of the primary investigation



E 1: Power comparison of different normality tests for asymmetric distributions at α=0.05(Razali & Wah, 2011)



(a) Overall success



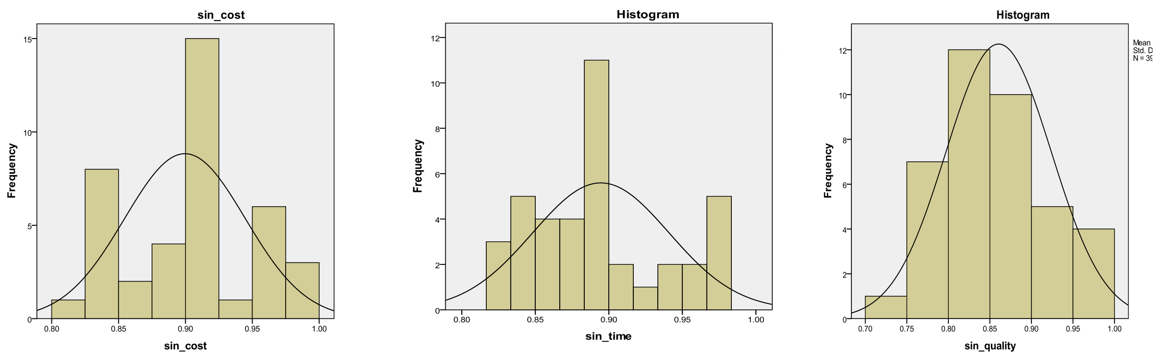
(b) Client satisfaction

E 2: The normal Q-Q plot for overall success and client satisfaction

E 3: Descriptive statistics of the variable: 'the overall success'

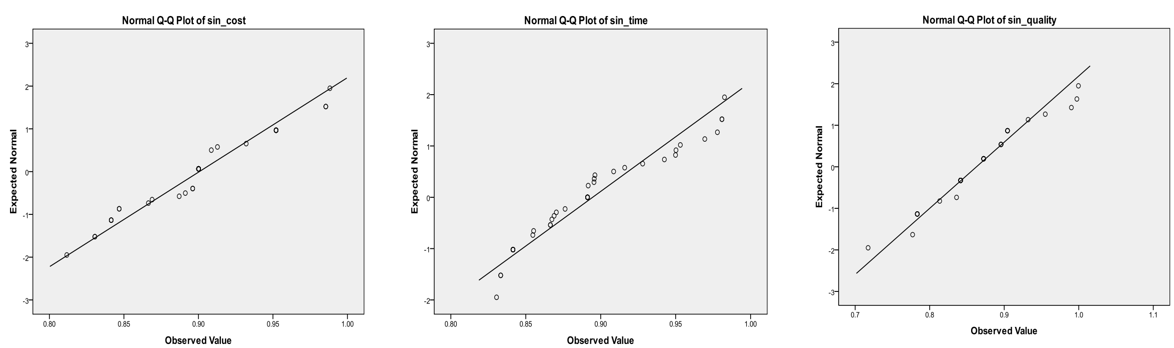
Descriptive statistics of 'overall success'		Descriptive statistics of 'client satisfaction'	
Mean	1.10	Mean	1.06
Median	1.09	Median	1.07
Mode	1.00[a]	Mode	1.08
Std. Deviation	.093	Std. Deviation	.057
Skewness	.773	Skewness	-.011
Std. Error of Skewness	.374	Std. Error of Skewness	.378
Kurtosis	.340	Kurtosis	-.595
Std. Error of Kurtosis	.733	Std. Error of Kurtosis	.741

a. Multiple modes exist. The smallest value is shown



(a) Sin_cost (b) Sin_time (c) Sin_qulaity

E 4: The histograms of the three variables: sin_cost, sin_time and sin_quality



(a) Sin_cost (b) Sin_time (c) Sin_quality

E 5: The Q-Q plots of the three variables: sin_cost, sin_time and sin_quality

E 6: The SW statistics of the five success measures

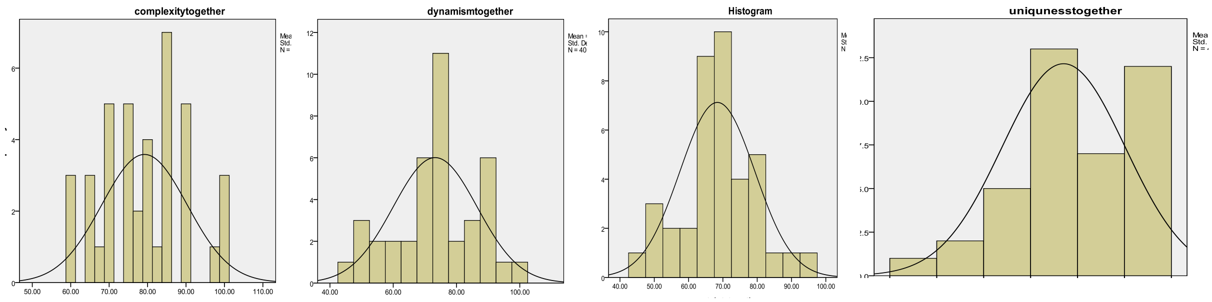
Success measure	Shapiro-Wilk		
	Statistic	df	Sig.
Initial cost: final cost	.908	40	.003
Initial duration: final duration	.903	40	.002
Achieved: intended quality	.667	40	.000
Achieved: intended client satisfaction	.963	40	.232
Overall success	.958	40	.156

E 7: The SW test statistics of the transformed variables related to cost, time, quality and client satisfaction

Transformed variables	Shapiro-Wilk		
	Statistic	Df	Sig.
Timely achievement			
Cos_time	.889	40	.001
Exp_time	.872	40	.000
Log_time	.925	40	.011
Ln_time	.925	40	.011
Sin_time	.946	40	.056
Sqrt_time	.914	40	.005
Inverse_time	.942	40	.042
Cost achievement			
Inverse_cost	.938	40	.030
SQRT_cost	.918	40	.007
Sin_cost	.940	40	.054
Ln_cost	.926	40	.012
Log_cost	.926	40	.012
Exp_cost	.878	40	.000
Cos_cost	.896	40	.001
Quality achievement			
Sin_quality	.953	39	.104

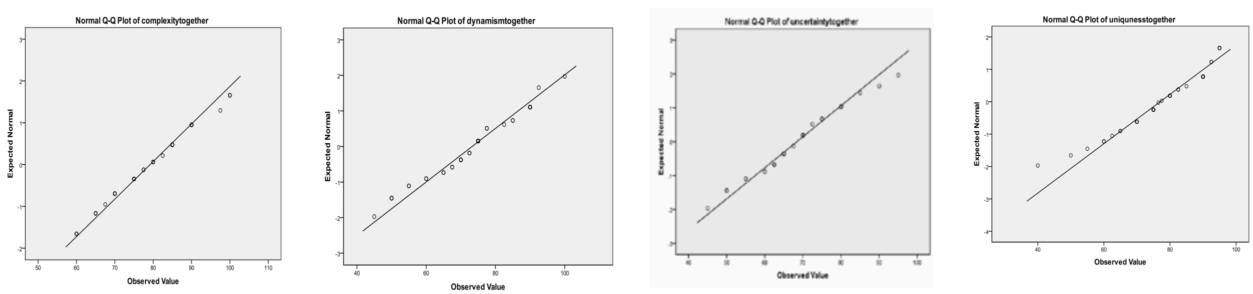
E 8: The central tendencies, skewness and kurtosis of sin_time, sin_quality and sin_cost

Statistic	Sin_time	Sin_quality	Sin_cost
Mean	.89	.86	.90
Median	.89	.84	.90
Mode	.89	.84	.90
Std. Deviation	.046	.063	.045
Skewness	.549	.279	.112
Std. Error of Skewness	.378	.378	.374
Kurtosis	-.714	.233	-.471
Std. Error of Kurtosis	.741	.741	.733



Complexity Dynamism Uncertainty Uniquness

E 9: Histogram for combined contingency variables



Complexity Dynamism Uncertainty Uniquness

E 10: Q-Q plots for combined contingency variables

E 11: Descriptive statistics after the transformation

Statistic	**Complexity**	**Dynamism**	**Uncertainty**	**Uniqueness**
Mean	79.2	73.3	68.4	77.0
Median	80.0	75.0	70.0	77.0
Mode	85.0	75.0	70.0	80.0
Skewness	0.1	-0.2	0.08	-0.7
Kurtosis	-0.6	-0.4	0.25	0.3

E 12: Shapiro-Wilk test values for strategies' improvements toward critical success factors

Project related factors	Shapiro-Wilk		
	Statistic	df	Sig.
Setting clear objectives	.851	36	.000
Coping with necessary variations	.811	36	.000
Improving communication	.771	36	.000
Speeding up decision making	.778	36	.000
Handling unforeseen ground conditions	.924	36	.017
Improving schedules and plans	.897	36	.003
Coping with legal/statutory requirements	.946	36	.079
Ensuring feedback and monitoring	.921	36	.013
Better handling of design complexities	.879	36	.001
Coping with estimation errors	.909	36	.006
Effective use of technology	.912	36	.007
Coping with site conditions	.890	36	.002

Organizational related factors	Shapiro-Wilk		
	Statistic	df	Sig.
Dealing with client's characteristics	.845	35	.000
Improving project finance from client	.897	35	.005
Ensuring contractor's cash flow	.910	35	.011
Minimizing delays and errors in design documents	.938	35	.055
Reducing waiting time for test samples	.950	35	.140
Improving site management and supervision	.896	35	.005
Smoothing work with sub-contractors	.926	35	.028
Getting top management support	.934	35	.051
Developing project organizational structure	.919	35	.020
Getting lower cadres' support	.903	35	.008

Resource related factors	Shapiro-Wilk		
	Statistic	df	Sig.
Minimizing material shortages	.805	36	.000
Coping with material changes	.880	36	.001
Deciding on off-site prefabrication	.857	36	.000
Handling labour shortages	.927	36	.020
Coping with low skill levels	.920	36	.013
Handling plant shortages	.895	36	.003
Coping with low efficiency of plants	.956	36	.162
Coping with plant breakdown	.924	36	.015
Avoiding wrong selection of plants	.914	36	.008

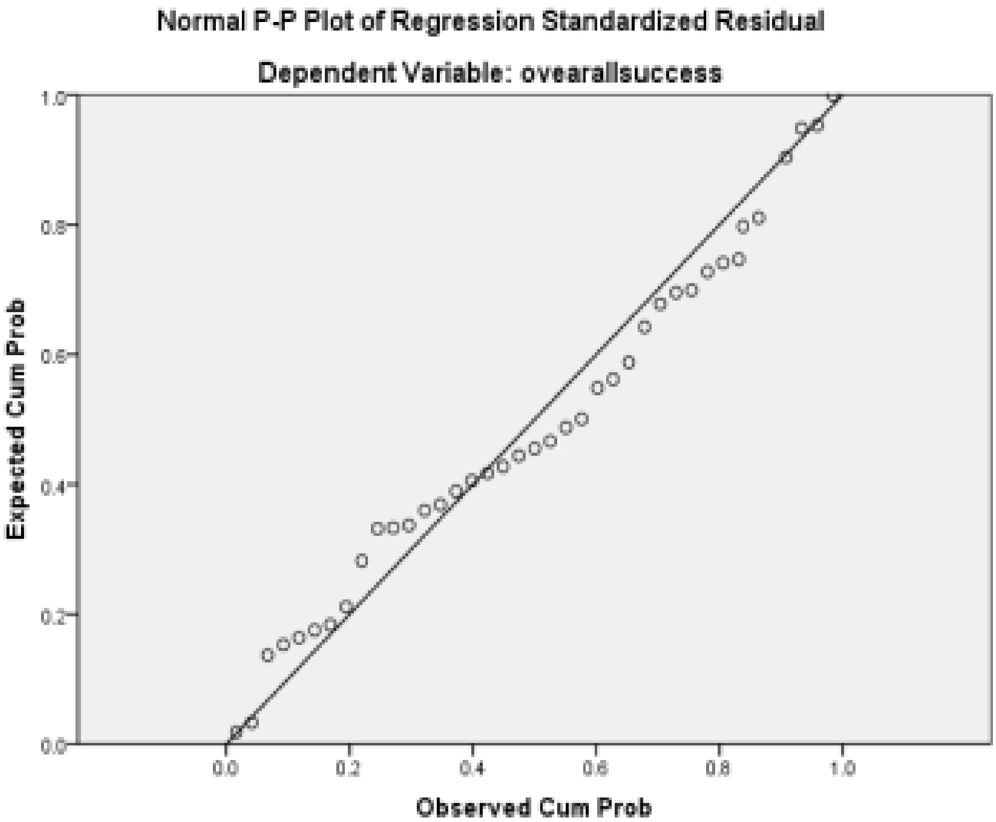
External factors	Shapiro-Wilk		
	Statistic	df	Sig.
Minimizing political issues	.910	36	.007
Minimizing economic issues	.910	36	.006
Minimizing social issues	.916	36	.010
Minimizing weather uncertainties	.955	36	.149

E 13: The reliability analysis of O4, O5 and O6

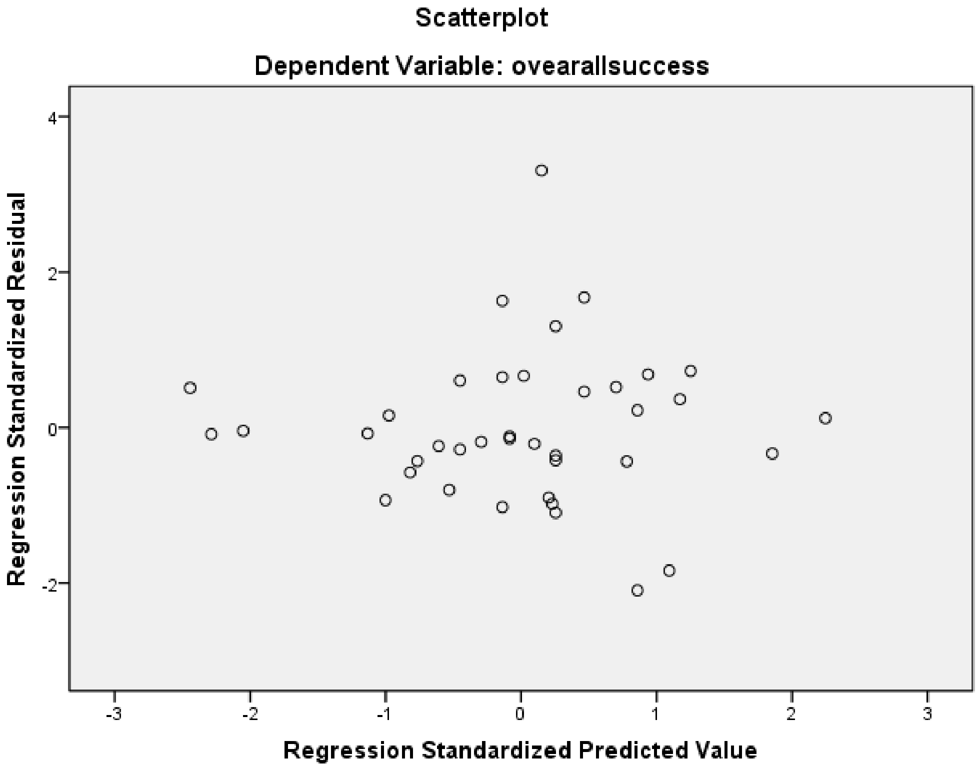
Items	Cronbach's Alpha if Item Deleted
improving site management and supervision	.523
minimizing delays and errors in design documents	.799
reducing waiting time for test samples	.529

E 14: reliability analysis for the group: planning related

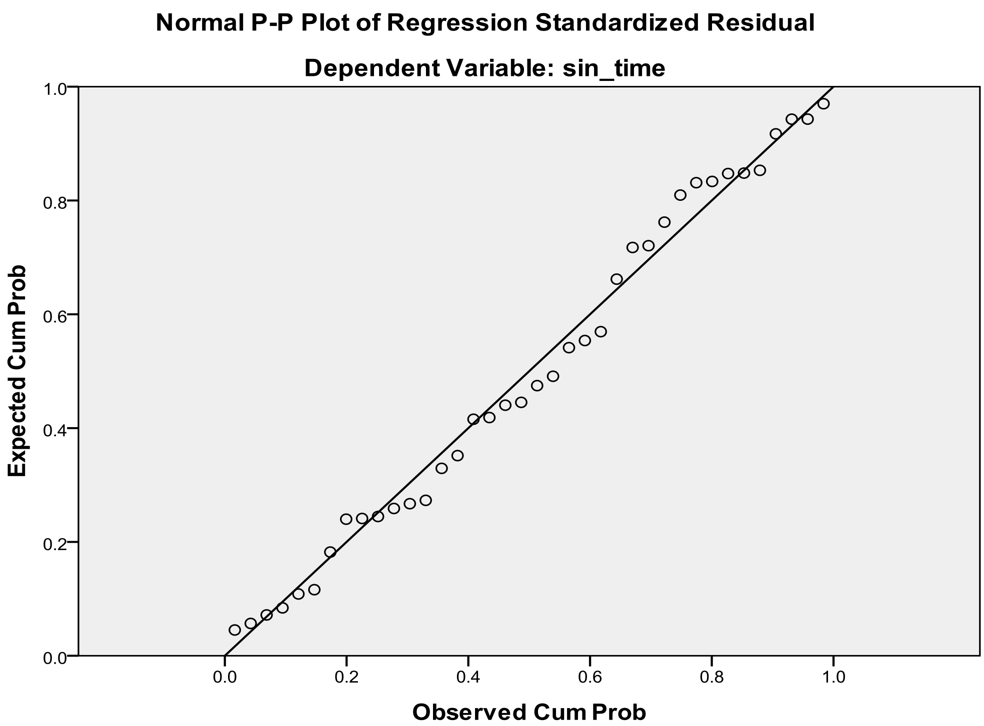
Item	Cronbach's Alpha if Item Deleted
Ensuring contractor's cash flow	.818
Coping with necessary variations	.803
Improving schedules and plans	.784
Ensuring feedback and monitoring	.797
Effective use of technology	.792



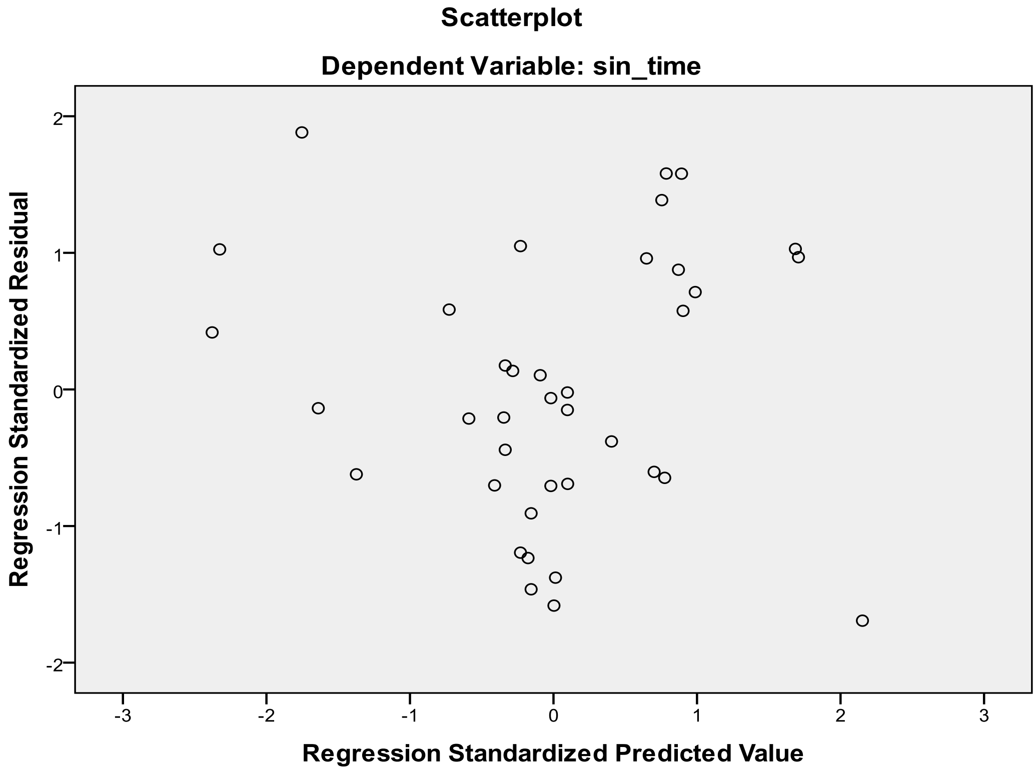
E 15: Normal probability plot for residuals: overall success



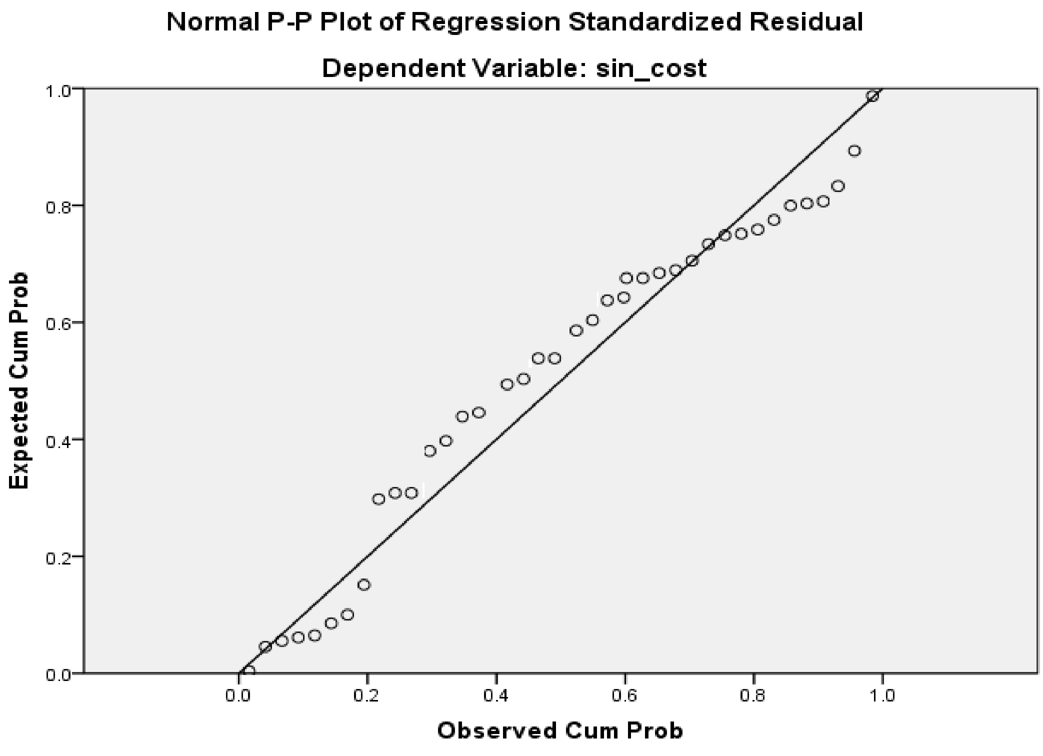
E 16: Standardized residual versus standard predicted values: overall success



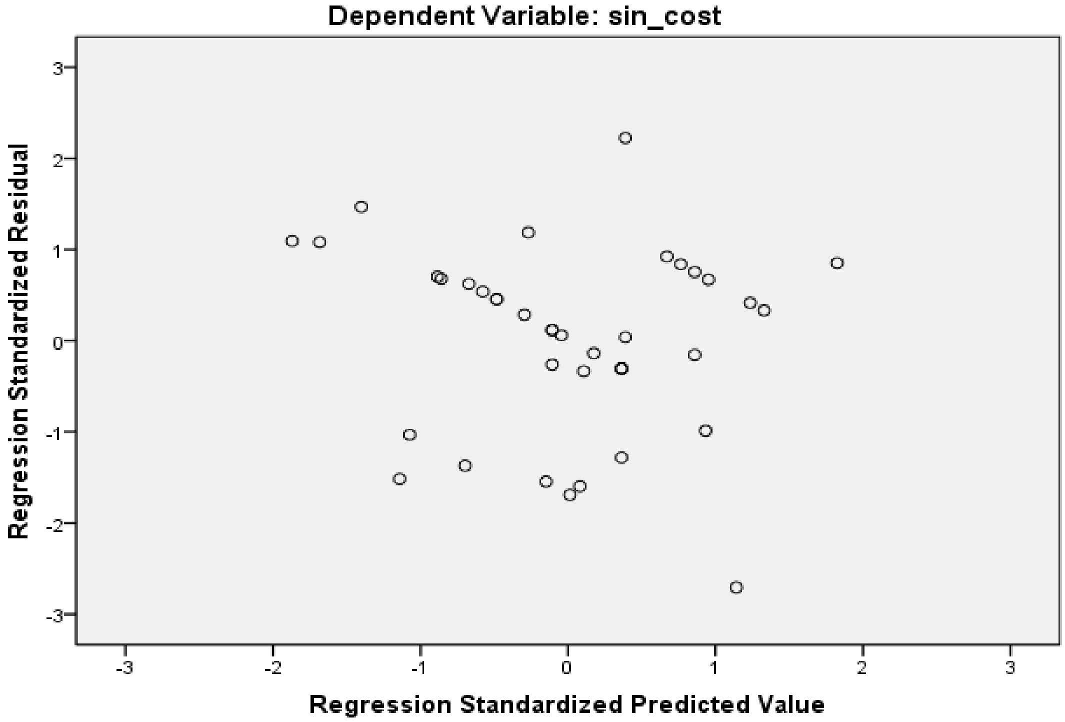
E 17: Normal probability plot for residuals: sin_time



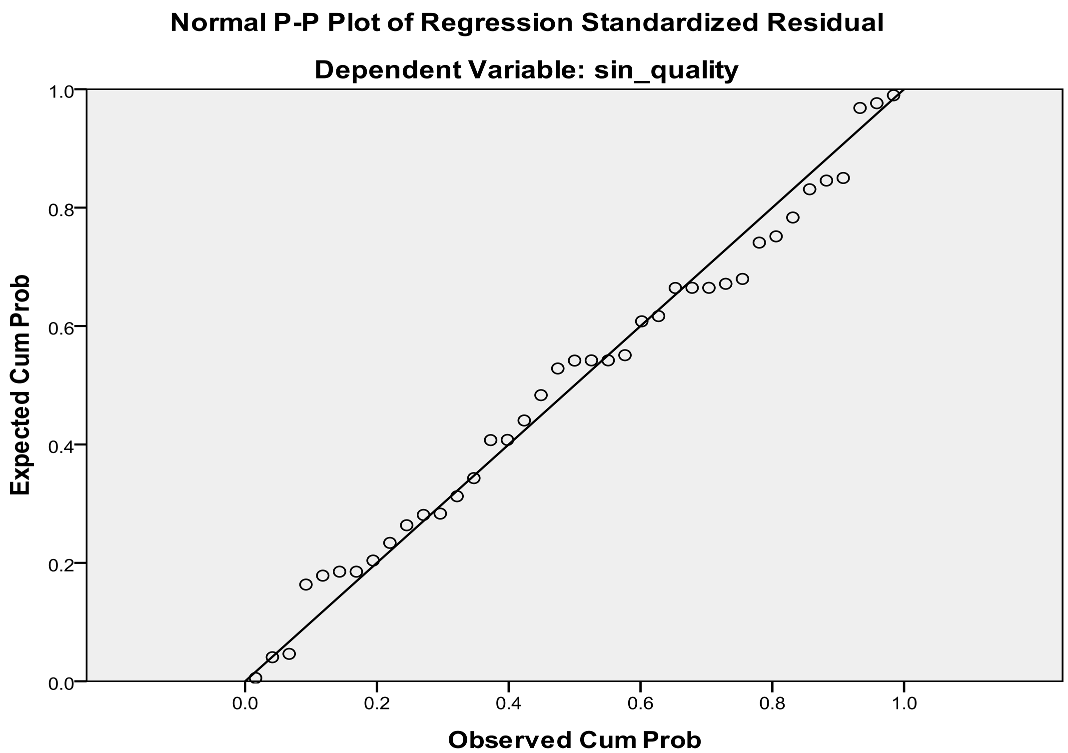
E 18: Standardized residual versus standard predicted values: sin_time



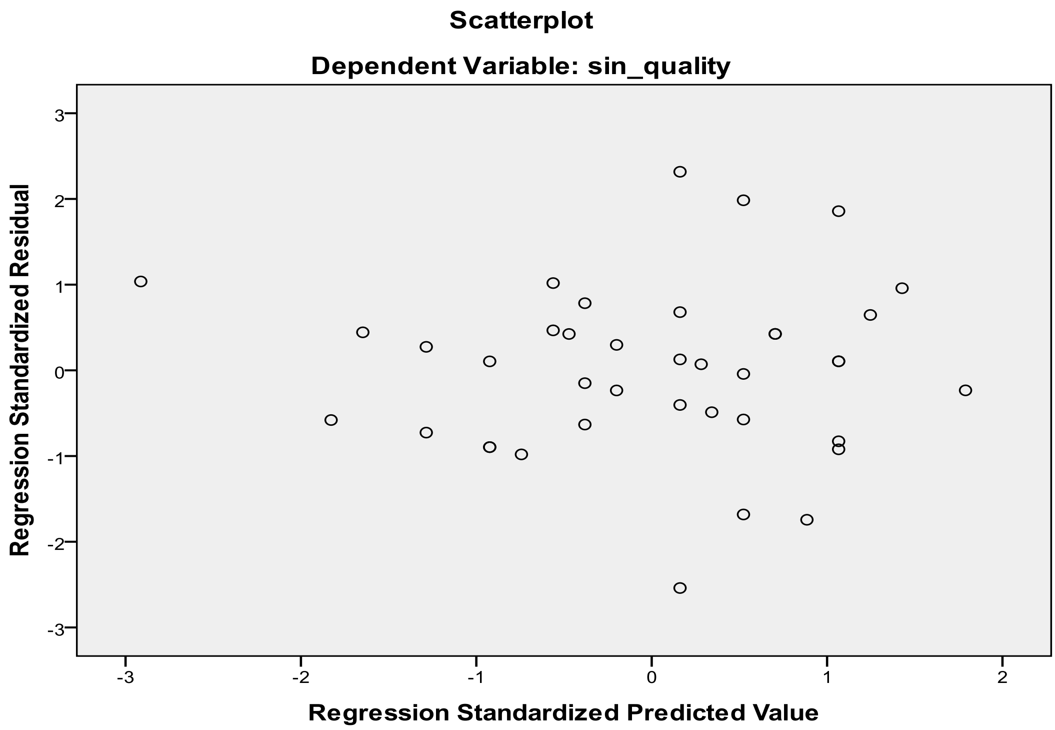
E 19: Normal probability plot for residuals: sin_cost



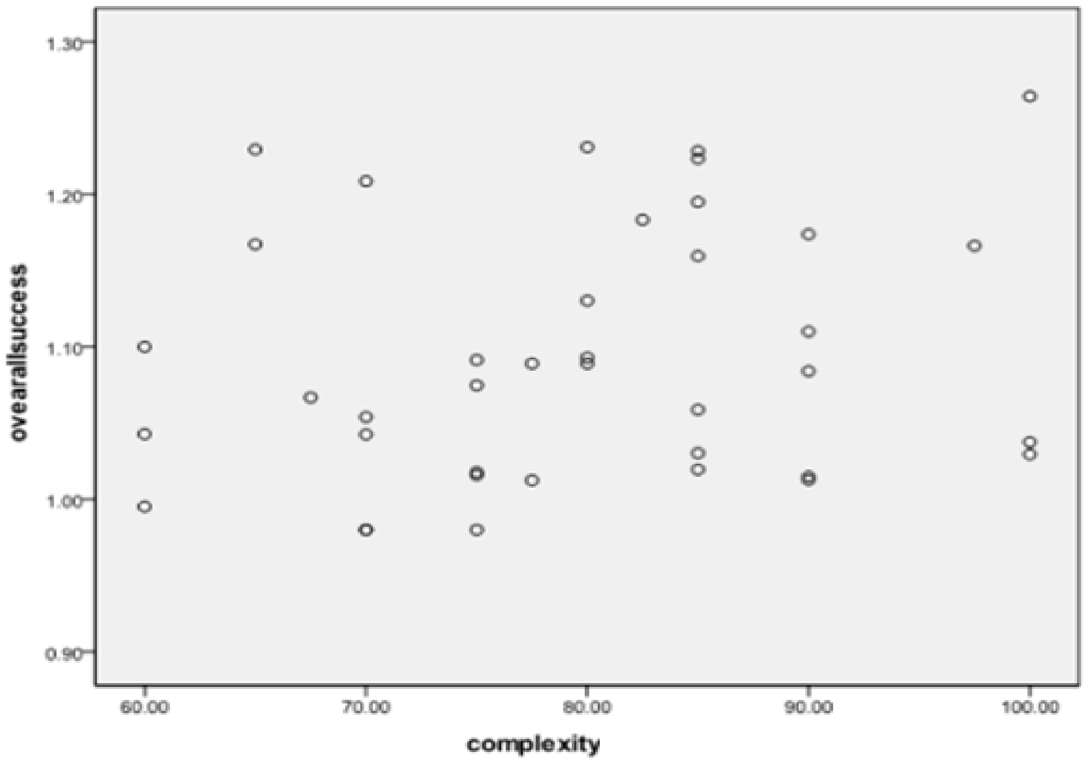
E 20: Standardized residual versus standard predicted values: sin_cost



E 21: Normal probability plot for residuals: sin_quality



E 22: Standardized residual versus standard predicted values: sin_quality



E 23: The scatter plot between complexity and overall success

Appendix F: Summary of pilot survey responses for timing effect toward the strategy-led approach

- Based on the best available data, the construction manager makes some deliberate strategies at conceptualizing stage. This conceptualizing stage is not same as the conceptualizing stage of Flewing's (2005) model. Rather, it represents the planning stage prior to construction works are commenced. Therefore, it can be after the award of contract for traditional procured projects and from the inception stage to DBFO projects.
- When construction projects advance from the conceptualization stage to implementation, the construction project manager realizes potential strategies emerged from options analysis, workshops and scope.
- It is up to the project manager and the team to select the best suitable project delivery pathway / strategy from strategies emerged through the conceptual and implementation stages, keeping project information into account. The selected project strategy is also known as the "Project Delivery Model (PDM)".
- After creating the PDM, a construction project is usually carried out with many sub strategies which can be deliberate or spontaneous.