

**THE ROLE OF STAKEHOLDERS IN SUCCESSFUL
IMPLEMENTATION OF DESIGN AND BUILD
PROJECTS IN SRI LANKA**

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Master of Science in Project Management

Department of Building Economics

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Dissertation submitted in partial fulfillment of the requirement for the
Degree Master of Science in Project Management

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DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for any Degree in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person where acknowledgement is made the text.

Further, I acknowledge the intellectual contribution of my research supervisors Ch. QS. Prof. (Mrs). B.A.K.S. Perera for the successful completion of this research dissertation. I affirm that I will not make any publication from this research without the names of my research supervisor as contributing author unless otherwise I have obtained written consent from my research supervisor.

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Ch. QS. Prof. (Mrs). B.A.K.S. Perera

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Date

Dissertation Supervisor

ABSTRACT

Recently, use of integrated procurement systems became popular among private and public sector projects. As a result, 'Design and Build' (D&B) method has been increasingly adopted in Sri Lanka's construction industry during the past decade, even though, stakeholders lack a proper awareness about their role in the project life cycle. Thus, the aim of this research was to identify the role of stakeholders in successful implementation of D&B building projects in Sri Lanka. The methodology of this research incorporated a mixed approach with semi-structured interviews and a questionnaire survey to attain the aim of developing a frame-work for the roles of stakeholders for successful implementation of design and build building projects in Sri Lanka. A purposive sample of nine professionals were interviewed to validate the findings of the literature survey, and manual content analysis was used to analyze the interview findings. In the second part of the study, data collection was done using a questionnaire which was distributed to different parties in the construction industry which included clients, D&B contractors and consultants. Questionnaire findings were analyzed using weighted mean rating statistical methods. According to the findings, client, contractor and consultant were validated as the key stakeholders. The results identified that there are eight stages in D&B project lifecycle and that there are specific roles for stakeholders at each stage. Also there are, enablers and barriers at each stage. Twelve solutions were identified to mitigate the barriers. This research recommends to use for the D&B to Clients, Contractors, Consultants and other stakeholders related to D&B projects. Further, practitioners in D&B construction industry can also use this study to identify the different stages of D&B projects and the roles of stakeholders.

Key words: Design and build, stakeholders, Project life cycle, Construction industry.

DEDICATION

*Dedicated to
my Beloved Parents
and
Respected Teachers*

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LIST OF ABBREVIATIONS

APUC	-	Advance Procurement for Universities and Colleges
CCPM	-	Complete Construction Project Management
CM	-	Construction Management
D&B	-	Design and Build
GDP	-	Gross Domestic Product
GNP	-	Gross National Product
PM	-	Project Manager
RIBA	-	Royal Institute of British Architect
DBIA	-	Design Build Institute of America

CHAPTER ONE

1. INTRODUCTION

1.1 Background

Construction industry generates both employment and wealth (Hammad, Shboul, Sweis, & Sweis, 2008) and significant contribution to the country's economy. When achieved the success factors of time, cost and quality of a construction project, it is considered as successful (Desai & Desale, 2013; Westland, 2018). In order to deliver the products successfully, numerous procurement systems are available (Idoro, 2012; Chanudha, Disarathna, Anuruddika, & Ariyachandra, 2017). Design and Build (D&B) is very common construction procurement system in the industry (Akintoye, 2006; Adamu, Sidik, & Ernest, 2017). According to Jayasena & Joseph (2008), Design and Build is a next alternative procurement system. Moreover Design and Build procurement system, is now used in both public and private sector projects of varying complexity (Anuba & Evbuomwan, 2010). Furthermore, D&B is anticipated to represent up to 44% of construction spending in the assessed segments by 2021 (Fails Management Institute (FMI), 2018).

D&B is becoming popular in the current context due to many highlighted advantages of this method of construction procurement, because contractor is doing the design process as early as possible, single point responsibility risk avoidance, greater price certainty, improved communication and reduced construction time among others (Adamu, Sidik, & Ernest, 2017). Further, there are also a number of disadvantages: such as quality of the design, the high cost of tendering and the changes by the client. Further, Anuba & Evbuomwan (2010) proposed a new process model to address many of the procurement route's prevailing short-comings. Particularly, the D&B is a process; project development through the integration of project stakeholders as a team, and overcome significant potential problems at the early stage of the project (Lam, Chan, & Chan, 2006). The scholars further described that the D&B method is also recognized by practitioners as, a method where the risks are transferred to the contractor, while making use of resources and expertise from the contractor, which makes it easy to meet the principles of public accountability and avoid variation,

thereby D&B method becoming a widely adopted method in public sector projects. Lam, Chan, & Chan (2003) have argued that, because of the complexity of the construction industry, it is need to identify the causes and barriers in the alternative procurement method to achieve project success.

D&B procurement system provides a platform for cooperation and collaboration of stakeholder involved in construction projects to obtain optimum project performance (Nursin, Latief, & Ibrahim, 2018). The briefing phase interaction between client and designers are recognized as social engagements, characterized by communicative sign use, where conceptual ideas are gradually transformed in to potential design solutions (Collinge & Harty, 2014). Further, a semiotic analysis of briefing communications between client stakeholders and designers provides evidence of the significance and importance of stakeholder's interpretation and understanding of design. To improve external stakeholder's relations, public and private sector projects employ their project participants to build up the relationship among the parties (Kivits, 2011). It has been demonstrated that, gathering of stakeholders and their opinion is very important to enhance the decision making and the project performance, as decision making can benefit from their knowledge, especially, in the context of large projects. Further, stakeholder engagement can positively contribute to the design-build procurement system and also exchange information within the stakeholders in the construction industry (Deelstra, Nooteboom, Kohlmann, Vanden Berg, & Innanen, 2003).

The expertise in the construction organization more fully involve the successful performance of the project (Doloi H. , 2010). Doloi argues further that, while the clients strive hard to make the best decision in selecting the right contractor for the right job, a clear understanding of the underlying attributes associated with selecting a contractor is critical to achieve overall successful project outcomes.

Some countries in the East, like Japan, have a very developed D&B market, while the use of D&B in Hong Kong is still developing (Lam, Chan, & Chan, 2006). There are three major types of D&B construction projects in Hong Kong namely traditional D&B, novation D&B and enhanced D&B. Although D&B has been gaining market share, reaching nearly 40% in the US in 2014 (RSMMeans, 2015).

The behavior of stakeholders and their roles were identified in practice and the contemporary management theory in the organizational dynamics and kept records

(Newcombe, 2003). Therefore, it is important to identify the stakeholder's involvement in successful implementation of D&B projects. Rostiyanti, Koesalamwardi, & Winata (2019) ; Dang & Hoai (2016); Adnan, Bachik, Supardi, & Marhani (2012) have demonstrated that, through several studies on the identification of success factors in developing collaborative D&B project team to improve project performance. Thus, this study is elaborating on the role of stakeholders in successful implementation of D&B building projects in Sri Lanka.

1.2 Problem statement

Design and Build project success is becoming hard to achieve, because of the project delivered by the stakeholders' unfamiliarity and inexperience with the D&B approach (Dang, & Hoai, 2016). D&B is fastest growing and most popular method used to deliver construction projects worldwide (DBIA, 2020), even though stakeholders lack a proper awareness about their role in the project lifecycle. Further, Joseph & Jayasena, (2008) identified barriers for successful performance of D&B projects in Sri Lanka, but still remain the study of the strategies for overcome barriers.

Any changes are addressed by the stakeholders in D&B project leading to collaborative problem solving (DBIA, 2020). It is generally accepted that a project's objectives should match with those of the stakeholders, and continue to fit stakeholder interests as the projects evolve, condition change and the interdependencies of key systems, stakeholders and their objectives change (Sterry & Sutrisna, 2007). Nursin, Latief, & Ibrahim (2018) said that lack of cooperation, trust, communication, visualization and different relationships between stakeholders are some highlighting problems of construction projects. (Dang, & Hoai, 2016) due to the increasing complexity, uncertainty and dynamics of construction projects, managing these issues become very difficult, and recognize of stakeholders very hard, who are the relevant stakeholder and how they influence the construction project, and what their motives are in so far as their actions affect project activity (Ward & Chapman, 2008). Market research by Fails Management Institute (FMI) predicts 18% design Build growth, with few traditional law bid projects and nearly half of the market utilizing design build

delivery method worldwide (DBIA, 2020). In Sri Lanka, private and public sector increasingly adapting D&B project delivery method.

Therefore, there is a need to study the role of stakeholders in the successful implementation of design and build projects in Sri Lanka.

1.3 Aim and Objectives

1.3.1 Aim

The aim of this study is to identify the role of stakeholders in successful implementation of D&B building projects in Sri Lanka.

1.3.2 Objectives

The aim of above research was achieved through five research objectives listed below:

1.3.2.1 Identifying stages of Design and Build project lifecycle.

1.3.2.2 Identifying the significant roles of stakeholders at each stage of the project lifecycle.

1.3.2.3 Identifying the significant enablers and barriers in successful performance of roles of stakeholders.

1.3.2.4 Identifying suitable strategies to overcome above identified barriers.

1.3.2.5 Developing a frame work for successful implementation of design and build projects.

1.4 Research Methodology

This descriptive study consists of primary and secondary data, which is analyzed using quantitative and qualitative (mixed) approaches.

Step1: A comprehensive literature survey, was carried out using journals, books, articles, reports, dissertations, previous research and using internet publications, was conducted in order to identify various facts and the theories which are relevant to the role of stakeholder for successful implementation of the D&B building projects.

Step 2: Semi-structured preliminary interviews were conducted with nine practitioners who are involved in the D&B process of the building construction industry to verify the findings of step 1. The research objectives were identified and were validated by preliminary interviews. Further, the assistance was taken to finalize the questionnaire in the area of problems in D&B projects in the building construction industry in Sri Lanka.

Step 3: A Questionnaire survey was conducted with a purposive sample of practitioners to identify the research objectives of D&B building projects in Sri Lanka.

1.5 Scope and Limitations

The scope of this study is limited to evaluating the perception of stakeholders who involve in the lifecycle of the D&B building projects. Engineer to contract, Design and Build contractor and the Client are the stakeholders.

1.6 Chapter Breakdown

1.6.1 Chapter One – Introduction

Chapter one describes the project rationale, research background, key research aim and objectives of the successful implementation of Design and Build Projects, research methodology, scope and limitation of the study with the organization of the report.

1.6.2 Chapter Two - Literature review

Chapter two discusses relevant theories and frame-works by analyzing published and unpublished literature available on the role of stakeholders in successful implementation of a Design and Build project. The purpose is to highlight and discuss the different stages of Design and Build project stakeholder involvement to fulfilling the aim and objectives.

1.6.3 Chapter Three - Research methodology

Chapter three presents the methodology that was adopted to achieve the objectives of the research. This chapter discusses the mixed research approach that was adopted in

the present study, research methods, data collection methods, data analysis strategy and research process etc.

1.6.4 Chapter Four- Research Finding and Analysis

Findings of the research are analyzed in detail in this chapter. All key findings /results were outlined in this chapter without interpreting the data or drawing any conclusion. It includes graphs, charts and tables and tries to identify meaningful patterns, trends and relationships.

1.6.5 Chapter Five- Conclusions and Recommendations

Chapter five draws conclusions by interpreting results of the research question, and states whether the research hypothesis has been verified. An important aspect of this section is to highlight linkage between the results and evidence from the literature and the research findings, and to make recommendations in regards to implication of the results and direction for future research. Finally, a summary of the overall research along with final judgments, opinions, and comments were included in the form of suggestions for improvement.

CHAPTER TWO

2. Literature Review

2.1 Introduction

The background of the study and a brief introduction to the research was presented in chapter one. Accordingly this chapter aims to explore the current knowledge regarding the research area and to place the research question in within the body of existing knowledge. Therefore, this chapter consists of literature relevant to the subject area considered in the research.

This research identifies the, stages of Design and Build project lifecycle, and the significant role of stakeholder's at each stage of the project lifecycle. It is also look at enablers and barriers in successful performance of roles of stakeholders. Further, it identifies suitable strategies to overcome identified barriers to develop a frame work for successful implementation of D&B projects.

2.2 Procurement Methods Used in Construction Industry

Most of the developed and developing countries: construction sector reflected considerable share for development process (Wibowo, 2010). Due to the complexity of the construction project, involvement of stakeholders is significantly high, other vice time consuming of the project will is also considerable and broad contractual relationships (Oyegoke, Dickinson, Malik., Mc Dermott, & Rowlinson, 2009). The term 'procurement' used in a building construction can be defined as the widespread process of acquiring a building (Ramus, Brichall, & Griffiths, 2006; Chanudha, Disarathna, Anuruddika, & Ariyachandra, 2017). Any procurement system highly depends on nature, culture, politics and economics of a country (Luu, Ng, & Chen, 2003). The success or failure of the procurement process is highly dependent on a proper understanding of the terms in the procurement document (Kornevs, Hauge, Meijer, & Dong, 2018). Since the construction procurement determines the overall structure of the construction process (Wahaj, Deep, Dixit, & Khan, 2017). Some scholars (Ratnasabhpathi & Rameezdeen, 2007) have explained that, different procurement methods are used in different projects, the selection of procurement method helps to acquirer project specific goals avoiding problems encompassing.

Besides, others have argued Mathonsi & Thwala, (2012); Wahaj, Deep, Dixit, & Khan, (2017); Omondi, Diang'a, Gwaya, & Onyanyo, (2017) that, 'procurement systems are vital in ensuring the successful implementation of a construction project, precisely executed for all phases of any particular project' (Idoro, 2012) in other words the procurement method adopted to deliver a project will determine whether the project will be successfully delivered or not.

2.3 Design and Build Procurement Method

Design and Build procurement method is defined by some scholars (Masterman, 2002) as "an arrangement where one contracting organization takes sole responsibility, normally on a lump sum fixed price basis, for the bespoke design and construction of a client's project". Adamtey (2019) has mentioned that "Design-Build is a project delivery system, where the owner manages only one contract with a single point of responsibility: designer and the contractor are on the same team, the contractor performs both design and construction under a single agreement. Nursin, Latief, & Ibrahim, (2018) ; DBIA (2020), the basis of this D&B procurement method is integration of design and the construction of a project.

Choice of procurement method is one of the significant aspects that highly influence the performance of construction industry (Ng & Chen, 2003; Yu, Chan, Chan, Lam, & Tang, 2016). Construction of a building is requirement of a client; adopting suitable procurement system helps to complete the project within specific time, cost and the quality, furthermore, Lam, Chan, & Chan, (2004); Adamu, Sidik, & Ernest,(2017) have held that the Design-build is one of such alternatives to deal with the problems of the traditional project delivery system and its use is on the rise in many countries. Further, Shiyamani, Rameezdeen, & Amarathunga (2005) have reviewed of the trends of project procurement system used in Sri Lanka and stated that the Measure and Pay was the most popular procurement method followed under Design and Build. Layton (2016) said that, the design build delivery method is a shift from the more traditional design bid build delivery of construction contracts. According to a study by Rameezdeen & De Silva (2002) economic growth has favored some of the alternative methods of procurement to emerge in Sri Lanka and design and build is one such

method developed mainly due to the industrial growth of the country. They further state that participants should be equipped with proper D&B knowledge for better project performance.

D&B is considered as most suitable procurement system to overcome issues and ensure the success of construction projects in developed and developing countries (Dang & Hoai, 2016). Furthermore, it provides a platform for cooperation and collaboration of stakeholder involved in construction projects to obtain optimum project performance (Nursin, Latief, & Ibrahim, 2018). Successful D&B projects offer and owner many benefits that add value to a project (Layton, 2016).

The Design-Build Institute of America (DBIA) predicted that 18% D&B growth, few traditional low bid projects and nearly half of the market utilizing design-build method (DBIA, 2020).

2.4 Types of Design and Build Contract

The common types of D&B contracts which were identified in literature are traditional D&B (pure D&B), Develop and construct, Turnkey, Package deal, Novation D&B, Management contracting and construction management. The different alternative approaches to D&B contracts identified are shown in table 2.1.

Table 2.1 Types of Design and Build Contracts

Types of D&B Contracts	A	B	C
• Traditional D&B (Pure D&B)			✓
• Develop and construct	✓	✓	✓
• Package deal	✓	✓	✓
• Management contracting	✓		
• Construction management	✓		
• Turnkey		✓	✓
• Novation D&B		✓	✓
A – Babatunde, Opawole, and Ujaddughe(2010), B – Car-Pusic, Radjkovic and Taurina (2008), C – Masterman (1996)			

2.4.1 Traditional Design and Build (Pure D&B)

In Design & build projects, everything is designed by the contractor. However, RIBA (2007) stated that the two- stage tender, consistent with appointing a consultant for the preparation stage, for gathering Employer’s requirements and the preparation of the

contractor's proposal. Further, as others have pointed out Car-Pusic, Turina, & Radjakovic, (2008) in pure D&B projects, design and construction expertise and other sufficient resources resides within the contractor's organization to complete the given task.

2.4.2 Develop and Construction

In development and construction method, the client has the design prepared up to some extent and a contractor will be chosen to 'finish-off' the design and construction (Babatunde, Opawole, & Ujaddughe, 2010). In addition, as argued by Baccarini, Davis, & Love, (2008) the develop and construct method is a method where consultants design the building up to a required, often in to scope design, and then a contractor will be selected to develop and complete the particular project. Further, RIBA (2007) stated that, the single stage tender, client is designing certain extent of the design part, contractor make continue from that level, not repeating the design scope done by the client.

2.4.3 Package Deal

Package deal is where the employer accepts a proposal based on a standard design from the contractor, effectively providing a single point of responsibility as the contractor is responsible for the design and construction of the entire project. Package deal is the method where the contractor provides an "off the-shelf building" (Babatunde, Opawole, & Ujaddughe, 2010). Further, it describes that the particular building type is already designed and some changes can be done according to the requirements. Moreover, innovation is limited when this method is used (Baccarini, Davis, & Love, 2008).

2.4.4 Turnkey

Lahdenpera, (2001) has argued that a turnkey contract is one under which the contractor is responsible for both the design and construction of a facility. Further, the concept of turnkey contract, the contractor shall provide the work ready for use at the agreed time and cost. But also for land acquisition, financing for the facility and may be operation and maintenance services as part as the total package in turnkey contracts.

2.4.5 Construction Management

Construction management is a procurement route in which the works are constructed by a number of different trade contractors. These trade contractors are contracted to the client but managed by a construction manager (CM). The CM has no contractual links with the trade contractors or members of the design team.

The design is carried out by the design team and there is generally an overlap between the preparation of the design and work on site as Management Contracting. A fee earning construction manager, will define and manage the work packages. All the contracts for the work packages are between the client and the trade contractors, therefore, the client has a considerable duty in managing separate contracts. The final cost of the project is not known till the last work package is let (APUC).

2.4.6 Novation Design and Build Contracts

In Novation D&B method, the client appoints a designer in the planning stage of the project in order to prepare an outline design and the clients brief and after contractor is selected design responsibility is then transferred to the contractor (Greenwood, Hilebrandt, Hughes, & Kwawu, 2006). The authors have further stated that novation is a process by which contractual rights and obligations are transferred from one party to another this transferring is called as novation. Furthermore, the same consultant continues until the end of the project.

2.5 Stages of Design and Build Project Lifecycle

The stakeholders are major players in D&B projects. Their role in D&B projects in separate stages. The project lifecycle has been defined as the stages from the inception to completion of the project by the Royal Institute of British Architects' (RIBA) Plan of Work 2013, that describes the briefing, designing, constructing, maintaining, operating and using building projects and divides them in to mainly eight stages identifying the first five stages as design stages, the pre-construction stage, construction stage and use or operation stage. There are different members who contribute to change the design during the design and construction stage of the building construction projects (Kathryn & Harvey, 2014). There are six stages of design and construction of the construction projects (Alison, 2008). In addition to that RIBA,

(2007) discusses the stages of D&B projects in two ways, namely, single stage D&B projects and the two stage D&B projects. The table 2.2 illustrated the stages of project life cycle of a Design and build projects.

Table 2.2 Stages of project life cycle of a Design and build projects

RIBA plan 2013, stages of project life cycle		A	B	C	D	E	F
A. Appraisal	Preparation stage	✓	✓		✓	✓	✓
B. Design Brief		✓	✓		✓	✓	✓
C. Concept design	Design stage	✓	✓	✓	✓	✓	✓
D. Design development		✓	✓	✓	✓	✓	✓
E. Technical design		✓	✓		✓	✓	
F. Production information	Pre- Construction stage	✓	✓	✓			✓
G. Tender documentation		✓	✓	✓			
H. Tender Action		✓	✓				
J. Mobilization	Construction stage	✓	✓	✓	✓	✓	✓
K. Construction to practical completion.		✓	✓	✓	✓	✓	✓
L. Post practical completion.	Use stage	✓	✓			✓	✓
A= RIBA 2007 single stage D&B projects, B= RIBA 2007 two stage D&B projects, C= Alison(2008), D= Dione, Ruwanpura & Hettiarachchi(2005), E= Zou et al (2007), F= (Wiki, 2019)							

According to the Dione, Ruwanpura, & Hettiarachchi (2005), construction project life-cycle involves the following stages: Initiation Phase, Concept Phase, Feasibility Phase, Planning Phase, Design/Implementation Phase and construction phase. Further, Zou, Zhang, & Wang (2007) have divided the comprehensive project lifecycle into four stages, Conceptual stage, Design stage, Construction stage, and Operation stage. Design & Build Wiki (2019) has reinforced the above stages presenting them as, Business justification stage, Feasibility study stage, Project brief stage, Concept design stage, Detail design stage, Production information stage, Mobilization stage, Construction stage, Occupation and Defect liability period are also as a stages of D&B project lifecycle.

Out of the six sources, RIBA plan of 2007 is discussed the stages of D&B project. The RIBA plan of work's strength lies in its clear presentation of the tasks involved in each stage of a project and RIBA, 2013 is the latest updated source since it was selected for this research, detailed discussed as Preparation stage, Design stage, Pre-Construction stage, Construction stage and Use or operation stage.

2.5.1 Preparation Stage

This stage consist with two stages, Appraisal stage and design brief stage (RIBA, 2007) and (Zou, Zhang, & Wang, 2007). As per RIBA (2007) plan stated that D&B single stage tender at the preparation stage, it is selecting adviser and the D&B two stage tender it is appointing consultant for design review. Design & Build Wiki, (2019) presented it as, Business justification stage and Feasibility study stage.

Appraisal stage

Design & Build Wiki, (2019) describe this stage as, the Business justification stage. According to Alison (2008), this is the first stage where by the client and the architect sit and discuss the requirements of the project.

Design brief stage

This stage also has an initial visit to the property, walk around and discuss the client's ideas, hopes and aspirations. Discuss and agree with the client's budget construction cost, was given design advice with this in mind (Design & Build Wiki, (2019).

2.5.2 Design Stage

The design stage consists The Royal Institutet of British Architect (RIBA) 2013, of Concept design, Design development and Technical design; However the RIBA (2007) states that in D&B single stage tender, select and confirm consultant in this stage, for design review with the concept design and the design development. In D&B two stage tender, the Contractor's proposal with the concept, design development, technical design and the production information are mentioned.

Concept Design Stage

In this stage implementation of design brief and preparation of additional data, preparation of concept design including outline proposals for structural and building services systems, outline specifications and preliminary cost plan, contractors proposal (RIBA,2007).

Design Development Stage

In this stage development of the concept design to include structural and building services systems, updated outline specification and cost plan. Completion of project brief, improve contractors proposal at the two stage tender for D&B (RIBA, 2007), and application for detailed planning permission.

Technical Design Stage

Preparation of technical design and specification, sufficient to coordinate components and elements of the project and information for statutory standard and construction safety are carried out at this stage (The Royal Institute of British Architects (RIBA), 2007).

2.5.3 Pre- Construction Stage

Contract Stage

Unlike a design –bid- build delivery, a design-build delivery can easily be broken into two separate contracts. This allows the Client's to take a second looks at the project before committing to complete the project. The structure for a split contract look something like the following; D&B two stage tender (RIBA, 2007),

Contract One: The design build team is contracted to complete the project design in sufficient enough detail to fix the price of the project.

Contract Two: The design build team is contracted to complete the design documents and the construction work.

D&B single stage tender final design activity; concept, design development, technical design possibly production details is doing by the Client these stages not repeated by the Contractor (RIBA, 2007).

2.5.4 Construction Stage

As per the RIBA plan this stage consist with mobilization and construction to the completion of the project. In mobilization stage: letting the building contract, appointing the contractor, issuing of information to the contractor and arranging site hand over to the contractor. Construction to practical completion: Administration of the building contract to practical completion, provision to the contractor of further information as and when reasonably required and review of information provided by contractors and specialist.

2.5.5 Use or Operation stage

Once the project has been handed over to the Client the last remaining actions; as (RIBA) plan, removals, occupancy, utilization of the building, defect liability period, settlement of final accounts and past contract review and Client feedback.

2.6 Stakeholders in projects

A stakeholder is anyone who has an interest in the process or outcome of project (Fewings, 2005; Milani, 2019). The project stakeholder “An individual, group, or organization, who may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project” (Project Management Institute, 2013).

Moreover Agyekum, (2012) identified that the broad categories of stakeholders are Client, Contractor and professional Consultants (Satankar & Jain, 2015) they also identified that the main stakeholder for construction project is the Client, the Contractor and the Consultant. Moreover, others have identified three groups of project stakeholders: they are Owners, Contractors and Consultant (Enshassi, Mohammed, & Abushaban, 2009). Further as Mills had argued (Mills, 2001) the Client, Contractor and Consultant participated in the monitoring and evaluation at all stages of the project implementation.

Clients are the eventual owners of the project and typical funding agent of the project (Cochrane, 2019), and that the Client directs the style, content and the overall look and feel of the building in conjunction with the budget, time-line, and available resources. The Contractors are essentially project managers, they direct the building process from initial planning to final approval, and Contractors supervise the project

time line, manage the budget and work with other stakeholders like government and industry. According to Rogers the consultant is a self – employed independent business person who has a special field of expertise or skill (Rogers II, 2001). The consultant provides expert opinion, advices or services. Further Cochrane, (2019) has indicated that the Consultant role is to evaluate the Client’s need and provide expert advice and opinions on what needs to be done while the Contractor’s role is generally to evaluate the client’s needs and actually perform the work.

Almost every project takes place in a context where stakeholders play a major role in the accomplishment of the tasks (Karlsen, 2002). Often the project is sensitive to actions and decisions taken by the stakeholder. According to Walker (Walker, 2000), there is a need for more investigations into stakeholders’ needs to find out how they are related in defining and influencing project decisions at different stages (Walker, 2000). Furthermore, Project stakeholders can include clients, end users, contractors, consultants, labor unions, line organization, public authorities, financial institutions, insurance companies, controlling organizations, media, third parties, and competitors. As others have argued, Lester (2007) the stakeholders are classified as, direct stakeholders, indirect stakeholders, positive stakeholders or negative stakeholders. Stakeholder’s preferred outcomes and relationships (Jonker & Foster, 2002). According to others, Jergeas, et al., (2000) efficient management of the relationship between the project and its stakeholders is an important key to project success. Both public and private organizations are increasingly employing stakeholder engagement as an important strategy for improving external stakeholder relations, (Deelstra, Nooteboom, Kohlmann, Vanden Berg, & Innanen, 2003). They have further stated that incorporating stakeholders' opinions is valuable for improving decision-making processes and project implementation.

2.7 Stakeholders in Design and Build project

Normally construction development is a thorny process which surrounds long project durations, many stakeholders, and knotty contractual relationships (Oyegoke, Dickinson, Malik., Mc Dermott, & Rowlinson, 2009). As key stakeholders in D&B projects, both clients and D&B contractors contribute towards the project success (Chan & Chan, 2001; Ling, Chan, Chong, & Ee, 2004; Lam, Chan, & Chan, 2008).

Success of the project is very hard to achieve, because of the stakeholders lacking experience with the D&B approach (Dang & Hoai, 2016). The table 2.3 illustrated the stakeholders in D&B projects.

Table 2.3 Stakeholders related to D&B projects

Stakeholders in literature		A	B	C	D	E	F	G	H	I
1	Client	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Contractor	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	Consultants	✓	✓	✓			✓	✓	✓	✓
4	Architect	✓	✓	✓			✓	✓	✓	✓
5	Engineer	✓	✓	✓			✓		✓	✓
6	Project Manager	✓	✓	✓						✓
7	End users	✓	✓						✓	✓
8	Financial institution	✓	✓						✓	✓
9	Insurance companies	✓								✓
10	Environmental groups	✓	✓						✓	✓
11	Public authorities	✓	✓						✓	✓

A= (Walker, 2000), B=(Lester,2007), C= (Alvani, Bemanian, & Hoseinalipou, (2014), D=(Ling, Chan, Chong, & Ee, 2004), E= (Oyegoke, Dickinson, Malik., Mc Dermott, & Rowlinson, 2009), F= (Plusquellec, Cimon, & Lehoux, (2016)), G =(Adamu, Sidik, & Ernest, 2017), H= (Stephen & Menassa, 2014 ; Yang & Zou, 2014), I = (Malkat & Byung-GYOO, 2012)

Plusquellec, Cimon, & Lehoux, (2016) have shown that the four main categories of the stakeholder in D&B project are the Client, the Architects, the Engineers, and the Contractor and both client and D&B contractors play a critical role in the project, they are required to possess different competences. Alvani, Bemanian, & Hoseinalipou, (2014) have demonstrated that the project related participants refer to related major parties in D&B projects including client, contractors, design consultants, project management consultants and project managers or project team. Further, Stephen & Menassa, (2014) ; Yang & Zou, (2014) have held the view that, stakeholders in construction project can include but not limited to owner , contractor, subcontractor designer, facility manager, investor, user government, community, pressure groups and assessor, and said further that the stakeholders for the D&B projects are Clients, Contractors and Consultants. Malkat & Byung-GYOO, (2012) have identified that, owners ,consultants and contractors are primary stakeholders such as government, general public, and communities are secondary stakeholders. Lester, (2007) demonstrated that, stakeholders for building design construction: as Client, Project

sponsor, Project manager, members of the project team, technical and financial services provider, internal or external consultants, material and equipment suppliers, site personnel contractors as well as end users.

2.8 Role of stakeholders for successful implementation of D&B projects

Project stakeholders should have a clear understanding of their own responsibilities and roles in D&B projects, and cooperate closely to achieve satisfactory project performance (Bo Xia, Chan, & Zuo, 2012).

2.8.1 Appraisal stage

This stage presenting as, Business justification stage Design & Build Wiki, (2019). The literature found eight roles of stakeholders as illustrated in table 2.4.

Table 2.4: Appraisal stage

Stakeholder's roles identified from Literature		Authors
1	Achieve client's consensus regarding the project objectives by the Architect	(Ambler , 2006)
2	Develop clear definitions of project scope	(Adnan , Bachik, Supardi , Marhani , 2012); (Alison, 2008),
3	Expresses requirement clearly in project briefs	(CCPM, 2016); (Suleiman & Luvara, 2016); (Collinge & Harty, 2014)
4	Discussion of the requirements of the project	(Alison, 2008)
5	Initiation of the budgetary requirement	(CCPM, 2016); (Adnan, Bachik , Supardi, Marhani, 2012); (DBIA-Prime, 2015)
6	Discussion of the special requirements	(CCPM, 2016); (Alison, 2008),
7	Develop feasibility study reports jointly with the relevant expertise	(D&B Wiki, 2019)
8	Proposal of project execution plan & strategic brief	(D&B Wiki, 2019)

In this stage involve identifying client's needs and objectives, business case and possible constraints on development and the feasibility study (Ambler, 2006 ; RIBA, 2007; Alison, 2008; CCPM, 2016; Design & Build Wiki, 2019), in addition to that it involves getting client consent weather to proceed or not. RIBA (2013) stated

that, in this stage, the project is strategically appraised and defined before a detailed brief is created.

2.8.2 Design Brief stage

Development of initial statement of requirement in to the design brief is doing in this stage. The literature found three roles of stakeholders as illustrated in table 2.5.

Table 2.5: Design Brief stage

Stakeholder's roles identified from Literature		Authors
1	Discussion of the client's ideas, hopes, and aspirations	(Adnan , Bachik, Supardi , Marhani , 2012); (Ackermann & Eden, 2011); (CCPM, 2016); (Bo Xia, Chan, & Zuo, 2012); (RIBA, 2007)
2	Discussion of the Designer requirements	(Suleiman & Luvara, 2016); (Collinge & Harty, 2014); (CCPM, 2016)
3	Discussion the financial commitment of the project	(Bo Xia, Albert, & Jian Zuo, 2012); (Cochrane, 2019)

Further, this stage, discusses and confirms the client key requirements and constraints, the stakeholders' roles identified by sources (RIBA, 2007; CCPM, 2016; Bo Xia, Albert, & Jian Zuo, 2012; Collinge & Harty 2014; Adnan, Bachik, Supardi, Marhani, 2012). Design brief creates a carrying out preparation activities and briefing in tandem.

2.8.3 Concept Design stage

This stage includes preparation of concept design including outline proposal for structural and building services system. The literature found seven roles of stakeholders as illustrated in table 2.6.

Table 2.6: Concept Design stage

Stakeholder's roles identified from Literature		Authors
1	Conversion of the design to graphic shape according to the client program	(Mehta & Scarborough, 2009)
2	Multiple revisions done until reaching its objectives	(Mehta & Scarborough, 2009)
3	Communication of the design proposal to the client including plans, elevations, sections, freehand sketches, and three-dimensional graphics	(Mehta & Scarborough, 2009)

Stakeholder's roles identified from Literature		Authors
4	Preparation of Client's requirements	(Layton, 2016)
5	Preparation of schematic design studies showing the scale and relationship of the project components	(RS Means, 2015)
6	Schematic design approval & addressed project requirements and cost	(Layton, 2016); (DBIA -Prime, 2015)
7	Revision of initial goals at the stage such as lifecycle cost, resource use, environmental architectural quality, indoor quality, and functionality	(DBIA-primer, 2015)

Additional data preparation is required in this stage for implement of design brief (RIBA, 2007). This point has been confirmed by, (Mehta & Scarborough, 2009); (RS Means, 2015); (DBIA-Prime, 2015); (Layton, 2016).

2.8.4 Design Development stage

This stage involves developing the concept design to include structural and building services systems. The literature found six roles of stakeholders as illustrated in table 2.7.

Table 2.7: Design Development stage

Stakeholder's roles identified from Literature		Authors
1	Schematic design decisions worked out in greater detail	(RS Means, 2015); (Design & Build Wiki, 2019)
2	Coordinated description of all aspects of the design including architectural, mechanical, and plumbing, electrical and fire protection	(Jonathan & Frederick, 2001); (RS Means, 2015)
3	Value Engineering proposal	(Layton, 2016)
4	Giving inputs to the architect	(Layton, 2016)
5	Deriving sustainability strategies by brainstorming	(RS Means, 2015); (Jonathan & Frederick, 2001),
6	Several revisions to achieve the client's needs	(DBIA, 2017)

Further, this stage requires updating the outline specification and preliminary cost plan, complete the project brief (RIBA, 2007). To achieve those, the stakeholders' roles have been identified in some sources (RS Means, 2015); (Jonathan & Frederick, 2001); (Layton, 2016; DBIA, 2017) according to them, stakeholders in the table above, make significant contribution.

2.8.5 Technical Design stage

Technical design comprises the residual technical work of the core design and respond to design queries as they arises. The literature found two roles of stakeholders as illustrated in table 2.8.

Table 2.8: Technical Design stage

Stakeholder's roles identified from Literature		Authors
1	Preparation of the technical designs and specifications sufficient to co-ordinate components and elements of the project	(RIBA, 2007)
2	Preparation of all architectural, structural and building services information, specialist sub contractor's design and specifications	(RIBA, 2013)

This stage recognizes the importance of design work undertaken by specialist sub-contractors and suppliers employed by the contractor (RIBA, 2013).

2.8.6 Pre Construction stage

In this stage preparation of production information in sufficient details carried out. The literature found six roles of stakeholders as illustrated in table 2.9.

Table 2.9: Pre Construction stage

Stakeholder's roles identified from Literature		Authors
1.	Appointment of the design build contractor to complete the design with sufficient details to fix the price of the project	(RIBA, 2007)
2	Form a contract with a D&B contractor to complete the design documents and the construction work	(RIBA, 2007)

Stakeholder's roles identified from Literature		Authors
3	Preparation of contract documents including drawing, specification, detailed price proposal and the required building permits from the authorities	(Jonathan & Frederick, 2001); (Scott, 2008)
4	Shifting of utility services & supply with temporary connection	(RS Means, 2015)
5	Approving agencies granting required approvals in time for smooth implementation of project as per the contract or program	(RS Means, 2015)
6	Controlling road traffic at the project location with the minimum inconvenience to the general public with sufficient safety precautions	(Conchrane, 2019)

Further, it has identified some stakeholder roles such as in this stage need to applying for a statutory approvals (RIBA, 2007; RS Means, 2015), and preparation of contract documents (Scott, 2008). The stakeholder's role to plan for public requirements to controlling road traffic at the project location has also been discussed (Cochrane, 2019).

2.8.7 Construction stage

This stage is included mobilization and construction to practical completion. The literature found seven roles of stakeholders as illustrated in table 2.10.

Table 2.10: Construction stage

Stakeholder's roles identified from Literature		Authors
1	Overall coordination of D&B project	(APUC); (RIBA, 2007); (Conchrane, 2019)
2	Construction planning, scheduling and implementing construction work	(RIBA, 2007); (APUC)
3	Monitor the contractor's progress	(Adnan , Bachik, Supardi , Marhani , 2012); (Mills, 2001); (Cochrane, 2019)
4	Construction management, Monitoring and control	(Adnan , Bachik, Supardi , Marhani , 2012)
5	Material procurement, specialist subcontract work allocation and coordination	(Layton, 2016); (Cochrane, 2019)
6	Cost control during the work	(RIBA, 2007)
7	Testing and commissioning of the works	(ASHRAE, 2012)

The stakeholders' roles in this stage have been identified many sources, this stage spans between the administration of the building contract to practical completion of

the project by reviewing the information provided by subcontractor and specialist (RIBA, 2007); (APUC); (Adnan, Bachik, Supardi, Marhani, 2012); (ASHRAE, 2012); (Conchrane, 2019).

2.8.8 Use or operation stage

This stage is about the project handover and closing out. The literature found four roles of stakeholders as illustrated in table 2.11.

Table 2.11: Use or operation stage

Stakeholder's roles identified from Literature		Authors
1	Utilization of the building	(RIBA, 2007)
2	Planning of furniture and equipment procurement	(APCU); (RIBA, 2007)
3	Assisting building user during initial occupation period	(Adnan , Bachik, Supardi , Marhani , 2012)
4	Review of project performance in use	(Agung, Rusdhi, & Wibowo, 2015)

This stage includes administration of the building contract after practical completion and making final inspections; stakeholders' roles have been identified sources: (RIBA 200); (APCU); (Adnan, Bachik, Supardi, Marhani, 2012); Agung, Rusdhi, & Wibowo, 2015).

2.9 Enablers and Barriers in successful performance of roles of stakeholders.

The enablers and barriers for successful performance of D&B project, with the perspective of role of stakeholders, literature provides the enablers as common to all stakeholders, which will vary from one to another, barriers also similar in construction project (Saaidin, Endut, Samah, & Ridzuan, 2017).

2.9.1 Enablers in successful performance of roles of stakeholders

The literature identified 10 enablers in successful performance of role of stakeholders as illustrated in table 2.12.

Table 2.12 Enablers in successful performance of roles of stakeholders

Identified enablers in literature		Author
1	Maintaining of the events closely with the client and the contractor	(Bo Xia, Chan, & Zuo, 2012)
2	Improve uncertainty of the D&B projects the means of stakeholders	(Ward & Chapman, 2008); (Ali & Rahmat, 2009)
3	Proper communication with all parties	(Adnan , Bachik, Supardi , Marhani , 2012); (Agung, Rusdhi , & Wibowo, 2015); (Ng and Aminah, 2006)
4	Design to Finalization at the initial stage before the construction commence	(Bo Xia, Chan, & Zuo, 2012)
5	Proper identification of Employer's requirements	(Anuba & Evbuomwan, 2010); (Chan, Chan, Chan, 2003)
6	Develop a clear understanding of the project scope	(Adnan , Bachik, Supardi , Marhani , 2012)
7	Access contractor's proposal thoroughly	(Adnan , Bachik, Supardi , Marhani , 2012)
8	Limit the change of Client requirement during construction	(Adnan , Bachik, Supardi , Marhani , 2012); (Lam, Chan, Chan, 2003)
9	Comprehensive pre-tender site investigation	(D&B Wiki, 2019); (Adnan , Bachik, Supardi , Marhani , 2012)
10	Understand and commit to the achievement of the project objectives	(Bo Xia, Chan, & Zuo, 2012)

The sources: (Quatman & Dhar, 2003; Ng & Aminah, 2006; Adnan, Bachik, Supardi, & Marhani, 2012; Bo Xia, Chan, & Zuo, 2012; Agung, Rusdhi , & Wibowo, 2015; Design & Build Wiki, 2019) identified enablers for successful performance of D&B projects.

2.9.2 Barriers in successful performance of roles of stakeholders.

The literature identified 15 barriers in successful performance of role of stakeholders. The barriers identified form literature are illustrated in table 2.13.

Table 2.13: Barriers in successful performance of roles of stakeholders

Identified barriers in literature		Author
1	Time, cost and quality control is a vital problem in D&B projects	(Chang, Fung, Tam, & Yu, 2008).
2	Design changes by the client in D&B projects	(Ali & Rahmat, 2009), (Kikwasi, 2012); (Agung, Rusdhi, & Wibowo, 2015)

Identified barriers in literature		Author
3	Lack of communication between Client and design builders	(Agung, Rusdhi, & Wibowo, 2015); (Adnan , Bachik, Supardi , Marhani , 2012); (Nursin, Latief, & Ibrahim, 2018)
4	Tendering burden	(Anuba & Evbuomwan, 2010); (Lam, Chan, Chan, 2003)
5	Rapidly changing market condition	(Agung, Rusdhi, & Wibowo, 2015); (Lam, Chan, Chan, 2003)
6	Stream lining of bureaucracy	(Lam, Chan, Chan, 2003)
7	Involvement of the client	(Lam, Chan, Chan, 2003)
8	Single responsibility on the contractor	(Bo Xia, Chan, & Zuo, 2012); (Saaidin, Endut, Samah, & Ridzuan, 2017)
9	Ambiguous client's brief and lack of communication of the client's precise wishes is conveyed to the contractor in D&B project	(Adnan , Bachik, Supardi , Marhani , 2012)
10	Lack of management expertise at the construction stage	(Agung, Rusdhi, & Wibowo, 2015); (Lam, Chan, Chan, 2003)
11	Delay in obtaining donor concurrence	(Bo Xia, Chan, & Zuo, 2012)
12	Changing of scope during the construction period	(Agung, Rusdhi, & Wibowo, 2015),
13	In appropriate decision taken at the early stage of the project	(Agung, Rusdhi, & Wibowo, 2015),
14	Misinterpretation of client's requirements	(Adnan , Bachik, Supardi , Marhani , 2012); (Lam, Chan, Chan, 2003)
15	Technical problems	(Sterry & Sutrisna, 2007); (Lam, Chan, Chan, 2003)

As illustrated in the table the sources: (Lam, Chan, & Chan, 2003); (Chang J. , Fung, Tam, & Yu, 2008); (Agung, Rusdhi , & Wibowo, 2015); (Adnan, Bachik, Supardi, & Marhani, 2012); (Saaidin, Endut, Samah, & Ridzuan, 2017). Further, Joseph & Jayasena (2008) identified barriers for successful performance of D&B projects in Sri Lanka.

2.10 Need to Identify Role of Stakeholder for Successful Implementation of Design and Build Project

Design & Build is the fastest growing and most popular method used to deliver construction projects worldwide (DBIA, 2020). It has become an alternative procurement method because of its fast track system (Adnan, Bachik, Supardi, &

Marhani, 2012). Project success is becoming hard to achieve, because of the project delivered by the stakeholders' unfamiliarity and inexperience with the D&B approach (Dang, & Hoai, 2016). Even though stakeholders lack a proper awareness about their role in the project life cycle. Joseph & Jayasena (2008) have identified barriers for successful performance of D&B projects in Sri Lanka, but still remain the study of the strategies for overcome barriers.

According to Walker (2000); Yu, Shen, Kelly, & Hunter (2005) stakeholder's involvement has undeniable impacts on project outcomes. Kornevs, Hauge, Meijer, & Dong (2018) stated that the stakeholders often give different interpretations based on their different perceptions. Thus stakeholders influence one another (Kauppi & Erik, 2015; Papakonstantinou & Bogetoft, 2017). There is a need for more investigations into stakeholders' needs to find out how they are related in defining and influencing D&B project decisions at different stages (Walker, 2000). In order to run a successful project it is important to address the needs of the projects stakeholders, effectively predicting how the project will affect them and how they can affect the project , the effective management of project stakeholders is considered an important key to project success (Olomolaiye & Chiniyo, 2010). Contractors' expertise and performance play significant roles in the successful delivery of a project while clients strive hard to make the best decisions in selecting the right contractor for the right job. Further, a clear understanding of the contractors' selection in the context of achieving successful project outcomes is critical (Doloi, Lyer, & Anil Sawhney, 2010).

Doloi H.(2010) further described that every construction project is unique and comprises of unique complexities and risks across many issues throughout the construction process. Kadefors, Bjo rlingson, & Karisson (2007) have suggests that when selecting a contractor for any kind of project the, client needs to consider not only technical competence but also organizational culture and proposal traits of the contractor's, such as trust worthiness, commitment, openness and ability to communicate. Although, Saaidin, Endut, Samah, & Ridzuan (2017) said that, suitability of D&B project approach must be carefully undertaken by ensuring the contractor is able to manage the risk: otherwise the contractor will pass this back to the client.

According to Olomolaiye & Chiniyo (2010) discussed the stakeholders' ability to influence the project and the parties involved in some way, whether financially, legally or by some other form of pressure. Equally each stakeholder needs to be aware of their roles and their responsibility to achieve the project success. Therefore the need to identify the role of stakeholder in the D&B project lifecycle in detail is vital.

2.11 Summary

The purpose of this chapter was to: identify the need of the roles of stakeholders in successful implementation of D&B projects in Sri Lanka's building construction industry. Discussing roles of stakeholders at each stage of the project lifecycle, the enablers and barriers in successful implementation of D&B project in perspective of the stakeholders, and strategies for the successful implementation was carried out exploring the prevailing literature.

During the above discussion, the researcher identified the background of the procurement methods, including D&B procurement methods, different stages of D&B project, stakeholder involvement as well as the different decision points of the lifecycle of the project. Moreover types of D&B contracts, stakeholders, in D&B projects, enablers and barriers, and the need to identify the role of stakeholders in successful implementation of D&B project in construction industry were also discussed.

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1 Introduction

This chapter aims to describe the research methodology applied to conduct this research and to explain about the intended pathway to achieve the objectives of the study. The research approach, research methodology and research process are the three main headings discussed in this chapter. The research approach explains how the literature review is used to further develop the research. As Wedawatta, Ingirige, & Amarathunga (2011) have shown proper determination of the research methodology is imperative to conduct a research study successfully. The research needs primary data as well as secondary data to achieve its objectives. This chapter describes and justifies the data collection methods and data analysis techniques applied in this research. The summary of this chapter is illustrated in the research process.

3.2 Research Approach

Research approaches are plans and procedures to do the research which takes broad assumptions to details methods of data collections, data analysis and interpretation (Creswell J. 2014). According to Niglas, (2004), there are three main research methodologies: namely qualitative , quantitative and mixed method. Elaborating on research on approaches, Creswell & Plano Clark (2011) have argued that the mixed approach enables a greater degree of understanding to be formulated than if a single approach were adopted to specific studies. Qualitative research approach is for exploring and understanding the meaning that the people attribute to a social or human problem (Venkatesh, Brown, & Bala., 2013). They further illustrate that, in qualitative research, the beliefs, understandings, opinions, views and so on of people are investigated. Quantitative approaches involve making measurements of data on suitable scales and these approaches are used in confirmatory studies. The combined methods give more accurate results than the other methods due to the fact that the qualitative approach could be used to improve the findings of the quantitative method (Ellis, et al., 2006). Therefore, the mixed approach used in this research.

Preliminary interviews with experts were carried out based on the findings of the literature survey. The literature survey was used as secondary resources to identify the stages of D&B project lifecycle and the significant role of stakeholders at each stage of project lifecycle. The RIBA plan and the many authors have described about the stages of D&B project lifecycle. Further the qualitative data helps to find out the significant enablers and barriers in successful performance of D&B projects. Moreover, identified enablers and barriers from the literature have been validated by experts, giving causes and solutions for enablers and barriers.

Using the findings from literature and the expert interview, the questionnaire was prepared. It was distributed among, those who are exposed to the D&B building construction industry in Sri Lanka. Among them were engineers, quantity surveyors and architects, working in consultancy firms, contracting organization or client organizations. The research was carried out adopting both qualitative and quantitative (mixed) approach with expert interview and questionnaire survey.

3.3 Research methods

Research methods are the instrument, tools that researches employ while they administer any form of inquiry or investigation (Walliman, 2011) and it is the researches responsibility to select the most appropriate tool (Wilkinson & Birmingham, 2003). According to the selected research approach for the present study, the research methodology was determined. Drawing from the argument that “the procedures by which researches go about their work of describing, explaining, and predicting phenomena” (Rajasekara, Philominaathan, & Chinnathambi, 2013). The present research’s methodology will take an overview that also incorporates ethics, potential risks and problems, and the limitations of any approach (Dawson, 2002).

3.3.1 Data Collection

In mixed research approach, the researcher collects and analyses both qualitative and quantitative data in a sequential and simultaneous manner, integrating the two forms of data rigorously (Creswell & Plano Clark, 2011). Further Rovai, Baker, & Ponton, (2014) have shown that data collection through mixed method is purposefully and carefully implemented in sequence to the study which is conscientiously documented

and evaluated. Bearing on the above observations, the present research used the mixed method is to collect data. Thus, a literature review was done initially. Based on the literature survey interviews were conducted to collect qualitative data, and a questionnaire was administered to collect quantitative data.

- **Interviews**

Drawing from the statement of De Marris that an interview is a process in which a researcher and participant engage in conversation focussed on questions related to a research study (De Marris, 2004). Interviews are conducted in face to face and over the phone (Harrell & Bradley, 2009). Preliminary interviews were conducted with purposive sample of nine professionals, those who have acquired adequate experience in Design and Build building construction projects in Sri Lanka. Those professionals were identified in such a way that they represent the Client, Contractor and the Consultant organizations.

The purpose of the semi structured interviews was to obtain the views of interviewees on the research objectives related to D&B projects that were identified through the literature review. Interview guidelines were discussed extensively with the interviewees and possible responses for each question were discussed. The enablers and barriers for the successful implementation of D&B projects, and the causes and solution for barriers, were discussed with the interviewers. As such, the questionnaire was prepared with the assistance of industry experts.

- **Questionnaire survey**

The questionnaire survey is a very well-known and widely used research technique for quickly and efficiently gathering data (Richard, Maria, & Encinas- Escribano, 2017). The details gathered form literature review and findings from interviews with a purposive sample were used to prepare the questionnaire, which was subsequently administered to gather quantitative data.

This study investigated the need of identifying the role of stakeholders in successful implementation of Design and Build building projects in Sri Lanka. The questionnaire was administered among a representative sample of respondents that included all

stakeholders including building clients, consultant and building contractors (D&B), architect, quantity surveyors and engineers.

3.3.2 Data analysis

Once the data collection is completed, the next most vital aspect to be considered under the research techniques is the data analysis (Schutt, 2012). Data analysis is the most crucial part of any research. Data analysis summarizes collected data, and it involves the interpretation of data gathered through the use of analytical and logical methods relating to determine patterns, relationships or trends (Research Guide, 2019). Content analysis is one of the most common methods to analysis qualitative data as it is a fast growing technique and, it is usually used to analyze responses from interviewees (Guide, 2018). The most commonly used quantitative data analysis method is descriptive statistics. Yet, quantitative data must be obtained and analyzed to help draw study's conclusions (Michael, 2016). Quantitative methods examines numerical data and often require the use of statistical tools to analyze the data collected, that allows for the measurement of variables and relationships. Qualitative data is non-numerical and focuses on establishing patterns. Mixed methods allows for explanation of unexpected results.

- **Data analysis for Interview**

The data collected from semi-structured interviews were analyzed using the content analysis technique which is a widely practiced and highly reliable qualitative data analyzing technique. As Leedy and Ormrod have defined this method allows detailed and systematic examination of the contents of a particular body of material for the purpose of identifying patterns themes or bases (Leedy & Ormrod, 2001). The content was analyzed in this research by using MS Excel work sheet manually.

- **Data analysis for Questionnaire survey**

Quantitative data collection is typically numeric and tends to use mathematical models as the methodology of data analysis (Creswell J. , 2002). Weighted mean is a tool in descriptive statistics that is used to analyse the results gained and ranked from the questionnaire survey. The weighted mean, which is known as sample mean, can be calculated, by the sum of individual values into number of respondents divided by total

number of respondents. The role of stakeholders, enablers and barriers, causes and solutions were ranked by using the weighted mean value of the given scores by respondents. The weighted mean value is calculated by using following equation.

$$\bar{x} = \frac{\sum_i^n XiWi}{n}$$

Where, \bar{x} - weighted mean, Xi - value of individual, Wi – number of scores for individual , n – Sample size(number of total respondents).

3.4 Research Process

The research process consists of several steps which have been arranged in sequential manner to carry out an effective research (Kothari, 2004). It involves identifying, locating, assessing, and analysing the information needed to support the research question (Library Guides, 2018). Furthermore, the above described research methodology and, the research process are directed to achieve the aim and objectives of the research. The research has been initiated with the background studies and would end up with research findings and recommendations. The research process has been illustrated in figure 3.1.

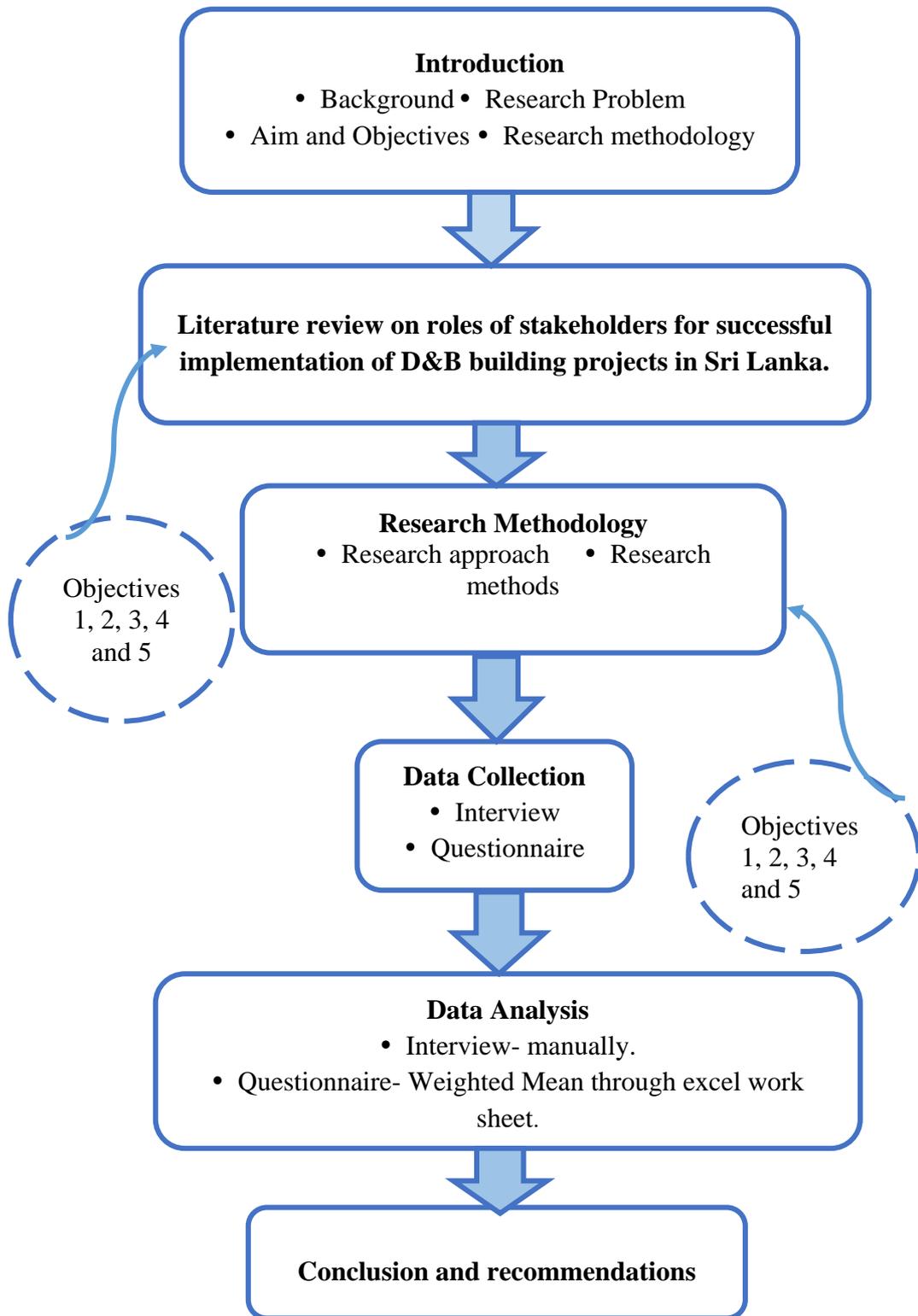


Figure 3.1: The research process

3.5 Summary

This chapter describes and justifies the research approach, and the methodology adopted for the research purpose. A mixed approach that includes qualitative and quantitative analysis of survey data was adopted.

The literature review chartered the roles of stakeholders in successful implementation of D&B building projects in Sri Lanka with the background studies. Based on insights from the literature survey, data was collected from primary and secondary sources through expert interviews and the questionnaire survey. The expert interviews were used for validation of the literature findings and the questionnaire helped collect more data from the industry practitioners with industry experience. The primary data content was analysed using MS Excel work sheets manually. The secondary data was analysed by using statistical application, weighted mean through MS Excel work sheets as advanced data analysis techniques were applied. The aim and objectives of this research study were accomplished through the processes described in this chapter.

CHAPTER FOUR

4. RESEARCH FINDING AND ANALYSIS

4.1 Introduction

The chapter discusses the research findings and presents the analysis. The interview guideline was prepared from the literature findings at the chapter two. To validate the literature findings using opinions of professionals, preliminary interviews were conducted with the construction industry experts with specific expertise in the Design and Build projects. Findings from the expert's interviews were analyzed and presented as the first part. The Questionnaire survey was administered with the help of the literature findings and the expert's interviews. The findings from the Questionnaire Survey analyzed and demonstrate in the second part of this chapter.

Using the outcome of the above exercise, this chapter proposes to develop a framework for successful implementation of Design and Build building projects in Sri Lanka.

4.2 Preliminary interviews

Preliminary interviews were conducted using the semi-structured interview guide line which was inform by the findings of the literature review with a purposive sample of nine practitioners involved in the Design and Build process of building construction industry. It was the first part of data collection in this research. The face to face interviews were conducted for an average within 45 minutes. The findings of the preliminary interviews were analyzed manually and discussed along with the findings of the literature survey.

4.2.1 Objectives of preliminary interviews

The main objective of the semi-structured preliminary interview was, to achieve the five research objectives to fulfill the aim of this research, "The role of stakeholders for successful implementation of Design & Build building projects in Sri Lanka". It was validated in the expert interviews while determining the stages of Design and Build project lifecycle and significant role of stakeholder at each stage of project lifecycle with the applicability to the Sri Lanka. Further these interviews were helpful in validating the findings from literature reviews and also preparation of the

questionnaire in the area of identified significant enablers and barriers, causes for barriers, strategies to mitigate the barriers. Moreover, the expert interviews helped to create structured questionnaire to conduct the questionnaire survey.

4.2.2. Design of the Preliminary interviews

With the help of the findings of the literature review the interview guideline was prepared to elicit information about the five questions relating to research objectives. Most of the questions were prepared to ascertain the correctness or applicability of literature findings to the Sri Lankan construction industry. The fifth question collected details from experts, as to what were the causes for barriers.

4.2.3. Profile of the respondents

The preliminary interviews were conducted with a purposive sample of nine experts, who were engineers, architects and quantity surveyors working in consultancy firms, contracting organizations and the client organizations, all of them have experience in D&B projects in Sri Lanka. Details are illustrated in table 4.1.

Table 4.1 Purposive sampling of above 5 years' experience in D&B projects.

Respondent code	Designation	Years of experience	Company type
R1	Managing Director	21 Years	Contractor
R2	Manager Projects	23 Years	Contractor
R3	Executive Director	28 Years	Contractor
R4	Design Engineer	8 Years	Consultancy
R5	Director	25 Years	Consultancy
R6	Architects	14 Years	Client
R7	Senior Engineer	20 Years	Client
R8	Deputy General Manager	26 Years	Consultancy
R9	Deputy General Manager	17 Years	Consultancy

According to table 4.1 the purposive sample of above 5 years' experience consist of; two interviewees more than 25 years, three interviewees with experience between 21-25 years, two interviewees with experience between 15-20 years, and two other experts with 14 years and 8 years' experience respectively. Out of nine interviewers, three were employed at consultancy organizations, two were at client organizations and the other four of them were at contractor organizations.

4.2.4 Analysis of the outcome of the preliminary interviews

The findings from the semi structured interview were analyzed with the related findings from the literature review, The nine expert interviews were used to identify and validate the findings of the literature survey on the stages of D&B projects life cycle, the stakeholders related to D&B projects, related roles of stakeholders at each stage of project lifecycle, enablers and barriers for successful performance of roles of stakeholders and causes and strategies to overcome the barriers for successful implementation of D&B project. Additionally, they contributed other valuable experience from practice. All questions in the semi-structured interview guideline were mainly directed on validity of the data suitability to the Sri Lankan Construction industry.

- **Stages of D&B project lifecycle**

There were different opinion of the stages of the D&B projects identified in the literature review by the expertise. The table 4.2 illustrated the literature findings and the interviewers comment.

Table 4.2: Stages of D&B project lifecycle

(RIBA) stages		Literature	Stages by interviewers									
			R1	R2	R3	R4	R5	R6	R7	R8	R9	
1	Appraisal stage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Design brief stage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	Concept design stage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	Design development stage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	Technical design stage	✓	✓	✓	✓	✓	✓	✓	✓	x	✓	✓
6	Pre-construction stage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	Construction stage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	Operation stage	✓	✓	✓	x	✓	x	✓	✓	✓	✓	✓

There were eight stages of D&B project lifecycle find from the literature. Except R3, R5 and R8, all other experts have accepted the eight stages as identified in the literature i.e. “Appraisal stage, Design brief stage, Concept design stage, Design development stage, Technical design stage, Pre construction stage, Construction stage, and Operation stage” Accordingly, they validated the D&B project lifecycle outline in literature is consistent with the Sri Lankan construction industry. Respondent R3 did not accepted the “use or operation stage” as a stage of a D&B project. R8 did not accept

that there was a “Technical design stage” as stage of a D&B project. R5 said that, “Use or operation stage” is not relevant to the stages of the D&B project lifecycle. Technical design stage was accepted by 8 respondents and “Use or operation stage” was agreed to by 7 respondents. The overall respondent rate is 95.83%, therefore, the research has considered all eight stages as related to lifecycle of the D&B projects.

- **The stakeholders related to D&B projects**

There are eleven stakeholders identified from the literature review related to D&B projects. The interviewees gave their opinion and many suggestions related to the stakeholder of the D&B projects as illustrated in the table 4.3.

Table 4.3: The stakeholders related to D&B projects

Stakeholders identified from Literature		Stakeholders by respondents								
		R1	R2	R3	R4	R5	R6	R7	R8	R9
1	Client	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Contractor	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	Consultants	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	Architect	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	Engineer	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	Project Manager	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	End users	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	Financial institution	✓	✓	✓	✓	✓	✓	✓	✓	✓
9	Insurance companies	✓	✓	x	✓	✓	✓	✓	✓	✓
10	Environmental groups	✓	✓	x	✓	✓	✓	✓	✓	✓
11	Public authorities	✓	✓	x	✓	x	✓	✓	✓	✓

The stakeholders identified in the literature are as follows: client contractor, consultant, architect, engineer, project manager, end users, financial institution, insurance companies, environmental groups and public authorities”. The experts validated and accepted that the client, the contractor and the consultant are the key stakeholders of the D&B projects as well as other eight stakeholders were also accepted and validated as stakeholders in D&B projects in Sri Lanka.

- **Role of stakeholders at each stage of the project lifecycle**

- **Appraisal stage**

There are eight related roles of stakeholders found out in the literature, discussed with the findings in the interviews as illustrated in table 4.4.

Table 4.4: Appraisal stage

Stakeholders role identified from Literature		Stakeholders roles by respondents								
		R1	R2	R3	R4	R5	R6	R7	R8	R9
1	Achieve client's consensus regarding the project objectives by the Architect	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Develop clear definitions of project scope	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	Expresses requirement clearly in project briefs	✓	x	✓	✓	✓	✓	✓	x	✓
4	Discussion of the requirements of the project	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	Initiation of the budgetary requirement	✓	✓	✓	✓	✓	✓	x	✓	x
6	Discussion of the special requirements	x	✓	✓	✓	✓	✓	✓	✓	✓
7	Develop feasibility study reports jointly with the relevant expertise	✓	✓	✓	✓	✓	✓	✓	x	x
8	Proposal of project execution plan & strategic brief	x	✓	✓	✓	✓	✓	x	✓	x

The 8 roles of stakeholder in the appraisal stage identified in the literature survey are as follows “Achieve clients consensus regarding the project objectives by the Architect, Developed clear definition of project scope, Eexpresses requirement clearly in project briefs, Discussion of the requirements of the project, initiation of the budgetary requirement, Discussion of the special requirements, Develop feasibility study reports jointly with the relevant expertise, Proposed project execution plan & strategic brief”. The respondent R1 validated six out of eight roles except roles six and eight. The R2 validated six out of eight roles except two and three. The R3, R4, R5, R6 were validated all eight roles as appraisal stage of D&B projects. R7 validated six roles out of eight except five and eight, R8 also validated six roles out of eight except three and seven, R9 validated five roles except five, seven and eight. The overall validation rate is 84.72%, and therefore, it has considered that eight roles have been validated by the respondents as roles of appraisal stage and applicability to Sri Lanka's construction industry.

➤ **Design brief stage**

The literature survey highlights three roles of stakeholders find and this was verified with the interviewees as illustrated in table 4.5.

Table 4.5: Design brief stage

Findings from Literature Survey		Stakeholders' roles by respondents								
		R1	R2	R3	R4	R5	R6	R7	R8	R9
1	Discussion of the client's ideas, hopes, and aspirations	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Discussion of the Designer requirements	✓	✓	✓	✓	✓	✓	x	x	✓
3	Discussion of the financial commitment of the project	x	✓	✓	✓	✓	✓	x	x	✓

The three roles identified in the literary survey for design brief stag are “*Discussion of the client's ideas, hopes, and aspirations, Discussion of the Designer requirements, and Discussion of the financial commitment of the project*”. All nine experts accepted and validated the role “*discussion of the client's ideas, hopes, and aspirations*” except R7 and R8, other respondent accepted the role “*discussion of the Designer requirements*”. Further R1, R7 and R8 did not validate the role “*discussion of the financial commitment of the project*”. However, other six respondents have validated this role as a part of the design brief stage and that it is relevant to Sri Lanka for D&B projects. The overall respondent approval rate is 81.48%.

➤ **Concept design stage**

There are four related roles of stakeholders as found from the literature survey were discussed with the respondent and the findings are illustrated in table 4.6.

Table 4.6: Concept design stage

Findings from Literature Survey		Stakeholders' roles by respondents								
		R1	R2	R3	R4	R5	R6	R7	R8	R9
1	Conversion of the design to graphic shape according to the client program	✓	✓	✓	✓	✓	✓	✓	x	✓
2	Multiple revisions done until reaching its objectives	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	Communication of the design proposal to the client including plans, elevations, sections, freehand sketches, and three- dimensional graphics	✓	✓	✓	✓	✓	✓	✓	✓	✓

Findings from Literature Survey		Stakeholders' roles by respondents								
		R1	R2	R3	R4	R5	R6	R7	R8	R9
4	Preparation of Employer's requirements	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	Preparation of schematic design studies showing the scale and relationship of the project components	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	Schematic design approval & addressed project requirements and cost	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	Revision of initial goals at the stage such as lifecycle cost, resource use, environmental architectural quality, indoor quality, and functionality	✓	✓	✓	✓	✓	✓	✓	✓	✓

The roles of stakeholders find from the literature for Concept design stage are ” *Conversion of the design to graphic shape according to the client program, Multiple revisions until reaching its objectives, Communication of the design proposal to the client including plans, elevations, sections, freehand sketches, and three- dimensional graphics, Preparation of Employer’s requirements, Preparation of schematic design studies showing the scale and relationship of the project components, Schematic design approval & addressed project requirements and cost, Revision of initial goals in this stage such as lifecycle cost, resource use, environmental architectural quality, indoor quality, and functionality*”. All respondent accepted and validated seven roles except R8 for role one “Conversion of the design to graphic shape according to the client program”.

➤ **Design development stage**

At the design development stage, there are six related roles as per the literature survey. They were discussed with the respondents and the findings are illustrated in Table 4.7

Table 4.7: Design development stage

Findings from the Literature Survey		Stakeholders roles by respondents								
		R1	R2	R3	R4	R5	R6	R7	R8	R9
1	Schematic design decisions worked out in greater detail	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Coordinated description of all aspects of the design including architectural, mechanical, and plumbing, electrical and fire protection	✓	✓	✓	✓	✓	✓	✓	✓	x
3	Value Engineering proposal	x	✓	✓	✓	✓	✓	x	✓	✓
4	Giving inputs to the architect	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	Deriving sustainability strategies by brainstorming	✓	✓	✓	✓	✓	✓	✓	x	x
6	Several revisions to achieve the client's needs	✓	✓	✓	✓	✓	✓	x	✓	✓

The design development stage is very important stage of the D&B projects. It is a turning point because of the one of the integrated procurement method is “ Design development which is a D&B process”, in this stage , roles of stakeholders find from the literature are “*Schematic design decisions worked out in greater detail, Coordinated description of all aspects of the design including architectural, mechanical, and plumbing, electrical and fire protection, value engineering proposal, giving inputs to the architect, deriving sustainability strategies by brainstorming, several revisions to achieve the client’s needs*“. All nine respondents accepted and validated the roles one and four, The roles two and six were accepted and validated by eight respondent except R9 for “*coordinated description of all aspects of the design including architectural, mechanical, and plumbing, electrical and fire protection*” and R8 for “*several revisions to achieve the client’s needs*”. The seven respondents were accepted and validated roles three and five, the role three was not accepted by R1 and R7 and also the role five was not accepted by R8 and R9. Although as per the Figure 4.7, the validation rate for all six roles is 88.89%. Therefore, the applicability of the state and its roles in D&B projects in the Sri Lanka’s construction industry has been fairly proven.

➤ **Technical design stage**

In the technical design stage, there are two relevant roles found in the literature survey and they were discussed with the respondents. The findings as illustrated in Table 4.8

Table 4.8: Technical design stage

Findings from the Literature Survey		Stakeholders' roles by respondents								
		R1	R2	R3	R4	R5	R6	R7	R8	R9
1	Preparation of the technical designs and specifications sufficient to co-ordinate components and elements of the project	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Preparation of all architectural, structural and building services information, specialist sub contractor's design and specifications	✓	✓	✓	✓	✓	✓	✓	✓	✓

Technical design stage is a very important stage of the D&B project, as this is the first tender stage of the pure D&B process. The roles of stakeholders of technical design stage are “ *preparation the technical designs and specifications sufficient to co-ordinate components and elements of the project, preparation of all architectural, structural and building services information, specialist sub contractor's design and specification*” these roles were *validated* by all experts as correct and applicable to D&B projects in Sri Lanka.

➤ **Pre-construction stage**

There are six relevant stakeholders roles found in the literature survey for the pre-construction stage. They are validated with the respondents and the findings are illustrated in Table 4.9,

Table 4.9: Pre-construction stage.

Findings from the Literature Survey		Stakeholders roles by respondents								
		R1	R2	R3	R4	R5	R6	R7	R8	R9
1	Appointment of the design build contractor to complete the design with sufficient details to fix the price of the project	x	✓	✓	✓	✓	✓	x	✓	x
2	Form a contract with a D&B contractor to complete the design documents and the construction work	✓	✓	✓	✓	✓	✓	✓	✓	✓

Findings from the Literature Survey		Stakeholders roles by respondents								
		R1	R2	R3	R4	R5	R6	R7	R8	R9
3	Preparation of contract documents including drawing, specification, detailed price proposal and the required building permits from the authorities	x	✓	✓	✓	✓	✓	✓	✓	✓
4	Shifting of utility services & supply with temporary connection	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	Approving agencies granting required approvals in time for smooth implementation of project as per the contract or program	✓	✓	✓	✓	✓	✓	✓	✓	✓

Pre –construction stage consist with tender documentation and tender action. The role of stakeholders in this stage “*Aappointment of the design build contractor to complete the design with sufficient details to fix the price of the project*”, “*Form a contract with a D&B contractor to complete the design documents and the construction work*”, “*preparing of contract documents including drawing, specification, detailed price proposal and the required building permits from the authorities*”, “*shifting of utility services & supply with temporary connection*”, “*granting required approvals in time for smooth implementation of project as per the contract or program*”, “*controlling road traffic at the project venue with minimum inconvenience to the general public with sufficient safety precautions*”. Except for roles one and three, all nine respondents validated other roles. Role three was validated by 8 experts except respondent R1. The role one was accepted by six respondents except R1, R7 and R9. According to the overall validation, the six roles have been accepted as stakeholders’ roles at the pre-construction stage of D&B projects and that they are applicable to Sri Lanka.

➤ **Construction stage**

In the construction stage, there are seven stakeholder roles as revealed from the literature survey. The findings from interviews are illustrated in Table 4.10.

Table 4.10: Construction stage

Findings from the Literature Survey		Stakeholders roles by respondents								
		R1	R2	R3	R4	R5	R6	R7	R8	R9
1	Overall coordination of D&B project	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Construction planning, scheduling and implementing construction work	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	Monitor the contractor's progress	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	Construction management, Monitoring and control	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	Material procurement, specialist subcontract work allocation and coordination	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	Cost control during the work	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	Testing and commissioning of the works	✓	✓	✓	✓	✓	✓	✓	✓	✓

The construction stage concerns with the mobilization and the construction to practical completion of the project. The roles of stakeholders as per the literature survey for the construction stage were as follows:- *“overall coordination of D&B project”*, *“construction planning, scheduling and implementing construction work”*, *“monitor the contractor's progress”*, *“construction management, monitoring and control”*, *“material procurement, specialist subcontract work allocation and coordination”*, *“cost control during the work”*, *“testing and commissioning of the works”* All experts have accepted and validated all of the above roles are applicable to Sri Lanka's construction industry.

Use or Operation stage

Use or operation stage has been identified with four stakeholders' roles in literature. Those are discussed along with interview findings as illustrated in Table 4.11.

Table 4.11 Use or Operation stage

Findings from the Literature Survey		Stakeholders roles by respondents								
		R1	R2	R3	R4	R5	R6	R7	R8	R9
1	Utilisation of the building	✓	✓	x	✓	✓	✓	✓	✓	✓

Findings from the Literature Survey		Stakeholders roles by respondents								
		R1	R2	R3	R4	R5	R6	R7	R8	R9
2	Planning of furniture and equipment procurement	✓	✓	x	✓	✓	✓	✓	✓	✓
3	Assisting building user during initial occupation period	✓	✓	x	✓	✓	✓	✓	✓	✓
4	Review of project performance in use	✓	✓	x	✓	✓	✓	✓	✓	✓

Operation stage is post practical completion stage. In this stage, roles of stakeholders are “*utilisation of the building, planning of furniture and equipment procurement, assisting building user during initial occupation period, review of project performance in use*”. All four roles were accepted and validated by eight respondents except R3. The response rate of each role is 88.89%, as such although the four roles related to D&B projects are validated as applicable to Sri Lanka’s construction industry.

- **Enablers and barriers in successful performance of roles of stakeholders.**

The literature finds many enablers and barriers to D&B projects. They are illustrated in Table 4.12.enablers and Table 4.13 barriers.

Table 4.12: Enablers in successful performance of roles of stakeholders

Enablers		Literature	Enablers by respondent								
			R1	R2	R3	R4	R5	R6	R7	R8	R9
1	Maintaining of the events closely with the client and the contractor	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Improve uncertainty of the D&B projects the means of stakeholders	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	Proper communication with all parties	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	Design to Finalization at the initial stage before the construction commence	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	Proper identification of Employer’s requirements	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	Develop a clear understanding of the project scope	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Enablers		Literature	Enablers by respondent								
			R1	R2	R3	R4	R5	R6	R7	R8	R9
7	Access contractor's proposal Thoroughly	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	Limit the change of Client requirement during construction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
9	Comprehensive pre-tender site investigation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10	Understand and commit to the achievement of the project objectives	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
11	Timely obtaining of approvals from government authorities	x	✓	✓	✓	✓	✓	✓	✓	✓	✓
12	Shifting of utilities and services in advance	x	✓	✓	✓	✓	✓	✓	✓	✓	✓
13	Proper interpretation of the contract clauses and design drawings	x	✓	✓	✓	✓	✓	✓	✓	✓	✓
14	Study the document and the designs at the pre-tender stage	x	✓	✓	✓	✓	✓	✓	✓	✓	✓
15	Select pre-qualified experience D&B contractor	x	✓	✓	✓	✓	✓	✓	✓	✓	✓

All nine experts validated the enablers found from the literature review. The interviewed experts clarified why these enablers important. Some of the enablers suggested by the respondent are state that in bold letters. According to their views, “*Maintaining of the events closely with the client and the contractor*”. The interviewees had to comment that it can minimize the discrepancies. About the enabler “*Improve uncertainty of the D&B projects the means of stakeholders*” experts further expressed that it help the proper performance of the project. Further “*Proper communication with all parties*” minimizes the discrepancies, according to the views of the experts. On the enabler, “*Design to finalization at the initial stage before the construction commences*” helps to minimize unnecessary delay and cost later. On the enabler, “*Proper identification of Employer’s requirements*” helps proper performance of the project. “*Developing a clear understanding of the project scope*” helps to minimize discrepancies between the stakeholders, and can reduce wasting

time and the money. Moreover, “*Access contractor’s proposal thoroughly*” can also minimize discrepancies. About the enabler “*Limit the change of Client requirements during construction*” experts commented that it is a tool to control the time and the quality of the work. To most of the respondent, “*Comprehensive pre tender site investigation*” can contribute to minimize unforeseen issues. Further, about “*Understand and commit to the achievement of the project objectives*” many of the experts said that it helps to proper implementation of the project. “*Timely obtaining of approvals from government authorities*” helps control the project time better. “*Shifting of utilities and services in advance*” some of the interviewees said that by taking early measures, unnecessary delays can be avoided. About “*Proper interpretation of the contract clauses and design drawings*”, most of the experts commented that it helps to continue the other stages of the project smoothly. “*Study the document and the designs at the pre-tender stage*” was an enabler most of the experts believed to help to mitigate the quarries at later stage. “*Select pre-qualified experience D&B contractor*” is an enabler that the respondents believed to minimize various issues related to the construction and helps to obtain better design and construction quality. Finally, they said that time, cost and quality are the success factors of the construction project.

Table 4.13: Barriers in successful performance of roles of stakeholders

Barriers		Literature	Barriers by respondents								
			R1	R2	R3	R4	R5	R6	R7	R8	R9
1	Time, cost and quality control is a vital problem in D&B projects	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Design changes by the client in D&B projects	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	Lack of communication between Client and design builders	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	Tendering burden	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	Rapidly changing market condition	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	Stream lining of bureaucracy	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	Involvement of the client	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	Single responsibility on the contractor	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
9	Ambiguous client’s brief and lack of communication of the client’s precise wishes is conveyed to the contractor in D&B project	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Barriers		Literature	Barriers by respondents								
			R1	R2	R3	R4	R5	R6	R7	R8	R9
10	Lack of management expertise at the construction stage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
11	Delay in obtaining donor concurrence	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12	Changing of scope during the construction period	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
13	In appropriate decision taken at the early stage of the project	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
14	Misinterpretation of client's requirements	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
15	Technical problems	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
16	Scarcity of construction material	x	✓	✓	✓	✓	✓	✓	✓	✓	✓
17	Impracticable programme and Planning of the project	x	✓	✓	✓	✓	✓	✓	✓	✓	✓
18	Errors in tender document	x	✓	✓	✓	✓	✓	✓	✓	✓	✓
19	Delay in design approval	x	✓	✓	✓	✓	✓	✓	✓	✓	✓
20	Lack of professionalism	x	✓	✓	✓	✓	✓	✓	✓	✓	✓

There are twenty barriers found from the literature review and the interviews they were validated by the all experts. Responding experts also commented on most of the identified barriers. Accordingly, “*time, cost and quality control*” is a problem in D&B projects, “*Design changes by the client in D&B projects*” cause failure of construction process and the project parameters. “*Lack of communication between Client and design builders*” increases problems for decision making. Apart from these, there are many other barriers that cause delay, loss, or inefficiency of the project, such as “*Tendering burden*”, “*Rapidly changing market condition*”, “*Stream lining of bureaucracy*”, “*Involvement of the client*”, “*Single responsibilities on the contractor*”, “*ambiguous client brief and lack of communication of the client’s precise wishes is conveyed to the contractor in D&B project*”, “*Lack of management expertise at the construction stage*”, “*Delay in obtaining donor concurrence*”, “*Changing of scope during the construction period*”, “*In appropriate decisions taken at the early stage of the project*”, “*Misinterpretation of client’s requirements*”, “*Technical problems*”. Some of the barriers suggested by the respondents are state that in bold letters. Those are “***Scarcity of construction material***”, “***Impracticable programme and planning of the project***”, “***Errors in the tender document***”, “***Delay in design approval***” and “***Lack of professionalism***”. The experts explained the causes and

suggested strategies to these barriers in ensure the successful implementation of D&B projects as illustrated in table 4.14.

Causes and strategies to mitigate the barriers.

Barriers were first identified from the literature review as listed in table 4.13, following the identification of those barriers, the table 4.14 below illustrates the causes and strategies to overcome the barriers identified through the interview process.

Table 4.14: Causes and strategies to overcome the barriers

	Causes		strategies
1	Natural disasters and unpredictable weather conditions prevailing in Sri Lanka	1	Closely monitor the weather pattern. Be vigilant with the NBRO reports on landslides risk areas.
2	Lack of team effort among the stakeholders	2	Improve and maintain good relationship among stakeholders to overcome problems. Proper communication and team works.
3	Time control in D&B contractor's Responsibility	3	Avoid changes. If a proper Employer's requirement is finalized it should not be a problem.
4	Lack of experience of the stakeholders on their task	4	Find expertise with sound experience.
5	Time, cost, and the quality concerns common to all types of projects	5	Should target on the end user and function of project.
6	Delay caused by architects	6	Coordinators to be appointed from both client's & contractor's sides.
7	Poor Estimated time on programmed work	7	Allocate practical time periods for each task.
8	No proper planning considering all possible things that can happen	8	Planning to be done considering past experience as well as a foreseeing the unexpected. Realistic time allocation for unforeseen.
9	Non availability of experts within the country	9	Arrangement to find overseas experts.
10	Inappropriate decisions taken at the early stages of the project. Improper understanding of project objectives by the parties	10	Accurate decisions with the involvement of experts in particular subject area. Clear definitions to be established on project objectives.
11	Weakness of employer's requirement as a result of failure of the feasibility study	11	Obtain experts' advice and maintain a continued research process until commencement of the project.
12	Unable to complete the finalized design with in estimated budget. Architect's failure on understanding of client's requirement	12	Should not change the Design once agreed. Prepare a workable and practical work program. Have several meetings with the client at different time periods during the

	Causes		strategies
			design development to get his feedback Integrated designs, especially services, should be finalized before the commencement of construction.
13	Price escalation. Dollar fluctuation, scarcity of material	13	Monitoring of the events closely by Client & Contractor.
14	Design changes as a result of short coming of the feasibility report and weakness of employer's requirements	14	Do proper feasibility study with the experts. With the advice of experts employers require to be prepared.
15	Lack of experience in D&B contractor	15	Pre-qualification to be considered.
16	Competition among the developer changes selling key points	16	Should have a good forecast on future market conditions. A feasibility should be done with economics expert.
17	Lack of team efforts among the stakeholders	17	To be arranged proper coordination.
18	Delay in approvals, clearance	18	Action on advice and smooth coordination
19	Delay in obtaining approvals, permits from relevant authorities	19	Maintaining close friendships / Coordination.
20	Delays in obtaining approvals, permissions from related authorities Improper security /insurance arrangement	20	Assign a separate team & allocate enough time for obtaining authority approvals. Establish proper security and insurance arrangement.
21	Difficulty to face independent decision by professionals	21	To minimize involvement & co-ordinate through Project Manager. Better to study the history of the client. Should analyze & aware about clients generate risk.
22	Lack of coordination meetings among parties	22	Frequent coordination meetings to be arranged and proper documentation / reporting process to be established among parties. An experienced person should be recruited to document the Employers requirements and this person should be cleared by the client.
23	Lack of awareness of the nature of D&B contract by the parties	23	Find correct expertise with sound knowledge.
24	Lack of coordination at the early stage of the preparation of client brief	24	An expert should be recruited overcome this situation. Use a questionnaire to verify client's awareness. Can use animations, 3D and joint to visits similar completed sites.
25	Lack of expertise of D&B contractors to manage professionals	25	Offering reasonable remuneration can prevent migration of experts.
26	Un availability of experts in particular special area or the field	26	Option for foreign consultation.

	Causes		strategies
27	Poor treatment methods followed by the management. Low remuneration packages with in the organization	27	Employee satisfaction to be prioritized.
28	The expert are lack sufficient experience in the D&B method	28	Offer high salaries to recruit qualified persons. Select an experienced consultant.
29	Skilled/Unskilled labour shortage at the market	29	Try to obtain labours from oversees.

The above table 4.14 shows the causes for barriers and strategies to overcom them for successful performance of the role of stakeholders. The respondents have outlined many causes for barriers as discovered in the literature review. Those details were in cooperated in to the preparation of the questionnaire.

4.3. Questionnaire Survey

The questionnaire was prepared based on the findings from the literature review and the interviews with help of the experts interview findings. The questionnaire survey was conducted among professionals who were, engineers, quantity surveyors, architects engaged with the D&B related projects. The survey was posed questions to witch, answers were ranked using a five point scale, were five (5) meant ‘highly significant’ and one (1) meant ‘not significant’.

Ranking was done for the significant roles of stakeholders at each stage of the D&B project lifecycle, and it ranked the significant of enablers and barriers for successful performance of roles of stakeholders. It also ranked the significance of causes for barriers. Further, when solutions to the barriers were identified. The questionnaire allowed them to be ranked as per the experience or belief of the respondents.

4.3.1 Objective of Questionnaire Survey

The questionnaire survey was designed to achieve a few objectives, these objectives were: - to find out the highly significant roles of stakeholders in each stage of the D&B building projects in Sri Lanka, to find out the significant enables and barriers, to find out causes for barriers, to find out solutions to mitigate the barriers. Finally, the objectives aimed at contributing to the development of a frame-work for successful implementation of D&B building projects in Sri Lanka.

4.3.2 Respondent details

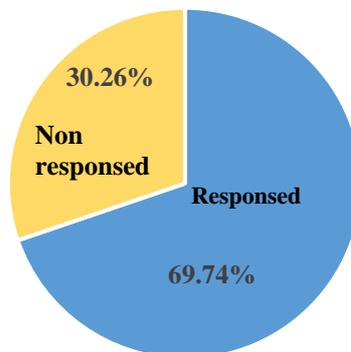
The questionnaire was distributed among 76 professionals in the construction industry experienced in the D&B projects and the personals who adhere to integrated procurement system. The table 4.16 illustrates their professional categories, work experience and response rate.

Table 4.15 Respondent details

Experience in years	Engineers	Quantity Surveyors.	Architects	Questionnaire Distributed	Answers Received	Response rate.
6-10	4	1	1	10	6	60%
11-15	6	3	6	18	15	83.33%
16-20	8	3	1	20	12	60%
21-25	7	6	2	20	15	75%
26 & above	1	3	1	8	5	62.5%
Total	26	16	11	76	53	69.74%

As the table above suggests the 6 respondents with 6-10 years' experience had a response rate 60%, 15 respondents with 11-15 years' experience had a response rate 83.33%. Among those 12 respondents with 16-20 years' experience, the response rate was 60% and the 15 respondents who have 21-25 years' experience showed a response rate of 75%. Finally and 5 respondents who had over 26 years' experience showed the least response rate of 62.50%.

Figure 4.1 : Response Rate of Questionnaire Survey

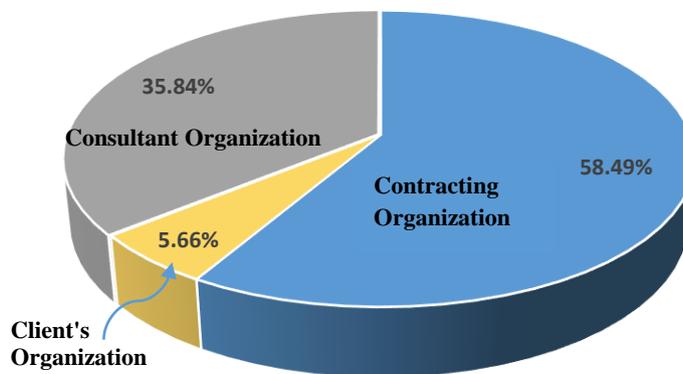


Thus 53 professionals have responded and 23 practitioners have not responded to the survey. Those who contributed to the survey by responding the questionnaire were engineers, quantity surveyors and architects working for client, contractor and consultant organizations in the Sri Lanka's construction industry. The reasons for not responding included, lack of awareness about the research area, time restraints professional background.

- **Type of Organization and professional background of the respondent**

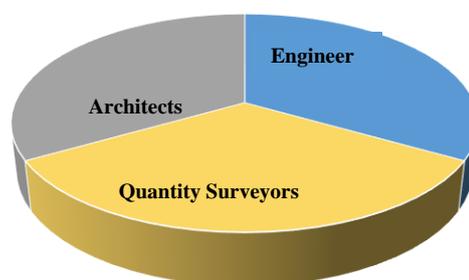
Type of organization of respondents are shown in the Figure 4.2

Figure 4.2 Type of Respondent's Employment



As illustrated in figure 4.2 among all respondents who contributed, 5.66% work at Client's organizations, 58.49% of the respondents worked at Contractor's organizations and 35.84% of the respondents were employed at consultant organizations.

Figure 4.3 Respondent's professional background



4.3.3 Analysis of the outcome of the Questionnaire Survey

Data collected through questionnaire survey was analyzed by applying descriptive statistics tools. Spread of scores (1-5) given by respondents for each stakeholder was measured with weighted mean value. Weighted mean is a statistical method which calculates the average by multiplying the weights with its individual value and taking its sum divided by the sample size.

4.4 Significant role of each stakeholder at each stage of D&B project lifecycle

4.4.1 Appraisal stage

Data collection covered the three key stakeholder roles, i.e. Client, D&B Contractor and Consultant (Engineer to the Contract). The results of the analysis of the appraisal stage is illustrated in Table 4.16.

Table 4.16 Appraisal stage

Role of Stakeholder		Client		Consultant		Contractor	
		WM	Rank	WM	Rank	WM	Rank
1	Achieve client's consensus regarding the project objectives by the Architect	4.754	1	4.471	2	2.679	4
2	Expresses requirements clearly in project briefs	4.754	1	4.245	6	2.622	6
3	Discussion of the requirements of the project	4.735	3	4.547	1	2.849	1
4	Initiation of the budgetary requirement.	4.716	4	4.056	8	2.849	1
5	Develop clear definitions of project scope	4.641	5	4.264	5	2.490	6
6	Develop feasibility study reports jointly with the relevant expertise	4.641	5	4.396	4	2.320	8
7	Discussion of the special requirements	4.603	7	4.471	2	2.773	3
8	Proposal of project execution plan & strategic brief	4.169	8	4.226	7	2.679	4

Accordingly, findings from the questionnaire were analyzed using weighted mean rating value and ranked the results in order. It was noticed that when the Client gives a higher rank to a stakeholder role, had affected to the contractor and consultant to a lesser degree, hereby assigning a lower rank. The role, "Achieve *client's consensus regarding the project objectives by the Architect.*" For instant, is highly significant to the Client and the Consultant than the Contractor, as reflected in the significance rank

each have given to the role. The role “*expresses requirement clearly in project briefs*” is also highly significant to the Client and, to a slightly lesser degree, to the Consultant. However, it is less significant to the Contractor. Client’s role is the most significant stakeholder’s role at this stage. The Consultant and the Contractor obtained rank 2 and 4 respectively for the role one, but they gave rank 6 for the second role. When the Contractor and Consultant obtain higher ranks for the role “*discussion of the requirements of the project.*” the Client obtained a lesser ranks. It shows that the Contractor and Consultant attribute higher significance to the role. The role “*initiation of the budgetary requirement*” is highly significant to the Contractor, and moderately significant to the Consultant than the Client. The role “*develop clear definitions of project scope*” is, similarly, more significant to the Client and the Consultant than the Contractor. The role “*develop feasibility study reports jointly with the relevant expertise*” is highly significant for the Consultant more significant to the Client than the Contractor. This role” *discussion of special requirements*” is highly significant to the Consultant and the Contractor than the Client. This role “*proposal of project execution plan & strategic brief*” is most important to the Contractor and the more significance to the Consultant than the Client. Finally, the significance each stakeholder attaches to various roles shows how synergy among main stakeholders is critical in the proper performance of the project.

4.4.2 Design Brief stage

The relevant roles of the three key stakeholders at this stage were analyzed using the weighted mean value, and the results are shown in table 4.17 below.

Table 4.17 Design Brief stage

Role of Stakeholder		Client		Consultant		Contractor	
		WM	Rank	WM	Rank	WM	Rank
1	Discussion of the financial commitment of the project	4.622	1	4.415	3	3.056	1
2	Discussion of the client’s ideas, hopes, and aspirations	4.528	2	4.509	2	2.716	3
3	Discussion of the designer requirements	4.169	3	4.566	1	3.018	2

The three roles were ranked under three main stakeholders. In order to client's roles ranked, against same roles contractors and consultant's ranked. Accordingly role "*discussion of the financial commitment of the project*" is the most significant role for Client and Contractor, but to the Consultant, that role is of lesser significant than to the other two stakeholders. The role "*discussion of the client's ideas, hopes, and aspirations.*" is more significant to the Client and the Consultant than the Contractor. Same as the above two roles "*discussion of the Designer requirements*" has obtained a lower rank in terms of its significance to the Client. But the same role is of higher significance to the Contractor as implied by the higher rank accorded to it. It is worth taking in to consideration than in D&B projects, it is the contractor who pays the role of the designer as opposed to many other models. Therefore, the Contractor has a large responsibility about the design. Similarly, the Consultant also considers the design, a high priority given his role as the reviewer for the design. The different scales of significance each stakeholder gives to various roles accentuates and reinforces the objective of this research. It also helps to identify the significance of the role of each stakeholder at various stages of the D&B projects.

4.4.3 Concept Design Stage

As per the expert validation and the findings from the literature review there are four stakeholders roles, analyzed under the 'concept design stage'. These roles are ranked accordingly, and the results of the analysis are illustrated in Table 4.18 below.

Table 4.18 Concept Design stage

Role of Stakeholder		Client		Consultant		Contractor	
		WM	Rank	WM	Rank	WM	Rank
1	Several revisions until achieving its objectives	4.490	1	4.471	1	2.735	7
2	Schematic design approval & addressed project requirements and cost	4.490	1	4.433	4	3.433	2
3	Communication of the design proposal to the client including plans, elevations, sections, freehand sketches, and three- dimensional graphics	4.471	3	4.377	5	3.075	4
4	Revision of initial goals at this stage such as lifecycle cost, resource use,	4.396	4	4.471	1	3.452	1

Role of Stakeholder		Client		Consultant		Contractor	
		WM	Rank	WM	Rank	WM	Rank
	environmental architectural quality, indoor quality, and functionality						
5	Preparation of schematic design studies depicting the scale and interrelationship of the project components	4.358	5	4.471	1	3.094	3
6	Preparation of Employer's requirements	4.320	6	4.320	6	2.867	5
7	Convert the design to graphic shape according to the client program	4.188	7	4.188	7	2.811	6

The role “*several revisions until achieving its objectives*” has received the highest rank from the Client and the Consultant. Understandably, it is the most significant role for the Client and the Consultant. The contractor obtained the lowest rank for this role and it is less significant to him. The role “*schematic design approval & addressed project requirements and cost*” is highly significant to the Client and is of more significance to the Contractor than the Consultant. The role “*communication of the design proposal to the client Including plans, elevations, sections, freehand sketches, and three-dimensional graphics*” has received the highest rank to the client slightly lesser rank to the Contractor because D&B projects design part is the responsibility of the Contractor. Similarly, the roles “*revision of initial goals at this stage such as lifecycle cost, Resource use, environmental architectural quality, Indoor quality, and functionality*” are important to the Contractor and the Consultant but the Client obtained lower rank. In the role “*preparation of schematic design studies depicting the scale and relationship of the project components*” the consultant obtained a higher rank which is highly significant than the Contractor and the Client, who obtained a lower rank. The role “*Preparation of Employer's requirements*” is one of the most significant roles to the client as well as the other two key stakeholders. The contract is based on the Employer's requirements. Moreover, the role “*Convert the design to graphic shape according to the client program*”. Is the role obtained lowest rank under the analysis and but, relatively more significant to the Contractor and other stakeholders rendered a lesser significance than Contractor. The above analysis illustrates how various roles under the ‘concept design stage’ are related to each of the key stakeholders. Thereby, this analysis contributes to the objective of the research by

way of highlighting different aspects of project stages and perspectives of key stakeholders.

4.4.4 Design Development Stage

There are six roles of stakeholders validated by experts against the findings of literary survey analyzed using weighted mean value and the result are illustrated in table 4.19 below.

Table 4.19 Design Development Stage

Role of Stakeholder		Client		Consultant		Contractor	
		MW	Rank	MW	Rank	MW	Rank
1	Several revisions to achieve the client's needs	4.320	1	4.339	1	3.867	6
2	Giving inputs to the architect	4.226	2	4.113	5	4.245	5
3	Deriving sustainability strategies by brainstorming	4.169	3	4.169	3	4.339	2
4	Schematic design decisions worked out in greater detail	4.075	4	4.207	3	4.603	1
5	Value Engineering proposal	4.037	5	4.075	6	4.339	2
6	Coordinated description of all aspects of the design including architectural, mechanical, and plumbing, electrical and fire protection	3.754	6	4.339	1	4.339	2

Design development stage is one of the changing points of a single stage tender design build project. This is one of the most critical stages in the project lifecycle of D&B project.

The role “*several revisions to achieve the client's needs*” is the most significant to the Client and the Consultant as seen in the analysis. As such the highest rank is also obtained by them. The lowest rank is obtained by the Contractor. According to the ranking of role “*Giving inputs to the architect*” it is most significant to the Client as per the result of the analysis. Besides, the role is similar, significant to the Consultant and to the Contractor. Furthermore, the role “*deriving sustainability strategies by brainstorming*” is most significant to the Contractor than Client and the Consultant. The fourth role, “*Schematic design decisions worked out in greater detail*” is most significant to the Contractor than the Consultant, and it is much lower in significance to the Client. Moreover, the fifth role “*Value Engineering proposal*” is most

significant to the Contractor, than the other two stakeholders. The last role “*Coordinated description of all aspects of the design including architectural, mechanical, and plumbing, electrical and fire protection*” is most significant to the Consultant than the contractor, but lowest significant to the Client. The results of the analysis illustrated the requirement of the stakeholder’s role for the successful performance of the D&B project.

4.4.5 Technical Design Stage

There are two stakeholders’ roles validated by the experts the literature review. The results of the analysis illustrated in the table 4.20.

Table 4.20 Technical Design Stage

Role of Stakeholder		Client		Consultant		Contractor	
		MW	Rank	MW	Rank	MW	Rank
1	Preparation of all architectural, structural and building services information, specialist sub contractor’s design and specification	3.320	1	4.113	2	4.792	1
2	Preparation of the technical designs and specifications sufficient to co-ordinate components and element of the project	3.207	2	4.207	1	4.773	2

The first role at this stage is “*Preparation of all architectural, structural and building services information, specialist sub contractor’s design and specification in this stage*”. According to the ranking of the results of the analysis. It is most significant to the Client and the Contractor, but less significant to the Consultant. The second role “*preparation of the technical designs and specifications sufficient to co-ordinate components and element of the projects*” most significant to the Consultant than the Contractor or the Client. The analysis shows that the same role is of varying significance to each stakeholder, i.e. the Contractor, the Client, and the consultant. It also proves that the roles of stakeholders are very important to the successful implementation of the D&B projects.

4.4.6 Pre-Construction Stage

At the Pre-Construction stage, there are six roles of stakeholders validated by the experts. These six roles have been analyzed using weighted mean value and the results are illustrated in table 4.21 below.

Table 4.21: Pre Construction Stage

Role of Stakeholder		Client		Consultant		Contractor	
		WM	Rank	WM	Rank	WM	Rank
1	Appointment of the design build contractor to complete the design with sufficient details to fix the price of the project	4.358	1	4.358	3	4.622	3
2	Form the contract with D&B Contractor to complete the design documents and the construction work	4.132	2	4.490	2	4.641	2
3	Granting required approvals in time for smooth implementation of the project as per the contract or program	3.830	3	4.000	4	4.490	4
4	Shifting of utility services & supply with temporary connection	3.509	4	3.509	5	4.415	5
5	Preparation of contract documents including Drawing, Specification, detail price proposal and the required building permits from the authorities	3.415	5	4.716	1	4.754	1
6	Controlling road traffic with the optimum inconvenience to the general public with sufficient safety precautions	3.169	6	3.113	6	4.377	6

According to the analysis of the ranking in table 4.21 the most significant role for the Client is “*appointment of the design build contractor to complete the design with sufficient details to fix the price of the project*”. However, from the side of the Contractor and the Consultant, it is a, less significant role.

The role, “*Form the contract with D&B Contractor to complete the design documents and the construction work*” is of similar high priority to all three stakeholders. In terms of the role “*Granting required approvals in time for smooth implementation of the project as per the contract or program*” the Client finds it more significant than the other two stakeholders. The contractor and the Consultant obtained similar significant rank to the same role. Moreover, the role “*Shifting of utility services & supply with temporary connection*” was rendered more significant to the Client, while and the other two stakeholders obtained similar significance levels lower than the Client.

The role “*Preparation of contract documents including drawing, specification, detail price proposal and the required building permits from the authorities*” is the most

significant role to the Contractor and to the consultant. However, the Client obtained a lesser rank for the same role. The sixth role is “controlling road traffic with the optimum inconvenience to the general public with sufficient safety precautions” As the results show it has obtained equally lesser significance levels rank by all three stakeholders.

4.4.7 Construction Stage

There are six roles in construction stage as found from the literature and they were verified by expert interview. Later, the same roles were analyzed with help of weighted mean value and the results are shown at the table 4.22 below.

Table 4.22: Construction Stage

Role of Stakeholder		Client		Consultant		Contractor	
		WM	Rank	WM	Rank	WM	Rank
1	Monitor the contractor’s progress	3.886	1	4.849	1	4.754	3
2	Testing and commissioning of the works	3.566	2	4.528	2	4.754	3
3	Construction planning, scheduling and implementing construction work.	3.113	3	3.735	4	4.849	1
4	Overall coordination of the D&B project	3.056	4	3.773	3	4.849	1
5	Construction management, Monitoring and control	3.018	5	3.679	5	4.754	3
6	Material procurement, specialist subcontract work allocation and coordination	2.962	6	3.603	6	4.754	3
7	Cost control during the construction period	2.905	7	3.132	7	4.735	7

According to the above analysis, the role “*monitor the contractor’s progress*”, is more significant to the Client and the Consultant than the Contractor. The role, “*Testing and commissioning of the works*” is equally significant to the Client and the Consultant than the Contractor. Furthermore, role “*Construction planning, scheduling and implementing construction work*” is proven to be a role that is most significant to the Contractor. The Client fined the role more significant than the Consultant. Moreover, the role “*overall coordination of D&B project*” is most significant to the Contractor. It is more significant to the Consultant than the Client, who scores the lowest rank. The role “*Construction management, Monitoring and control*”, is most significant to

the Contractor, and it's of similar significance to the both other stakeholders. In addition that the role "*Material procurement, Specialist subcontract work allocation and coordination*" is a role to which the Contractor renders the most significance. The other two stakeholders, namely, the Contractor and the Client show similar significance to it. The role "*Cost control during the work*" is similar significance to the Contractor and both other stakeholders.

4.4.8 Use or Operation stage

There are four stakeholder role validated by the experts. Subsequently, they were analyzed based on the mean value and ranked accordingly as illustrated at table 4.23.

Table 4.23: Operation stage

Role of Stakeholder		Client		Consultant		Contractor	
		WM	Rank	WM	Rank	WM	Rank
1	Assisting building user during initial occupation period	4.698	1	3.264	4	2.754	4
2	Review of project performance in use	4.660	2	3.528	2	3.150	2
3	Planning of furniture and equipment procurement	4.641	3	3.886	1	2.924	3
4	Utilisation of the building	4.622	4	3.471	3	3.377	1

In terms of the analysis, the role "*Assisting building user during initial occupation period*" is most significant to the Client, while the other two stakeholders have obtained equal significance below that of the Client. Moreover, the role "*review of project performance in use*" is equally significant to all three stakeholders. The third role "*planning of furniture and equipment procurement*", Is the most significant to the Consultant, while the other two stakeholders obtained equal but lower significance levels. Furthermore, "*utilisation of the building.*" is most significant to the contractor's role, then the consultant role and the Client. The above analysis shows that the roles of each stakeholder in the project lifecycle is critical for the project to be successfully implementation under the D&B method in Sri Lanka.

4.5 Significance of enablers for successful performance of roles of stakeholders

The enablers found from the literature survey were validated by the experts and the then subjected to the following analysis using weighted mean value. The results are illustrated in table 4.24 below.

Table 4.24: Significance of enablers for successful performance of roles of stakeholders

Significance enablers		Client		Consultant		Contractor	
		WM	Rank	WM	Rank	WM	Rank
1	Proper initiation of Employer's requirements	4.150	1	3.830	6	4.716	2
2	Timely obtaining of approvals from Government authorities	4.113	2	4.150	1	4.603	4
3	Select a pre-qualified and experienced D&B contractor	4.018	3	3.663	7	4.641	3
4	In advance shifting of utilities & services	4.000	4	3.610	9	4.018	11
5	Comprehensive pre-tender site investigation	3.981	5	3.981	5	4.603	4
6	Access Contractor's proposal thoroughly	3.679	6	4.113	3	4.000	14
7	Proper interpretation of the contract clauses & design drawings	3.528	7	4.132	2	4.735	1
8	Design finalization at the initial stage before the construction commences	3.425	8	3.622	7	4.603	4
9	Study the document and the design at the pre-tender stage	3.321	9	3.452	11	4.132	9
10	Understand and commit to the achievement of the project objectives	3.312	10	4.018	4	4.150	8
11	Improve uncertainty of the D&B projects with means of stakeholders	3.312	10	3.201	15	4.018	11
12	Proper communication among all parties	3.226	12	3.321	12	4.000	14
13	Develop a clear understanding of the project scope	3.201	13	3.226	14	4.018	11
14	Limit the change of Client requirements during the construction period	3.118	14	3.268	13	4.113	10
15	Maintaining of the events closely with the Client, Consultant and the Contractor	2.981	15	3.568	10	4.320	7

“Proper initiation of Employer's requirement.” Is a highly significant enabler for the Client but most significant to the Contractor, and relatively less significant to the

Consultant. This is obvious because the Employer's requirement is the base of the D&B contract.

The "*Timely obtaining approvals from Government authorities.*" is highly significant enabler for the Client as per the results of the analysis. Consultant role is more significant than the Contractor's role. "*Select pre-qualified experience D&B contractor*" is an equally significant enabler to the Client and the Contractor than the Consultant. Moreover, the enabler "*In advance shifting of utilities & services*" is more significant to the Client and of similar significance to the Contractor and Consultant. Further, "*Comprehensive pre tender site investigation*" is an enabler that is highly significant to the Contractor and of similar significance to the Client and the Consultant. Moreover, the enabler "*Access Contractor's proposal thoroughly*" is most significant to the Consultant than the Client but less significant to the Contractor. "*Proper interpretation of the contract clauses & design drawings*" is mostly significant to the Contractor and, the Consultant than to the Client". *Design finalization at the initial stage before the construction commence*" is an enabler that is most significant to the Contractor. It is less significant to the consultant and of lowest significance to the Client. "*Study the document and the design at the pre tender stage*" is highly significant to the Contractor and to the Client than the Consultant. The enabler "*Understand and commit to the achievement of the project objectives*" is a highly significant enabler to the Consultant than the Contractor, and even less significant to the Client. "*Improve uncertainty of the D&B projects with means of stakeholders*", is an enabler that is highly significance to the Contractor and most significance to the Client than the consultant. Further, "*Proper communication of all parties*" has been identified as highly significant to the Contractor, the Client and the Consultant. "*Develop a clear understanding of the project scope*" is most significant to the Contractor and more significant to the Client than the Consultant. "*Limit the change of Client requirements during the construction period*" is highly significant to the Contractor and more significant to the Consultant than the Client. "*Maintaining of the events closely with the Client, Consultant and the Contractor*" is highly significant to the Contractor, and most significant to the Consultant than the Client. Finally, it is identified that the significance of enablers to various stakeholder's role is critical to the proper and successful performance of the project.

4.6 Significance of barriers in the successful performance of roles of stakeholder

There are some barriers that were identified from the literature review and the interviews. These findings were further investigated using a questionnaire and the results were analyzed using weighted mean rating value and ranked accordingly. The results are illustrated in the table 4.25 below.

Table 4.25: Significant of barriers in successful performance of stakeholders' roles.

Significant barriers		Client		Consultant		Contractor	
		WM	Rank	WM	Rank	WM	Rank
1	Lack of communication between the Client and the design builders	4.584	1	4.113	3	4.716	4
2	Design changes by the client in D&B projects	4.566	2	4.113	3	4.735	2
3	Unnecessary involvement of the client	4.358	3	3.981	7	4.641	7
4	Ambiguous client brief and lack of communication of the client's precise wishes	4.245	4	3.867	9	4.471	8
5	Changing of the scope during the construction period	4.245	4	3.226	15	4.245	15
6	Rapidly changing market condition	4.169	6	4.037	5	4.660	5
7	Inappropriate decisions taken at the early stage of the project	4.132	7	3.075	18	3.928	20
8	Time, cost and quality control	4.094	8	4.169	2	4.735	2
9	Delay in design approval	4.075	9	4.283	1	4.849	1
10	Errors in the tender document	3.981	10	3.207	16	4.094	16
11	Misinterpretation of client's requirements	3.943	11	3.566	11	4.396	12
12	Stream lining of bureaucracy	3.886	12	4.018	6	4.660	5
13	Delay in obtaining donor concurrence	3.867	13	3.452	14	4.264	14
14	Impracticable programming and planning of the project	3.792	14	3.150	17	4.075	17
15	Lack of management expertise	3.584	15	3.584	10	4.433	10
16	Single responsibility on contractor	3.471	16	3.981	7	4.471	8
17	Tendering burden	3.471	17	3.566	11	4.433	10
18	Scarcity of construction material	3.358	18	3.547	13	4.339	13
19	Lack of professionalism	3.226	19	3.018	19	4.075	17
20	Technical problems	3.150	20	2.924	20	4.075	17

The above table helps understand some important connections and relations among roles and key stakeholders as well as among stakeholders themselves. The barrier *“Lack of communication between the Client and the design builders”* is most significant to the Client as a stakeholder. Further, it is more significant to the Consultant than the Contractor. The second barrier, *“Design changes by the client in D&B projects”* that disturbs the construction process, is most significant to the Client, and the Contractor but lesser significant to the consultant while, the Client and the Contractor obtained similar significance but lesser than the Client. Further *“unnecessary Involvement of Client”* is a barrier that is most significant to the Client. It is similar significant to the Consultant and the contractor.

The barrier *“ambiguous client’s brief and lack of communication of the Client’s precise wishes”*, is a barrier that is most significant to the Client, and more significant to the Consultant than the Contractor. Furthermore, *“changing of the scope”* is most significant to the Client. To the Consultant, it is less significant than to the Client. *“Rapid changing market condition”* is of similar significance to the Contractor and the Client.

The barrier *“Inappropriate decision taken at the early stage of the project”* is most significant barrier to the Client and as per the result of the analysis and the effect of this barrier is less significant to the Contractor than to the Consultant. The next barrier discuss was *“The time, cost and quality control is a vital problem in D&B projects”* the Contractor and Consultant are the most significant role players in this regard. It is, less significant to the Client. This role, *“Delay in design approval”* is highly significant to the Contractor and the Consultant than the Client.

Moreover, the barrier *“Errors in tender document”* is significant to the Client more than the Contractor and the Consultant. *“Misinterpretation of the Client’s requirements”* is more significant barrier to the Consultant than the Client or the Contractor. *“Stream line of bureaucracy”* is most significant barrier for Contractor then Consultant and lesser significant for the Client.

Another important barrier is “*Delay in obtaining donor concurrence*” and this barrier is more significant to the Consultant than the Client but even less significant to the Contractor’s role. Furthermore, the barrier “*Impracticable programme and planning of the project*” is more significant for Client’s than the Contractor and the Consultant’s role. Further, “*Lack of management expertise*” is most significant, but, more significant to the Contractor and the Consultant than the Client. Moreover, the barrier “*Single responsibility on contractor*” is a significant barrier to the Contractor while the Consultant and the Client are little affected by it. The barrier, “*Tendering burden*” is more significant to the Consultant and the Contractor than the Client. However, “*Scarcity of construction material*” is a barrier to all stakeholders alike. The barrier “*Loss of professionalism*” is highly significant to the Contractor. And it is less significant to the Client. “*Technical problems*” is also highly significant barrier to the Contractor than the Consultant, and it is even less significant to the Client. To overcome these barriers the respondents have suggested some causes and solutions which also were analysed in the present study.

4.7 Significant causes of barriers in the successful performance of stakeholder roles

The reasons enumerated from the interviews for barriers were, further tested in the questionnaire survey. The respondent were analyzed using weighted mean rating value and ranked as illustrated in Figure 4.26

Table 4.26 Significance causes of barriers in the successful performance of stakeholders roles

Significant causes for barriers		Client		Consultant		Contractor	
		WM	Rank	WM	Rank	WM	Rank
1	Design changes as a result of short coming of the feasibility report and weaknesses of employer’s requirements	4.452	1	4.018	3	4.226	9
2	Lack of team efforts among the stakeholders	4.377	2	4.415	1	4.490	5
3	Delays in obtaining approvals, permits from relevant authorities	4.301	3	3.471	7	4.415	6
4	Lack of awareness of the nature of D&B contract by the parties	4.226	4	3.962	5	4.584	4

Significant causes for barriers		Client		Consultant		Contractor	
		WM	Rank	WM	Rank	WM	Rank
5	Exceptional event or circumstance (Force Majeure)	4.207	5	3.377	8	4.358	7
6	Lack of experience in D& B contractors	4.169	6	4.000	4	4.754	2
7	Lack of expertise of D&B contractors to manage professionals	3.962	7	4.094	2	4.622	3
8	Non availability of experts within the country	3.830	8	3.792	6	4.339	8
9	Skilled / unskilled labour shortage at the market	3.528	9	3.245	9	4.811	1

From the analysis of the causes of barriers, some important relations were revealed “*Design changes may happen as a result of short coming of the feasibility report and weakness of employer’s requirements*” is a cause that is most significant to the Client than the Consultant, and it is less significant to the Contractor. “*Lack of team effort among the stakeholders*” is most significant to the Consultant’s role. However it is more significant to the Client than to the Contractor’s role. With regard to the role “*Delays in obtaining approvals, permits from relevant authorities*” most significant role player is the Client, while it is more significant to the Contractor than the Consultant. The cause for barrier “*Lack of awareness of the nature of D&B contract by the parties*” is most equally significant to the Client and the Contractor than the Consultant.

In terms of the cause of barrier “*Exceptional event or circumstance (Force Majeure)*” the most significant role player is Client while the Contractor’s role has some significant relation with it, the Consultant role comes last in significance. Another barrier that was tested “*Lack of experience in D&B contractors*”. The Contractor is the stakeholder, to whom it is of highest significance. With regards to the cause of barrier, the Consultant has more significant a role than the Client. Next cause of barrier to be analyzed was “*Lack of expertise of D&B contractors to manage the professionals*”. It has a highly significance to the Consultant. The Contractor’s role is more significant than the Client’s role. With regard to the “*Non availability of experts within the country*” the most significant role player is the Consultant than the Contractor role and the Client. Last cause of barrier is “*Skilled / unskilled labour shortage at the market*” it is highly significant to the role of the D&B Contractor. The Client’s role and the Consultant’s role have little significance to it.

4.8 Significance of strategies to overcome the barriers for successful performance of stakeholder roles

In accordance with the suggestion made by the respondents of this survey, many strategies were obtained to overcome the barriers, which were tested using the questionnaire. The outcome were ranked as per the descriptive statistics as illustrated in the table 4.27

Table 4.27 Significance of strategies to overcome the barriers for successful performance of stakeholders' roles

Significant strategies to overcome the barriers		Client		Consultant		Contractor	
		WM	Rank	WM	Rank	WM	Rank
1	Avoid Design changes at the construction stage to control the time	4.566	1	4.358	3	4.528	5
2	Improve and maintain good relationship among stakeholders to overcome the problem within the parties	4.528	2	4.358	3	4.566	4
3	Regular meeting to be conducted with proper scheduling	4.132	3	4.415	2	4.735	1
4	Frequent coordination meetings to be arranged and proper documentation / reporting process to be established among parties	4.075	4	4.603	1	4.716	3
5	Obtain experts' advice and continues research process to control the Time, Cost and Quality of the project	4.037	5	4.283	6	4.471	8
6	Contract documents to be made sound & user friendly, and identify the risks at pre-tender stage	3.943	6	4.320	5	4.528	5
7	Offer reasonable remuneration packages for mitigate the leaving of experts	3.867	7	3.849	9	4.358	10
8	Implement cost control systems and proper planning throughout the system	3.679	8	3.924	6	4.735	1
9	Need to monitor weather pattern.	3.603	9	3.679	10	4.528	5
10	Select a team with past experience in similar projects	3.528	10	3.566	11	4.018	12
11	Proper procurement plan to be scheduled	3.113	11	3.266	12	4.471	8
12	Booking material in advance	3.056	12	3.924	6	4.358	10

Important findings were made in the above analysis. *“Avoid Design changes at the construction stage to control the time”* is a strategy that is highly significant to the

Client to mitigate the barriers. It is, more significant to the Consultant's than the Contractor. Further, *improve and maintain good relationship among stakeholders to overcome the problem within the parties* is a highly significant solution to the Client. While it is of slightly, but important significance both Contractor and the Consultant roles. The next strategy, *Regular meeting to be conducted with proper scheduling* is highly significant to the Contractor, while it is more significant to the Consultant than the Client.

The third strategy *Frequent coordination meetings to be arranged and proper documentation/reporting process to be established among parties* is a highly significant strategy to the Consultant to mitigate the barriers, and it is more significant to the Contractor than the Client. *Obtain experts' advice and continues research process to control the Time, Cost and Quality of the project* is a strategy that is of equal significance to the three stakeholders.

The suggested strategy, *Contract documents shall be sound & user friendly, identify the risk at pre-tender stage* is of equal significance to the Contractor and the Consultant, but it is of less significance to the Client. Further, *Offer reasonable remuneration packages to mitigate the leaving of experts* is most relevant to the Contractor, while the Consultant and the Client have similar significance. Moreover, *Implement cost control systems and proper planning throughout the system* is a highly significant strategy for the Contractor to mitigate the relevant barriers. Further it is more significant to the Consultant also than the Client. This strategy *Need to monitor weather patterns* is highly significant to the Contractor, and to a lesser degree, to the Client than the Consultant. The strategy for barrier *Select a team with past experienced in similar projects* is highly significant to the Client than the Consultant and the Contractor, who scores least in the category. Moreover, the strategy, *Proper procurement plan to be scheduled* is highly significant to the Contractor, and it is more significant to the Client than the Consultant. The final strategy in this category, *Booking materials in advance* is most significant to the Contractor and the Consultant than the Client. The above discussion illustrates the significance of various suggestions to each stakeholder to mitigate some of the barriers.

4.9 Frame work for successful implementation of D&B building projects in Sri Lanka

The frame work for successful implementation of D&B building projects was developed based on significant roles, enablers, barriers, strategies to overcome the barriers that were identified according to the weighted mean rating values. However, the weighted mean ratings of enablers, barriers and strategies, each ten numbers included in the frame work, and others were not much significant. Figure 4.4, 4.5 and 4.6 illustrates the conceptual model developed for successful implementation of D&B building projects in the perspective of roles of client, consultant and contractor respectively. Frame works are illustrated as Figure 4.4, 4.5 and 4.6.

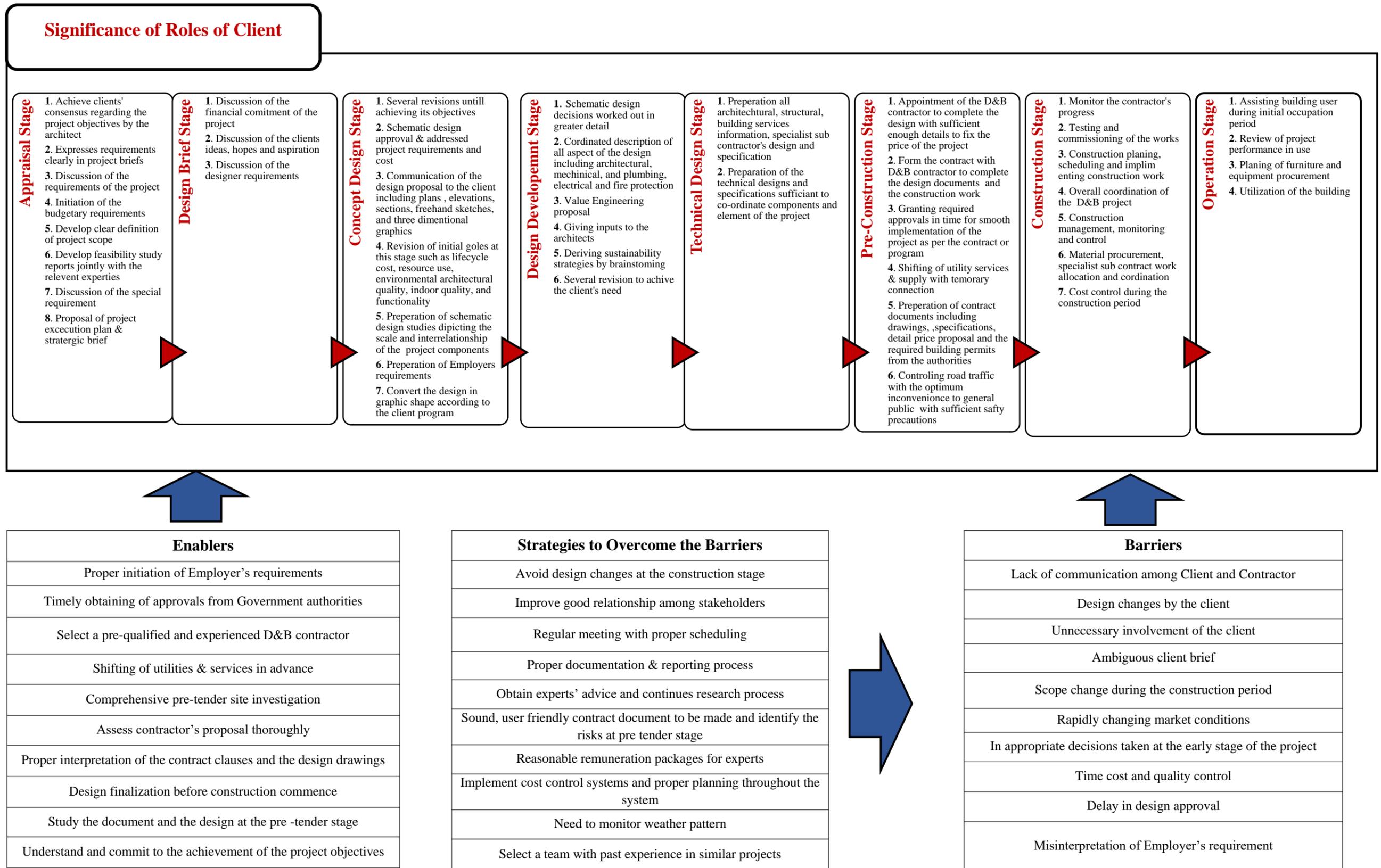


Figure 4.4: Framework for successful implementation of D&B projects in Sri Lanka - Role of Client

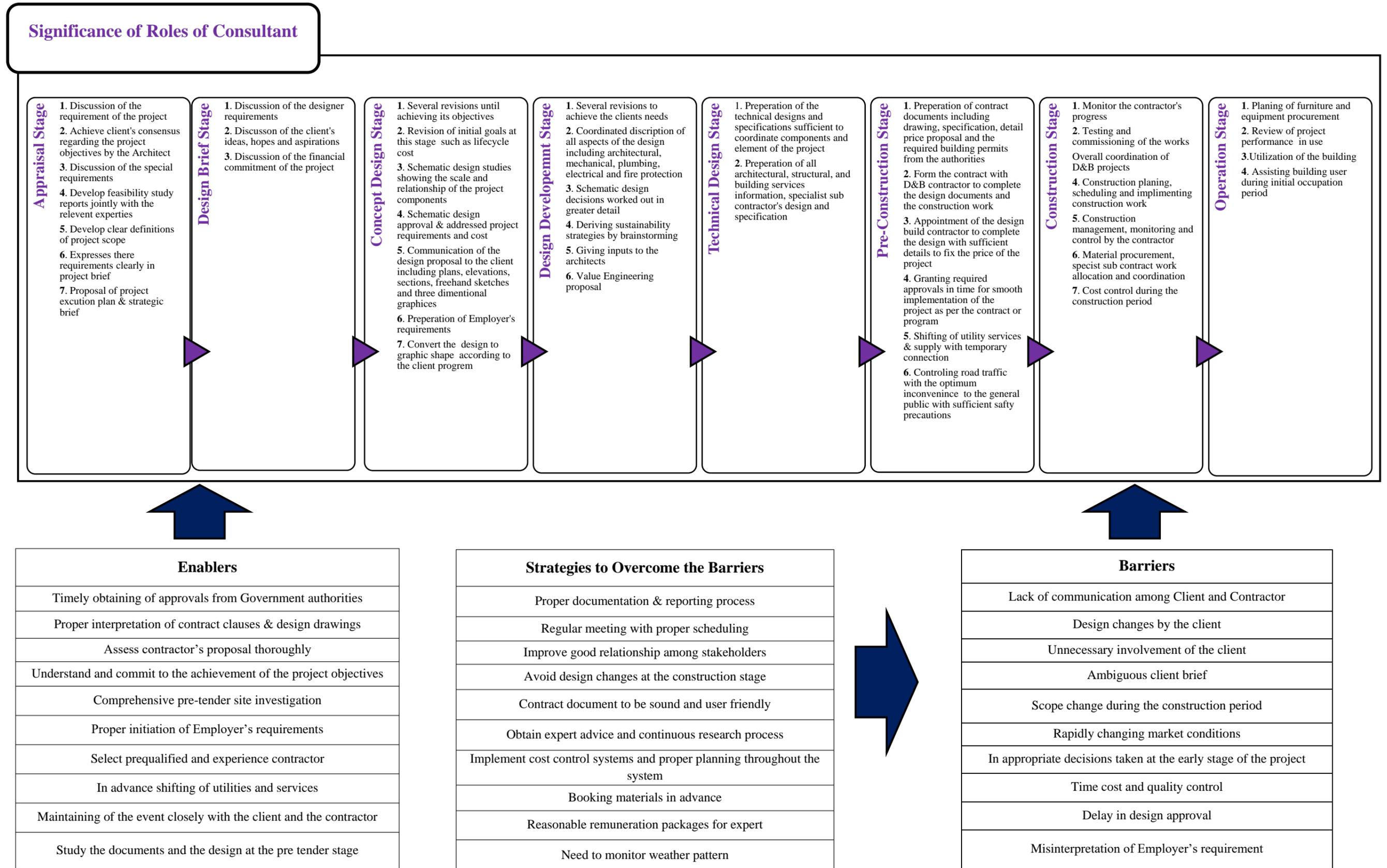
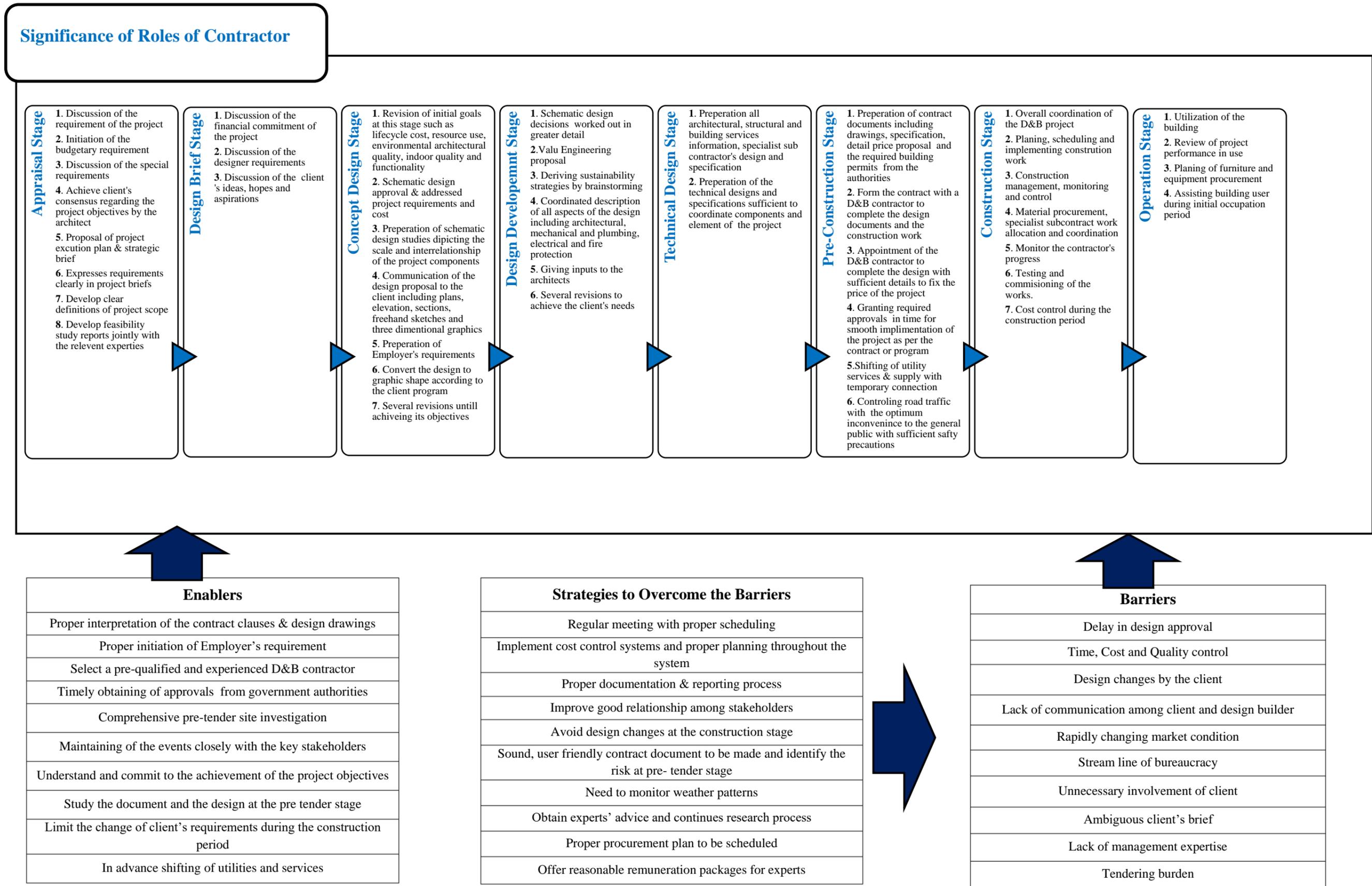


Figure 4.5: Framework for successful implementation of D&B projects in Sri Lanka - Role of Consultant



It can be seen in the Figure 4.4, “*Avoid design changes at the construction stage*” was identified as most significant strategy that can be used to overcome the barriers of roles of clients. Whereas, “*the Time, Cost and Quality control*” is the most significant barrier that can be overcome, avoiding design changes. Figure 4.5 clearly presents the most significant strategy was applicable to the consultant is “*Proper documentation & reporting process*” from the questionnaire. This strategy was applicable to most significant barriers of roles of consultant.

As per the developed framework, Figure 4.6 illustrated that, “*regular meetings with proper scheduling*” is the most significant strategy to the contractor, the contractor can overcome many barriers using that strategy. Whereof “Delay in design approval, Design changes by the client, Time cost and quality control etc.

4.10 Discussion

Project stakeholders should have a clear understanding of their own responsibilities and roles in each stage of Design and Build projects, and cooperate closely to achieve satisfactory project performance (Bo Xia, Chan, & Zuo, 2012). This study is intended to do, fill the research gap of identifying the roles of stakeholders in successful implementation of D&B building projects.

Through the literature survey identified 8 stages of D&B project life cycle (RIBA, 2007) and the (RIBA, 2013), other sources (Zou et al. 2007; Alison 2008; Design & Build Wiki, 2019) extensively discussed about the stages of project lifecycle. There were different opinion of the eight stages by the expert interviewees as discussed in detail in the table 4.3. The role of stakeholder in each stage was identified through literature were tabulated in table 2.4 - 2.11 it was validated by all interviewees without any discrepancies, the outcome of the analysis detail discussed in the tables 4.4 - 4.11, rank under the key stakeholders. But interviewees not suggested any additional roles for the stages they had contrast opinions to the roles which are identified from the literature.

In addition to that the literature finds 10 nos enablers as tabulated in table 2.12 illustrating the sources, the interviewees validated same and suggested additional 5 nos

enables as details discussed in the table 4.12 with the outcome of the analysis and ranked . Further, literature finds 15 nos barriers as tabulated in table 2.13 illustrating the sources, the interviewees' validated same and suggested additional 5 nos barriers as detail discussed with the outcome of the questionnaire in the table 4.13. The interviewees proposed many strategies to overcome the above identified barriers, through the outcome of the research it was identified most significant strategy for client, "***Avoid design changes at the construction stage***" it was not such significant to the consultant and the contractor. Most significant strategy for consultant is "***Proper documentation reporting process to be established among parties***" it was also not such significant to the contractor and the client. Most significant strategy for contractor is "***Regular meetings with proper scheduling***" but it was not such significant to the client and the consultant. It shows that the level of significant is different in different stakeholders.

The findings of the present study have outlines significant roles of stakeholders in successful implementation of D&B projects in Sri Lanka construction industry. This study provides useful inputs to the decision making process that helps to complete a D&B project successfully and help to yield better project performance. Further, it provides a broad approach to be adopted by all key stakeholders as a framework to ensure smooth completion of D&B projects in Sri Lanka.

4.11 Summary

This Chapter illustrated a detailed analysis of the data collected in interviews using manual methods and, through questionnaires using methods of descriptive statistics. The stages of D&B projects lifecycle are identified as Appraisal stage, Design Brief stage, Concept Design stage, Design Development stage, Pre-Construction stage. Construction stage and Operation stage. The key stakeholders were identified the Client, the D&B Contractor and the Consultant (Engineer to Contract). The roles of stakeholders at each stage of D&B project were also identified as illustrated in tables 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10 and 4.11. Further, the enablers and barriers for successful performance of D&B projects were identified, as tabulated in table 4.12 and

4.13. Moreover, strategies to overcome the barriers in ensuring successful implementation of D&B projects were also identified, as tabulated in table 4.14.

Finally this chapter concludes, by means of the framework, that a proper understanding of the various stages of a D&B project and the roles of each key stakeholder at each stage in the project lifecycle as well as a strategies to overcome the barriers, helps ensure smooth and successful implementation of D&B projects in Sri Lanka.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter draws the conclusions of the research addressing how each of the research objectives was accomplished. It suggests some recommendations regarding the stakeholders and the practitioners in the D&B construction industry in Sri Lanka and outlines some areas for further research.

5.2 Conclusions

In order to draw conclusions of the present research, the following sections describe the methodology followed in accomplishing each objective of this research together with its findings in detail.

Objective 1 - Identify stages of Design and Build project life- cycle

The first objective of this research was attained through surveying the prevailing literature and by conducting interviews. It was found that there are eight different stages in D&B project lifecycle. The preparation stage consists of the appraisal stage and Design Brief stage. At this stage, selection of an adviser for D&B project is completed in single stage tender. D&B project two stage tender / Common D&B / Pure D&B (all design by contractor), it is appointed Consultants at this stage. The Design stage consists of three stages, namely, Concept design stage, Design Development stage and Technical design stage. At these stages, D&B single stage tender, selection or confirmation of consultants and contractor's proposal, in D&B two stage tender of Contractor's proposals. The pre-Construction stage consists of Production information, Tender Documentation and Tender Action, in D&B single stage tender and two stage tender both is planning, reviewing Employers requirement's and contractor's proposals. The Construction stage consists of with mobilization and the construction to practical completion. 'Operation stage' is considered post practical completion.

Objective 2 - Identify the significant roles of stakeholders at each stage of project life cycle

The second objective of this research was accomplished through the literature survey, interviews and the questionnaire survey. Eight stakeholders' roles were categorized under the Appraisal stage. For the Design Brief stage, three stakeholders' roles were identified, and for the Concept design stage there were seven stakeholders' roles. For the Design Development stage, there are six stakeholder's roles. The next stage is the Technical design stage and there are two stakeholders' roles. Six stakeholders' roles were identified for the Pre-Construction stage. One of the critical implementation stage is the Construction stage there were seven stakeholder's roles in it. The last of the D&B process is the operation stage, and there are four roles identified from the stakeholders.

There were altogether 43 roles of various stakeholders identified for the successful completion of D&B project lifecycle. These roles were ranked under each stages of the D&B process, using the weighted mean value for three key stakeholders as, found from the questionnaire survey. Likert scale of 1 to 5 was used to measure the significance of each role for each key stakeholder at each stage of the project lifecycle, where 1 represents not significant and 5 represents 'highly significant'. When ranking of the results for the same role, different ranks were obtained by the Client, the Contractor and the Consultant.

Objective 3 - Identify the significant enablers and barriers for successful performance of roles of stakeholders

The third objective of this research was accomplished through a literature review, interviews and a questionnaire survey. The present study could identify 15 enablers and 20 barriers that affect the successful implementation of D&B projects either positively or negatively. The enablers were ranked under the three main stakeholders i.e., the client, the contractor and the consultant. It was observed that, when the highest rank was obtained the client, consultant and the contractor obtained different ranks for the same enabler. A higher rank means that role is more important.

The identified 20 barriers were also ranked in the same manner as the enablers. The highest ranked barrier under the Client category was "Lack of communication between

the client and design builders contributes to the problem for the decision making” and the lowest ranked barrier was “Technical problem”. The highest ranked barrier under the Contractor category was “Delay in design approval” and the lowest ranked barrier is “inappropriate decision taken at the early stage of the project”. Further, the highest ranked barrier under the Consultant category was also “Delay in design approval” but the lowest ranked barrier was “Technical problem”. Thus, the identified enablers and barriers in the successful performance of roles of stakeholders for D&B projects impact the project to various degrees.

Objective 4 - Rank the suitable strategies to overcome the barriers identified above

The objective 4 of this research was accomplished through interviews and the questionnaire. Various strategies have been suggested to overcome negative effect of the barriers. There were 12 strategies for mitigate the barriers. The highest rank obtained strategy for mitigate the barriers under the client is “Avoid Design changes at the construction stage to control the time”, under the Contractors point of view “Regular meetings to be conducted with proper scheduling” and also consultant to be “Frequent coordination meetings to be arranged and proper documentation/ reporting process to be established among parties”. Thus identified strategies for overcome the barriers for successful performance of the D&B projects in Sri Lanka’s Construction industry.

Objective 5 - To develop a frame work for successful implementation of design and build project

According to the findings of the research the framework was developed for successful implementation of D&B project related to each key stakeholder, the Client, the Contractor and the Consultant. It is consist with the roles of stakeholders for each stage of lifecycle of the D&B project from highest rank to lower, and enablers, barriers, and strategies for overcome the barriers.

5.3 Recommendations

This research focuses on roles of stakeholders for successful implementation of D&B building projects in Sri Lanka's construction industry. The research identified stages of D&B project life cycle and the roles of stakeholders at each stage. Further the research identified enablers and barriers for successful performance of D&B projects and also identified strategies for mitigate the barriers. The Stakeholders in D&B construction industry, the Client, the Contractor, the Consultant and other stakeholders can use these research findings. Further practitioners in D&B construction industry can use to identify the different stages of D&B projects and the roles of stakeholders. And also can be used for university students for further research.

5.4 Limitation to Research

The research is limited to evaluate the perception of the stakeholders who involve in the lifecycle of the D&B building projects in Sri Lanka. The Key Stakeholders, Engineer to contract (the Consultant), Design and build Contractor and the Client. Therefore research is limited to the professionals who are Engineers, Quantity surveyors and the Architects working in Contracting organization, Consulting organizations and the Client organizations. The ranking in the questionnaire was very critical because of the three different weighted mean values for same role, enabler and the barrier for three stakeholders.

5.5 Further Research

The research is looking forward regarding the development of the Design and Build projects in Sri Lanka's Construction industry. Therefore, this research suggests following research areas for future researches:

1. Identify the skills and competencies required by stakeholders for successful implementation of design and build projects.
2. Suitability of "Pure design & build" Vs. "Develop and Construct design & build" to the Sri Lanka construction industry.
3. Enhancing the communication among design and build project stakeholders in Sri Lanka construction industry.

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APPENDIX A: INTERVIEW GUIDELINE

PERSONAL INFORMATION

1. Type of Organization (Contractor/Consultant/Client/or/any other)
: _____
2. Designation : _____
3. Experience : _____
4. Date : _____

GENERAL INTRODUCTION

A) Research Heading :

Role of Stakeholders in successful implementation of Design and Build building projects in Sri Lanka.

B) Research Objectives :

1. Identifying stages of Design and Build project life- cycle.
2. Identifying the role of stakeholders at each stage of the project life cycle.
3. Identifying the enablers and barriers in successful performance of roles of stakeholders.
4. Identifying suitable strategies to overcome above identified barriers.
5. Developing a frame work for successful implementation of design and build projects.

3. What are the role of stakeholders at each stage of project life cycle?

Identified stages and role of stakeholders in each stage	If it is correct or applicable to Sri Lanka (√)	If it is incorrect (X)
<u>Appraisal stage</u>		
1. Achieve client’s consensus regarding the project objectives by the Architect		
2. Developed clear definitions of project scope		
3. Expresses their requirement clearly in project briefs		
4. Discussion of the requirements of the project		
5. Initiation of the budgetary requirement		
6. Discussion of the special requirements		
7. Develop feasibility study reports jointly with the relevant expertise		
8. Proposal of project execution plan & strategic brief		
<u>Design brief stage</u>		
1. Discussion of the client’s ideas, hopes, and aspirations		
2. Discussion of the Designer requirements		
3. Discuss of the financial commitment of the project		
<u>Concept design stage.</u>		
1. Convert the design to graphic shape according to the client program		
2. Revisions until achieve its objectives		
3. Communication of the design proposal to the client Including plans, elevations, sections, freehand sketches, and three- dimensional graphics		
4. Preparation of Employer’s requirements		

Identified stages and role of stakeholders in each stage	If it is correct or applicable to Sri Lanka (√)	If it is incorrect (X)
5. Preparation of schematic design studies showing the scale and relationship of the project components		
6. Client was done schematic design approval & addressed project requirements and cost		
7. The revision of initial goals at this stage such as Life cycle cost, Resource use, Environmental Architectural quality, Indoor quality, and functionality		
<u>Design development stage</u>		
1. Schematic design decisions worked out in greater detail		
2. Coordinated description of all aspects of the design including Architectural, Mechanical, and Plumbing, Electrical and fire protection		
3. Value Engineering proposal		
4. Giving inputs to the architect		
5. Deriving sustainability strategies by brainstorming		
6. Several revisions to achieve the client's needs.		
<u>Technical design stage</u>		
1. Preparation of the technical designs and specifications sufficient to co-ordinate components and element of the project		
2. Preparation all architectural, structural and building services information, specialist sub contractor's design and specification in this stage		
<u>Pre-construction stage</u>		
1. Appointment of the design build contractor to complete the design in sufficient enough details to fix the price of the project		
2. Form the contract with the D&B contractor to complete the design documents and the construction work		

Identified stages and role of stakeholders in each stage	If it is correct or applicable to Sri Lanka (√)	If it is incorrect (X)
3. Preparation of contract documents including Drawing, Specification, detail price proposal and the required building permits from the authorities		
4. Shifting of utility services & supply with temporary connection		
5. Granting required approval in time for smooth implementation of project as per the contract or program		
6. Controlling road traffic at the project with the optimum inconvenience to the general public with sufficient safety precautions		
<u>Construction stage</u>		
1. Overall coordination of D&B project		
2. Construction planning, scheduling and implementing construction work by the Contractor		
3. Monitor the contractor's progress		
4. Construction management, Monitoring and control		
5. Material procurement, Specialist subcontract work allocation and coordination		
6. Cost control during the construction period.		
7. Testing and commissioning of the works		
<u>Operation stage.</u>		
1. Utilisation of the building		

Identified stages and role of stakeholders in each stage	If it is correct or applicable to Sri Lanka (✓)	If it is incorrect (X)
2. Planning of furniture and equipment procurement		
3. Assisting building user during initial occupation period		
4. Review of project performance in use		

b) If there are any other roles of stakeholders at each stage Pl. specify.

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4).What are the enablers and barriers for successful performance of roles of stakeholders.

(a) Enablers

Identified enablers in literature.		If it is correct or applicable to Sri Lanka (✓)	If it is incorrect (X)
1	Maintaining of the events closely with the client and the contractor		

Identified enablers in literature.		If it is correct or applicable to Sri Lanka (√)	If it is incorrect (X)
2	Improve uncertainty of the D&B projects the means of stakeholders		
3	Proper communication with all parties		
4	Design to Finalization at the initial stage before the construction commence		
5	Proper identification of Employer's requirements		
6	Develop a clear understanding of the project scope		
7	Access contractor's proposal Thoroughly		
8	Limit the change of Client requirement during construction		
9	Comprehensive pre-tender site investigation		
10	Understand and commit to the achievement of the project objectives		

b) Barriers

Identified barriers in literature		If it is correct or applicable to Sri Lanka (√)	If it is incorrect (X)
1	Time, cost and quality control is a vital problem in D&B projects		
2	Design changes by the client in D&B projects		
3	Lack of communication between Client and design builders		
4	Tendering burden		
5	Rapidly changing market condition		
6	Stream lining of bureaucracy		
7	Involvement of the client		
8	Single responsibility on the contractor		

5).What are the causes for above barriers for successful implementation of Design and Build project and what are the strategies for that?

(a)

Identified barriers in literature		Causes for barriers	Strategies for overcome barriers
1	Time, cost and quality control is a vital problem in D&B projects		
2	Design changes by the client in D&B projects		
3	Lack of communication between Client and design builders		
4	Tendering burden		
5	Rapidly changing market condition		
6	Stream lining of bureaucracy		
7	Involvement of the client		
8	Single responsibility on the contractor		
9	Ambiguous client's brief and lack of communication of the client's precise wishes is conveyed to the contractor in D&B project		
10	Lack of management expertise at the construction stage		
11	Delay in obtaining donor concurrence		
12	Changing of scope during the construction period		
13	In appropriate decision taken at the early stage of the project		
14	Misinterpretation of client's requirements		
15	Technical problems		

b) If there are any other reasons, solutions, for barriers for successful implementation of Design and Build project, please specify;

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APPENDIX B: QUESTIONNAIRE GUIDELINE

DETAIL QUESTIONNAIRE

TO IDENTIFY THE ROLE OF STAKEHOLDERS FOR SUCCESSFUL IMPLEMENTATION OF DESIGN AND BUILD BUILDING PROJECTS IN SRI LANKA.

Dear Sir/Madam;

Request for filling the Questionnaire

I am H.G. Hettiarachchi, a student at MSC in Project Management program conducted by the Department of Building Economics, University of Moratuwa. As a part of my degree program I am carrying out my dissertation on the topic of **“Role of stakeholders in successful implementation of design and build building projects in Sri Lanka”**.

I would be grateful if you could complete the attached questionnaire with in your busy work schedule. The information furnished here with will only be used to complete my research program and all of your information will be treated confidentially by the research team .Your early responses would be highly appreciated since I have to undergo with a tight –time schedule.

Thank You,

Yours Faithfully

Geethanganie Hettiarachchi
Senior Quantity Surveyor
Sanken Construction (Pvt) Ltd.

Aim and Objectives

Aim

The aim of this study is to identify the role of stakeholders in successful implementation of Design & Build projects in Sri Lanka.

Objectives

The above research aim will be achieved through five research objectives listed below;

1. Identifying stages of Design and Build project life- cycle.
2. Identifying the significant roles of stakeholders at each stage of the project life cycle.
3. Identifying the significant enablers & barriers in successful performance of roles of stakeholders.
4. Identifying suitable strategies to overcome above identified barriers.
5. Developing a frame work for successful implementation of design and build project.

Instruction to Respondents.

This shall be taken up approximately 30- 45 minutes of your time.

SECTION A- GENERAL INFORMATION

1. Type of your organization:

Client Contractor Consultant

Any other (mention).....

2. Your role in Construction industry:

Architect Engineer Quantity Surveyor

Other (mention).....

3. Experience in construction field:

6-10 Years 11-15 Years 16-20 years
 21-25 years 26 and above

SECTION B- STUDY QUESTIONS

Please rank each stages of Design and Build (D&B) Project Life Cycle using following scale.

1	2	3	4	5
Not significant	Little significant	Somewhat significant	significant	Highly significant

(A) Rank the significance of **each stage** of D&B project life cycle.

(1). Appraisal stage

Role of stakeholder	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1. Achieve client’s consensus regarding the project objectives by the Architect.															
2. Developed clear definitions of project scope.															
3. Expresses their requirement clearly in project briefs.															
4. Discussion of the requirement of the project.															
5. Initiation of the budgetary requirement.															

Role of stakeholder	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
6. Discussion of the special requirements,															
7. Develop feasibility study reports jointly with the relevant expertise.															
8. Proposal of project execution plan & strategic brief.															

(2). Design Brief stage

Role of stakeholder	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1. Discussion of the client's ideas, hopes, and aspirations.															
2. Discussion of the Designer requirements															
3. Discuss of the financial commitment of the project.															

(3). Concept Design stage

Role of stakeholder	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1. Convert the design to graphic shape according to the client program.															
2. Revisions until achieve its objectives.															
3. Communication of the design proposal to the client Including plans, elevations,															

Role of stakeholder	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
sections, freehand sketches, and three-dimensional graphics.															
4. Preparation of Employer's requirements.															
5 Preparation of schematic design studies showing the scale and relationship of the project components.															
6. Schematic design approval & addressed project requirements and cost.															
7. Revision of initial goals at this stage such as Life cycle cost, Resource use, Environmental Architectural quality, Indoor quality, and functionality.															

(4). Design development stage

Role of stakeholder	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1. Schematic design decisions worked out in greater detail.															
2. Coordinated description of all aspects of the design including Architectural,															

Role of stakeholder	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Mechanical, and Plumbing, Electrical and fire protection.															
3. Value Engineering proposal.															
4. Giving inputs to the architect.															
5. Deriving sustainability strategies by brainstorming.															
6. Several revisions to achieve the client's needs.															

(5). Technical design stage

Role of stakeholder	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1. Preparation of the technical designs and specifications sufficient to coordinate components and element of the project.															
2. Preparation of all architectural, structural and building services information, specialist sub contractor's design and specification in this stage.															

(6). Pre- Construction stage

Role of stakeholder	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1. Appointment of the design build contractor to complete the design in sufficient enough details to fix the price of the project.															
2. Form the contract with a D&B contractor to complete the design documents and the construction work.															
3. Preparation of contract documents including Drawing, Specification, detail price proposal and the required building permits from the authorities															
4. Shifting of utility services & supply with temporary connection.															
5. Granting required approval in time for smooth implementation of project as per the contract or programme.															
6 Controlling road traffic with the optimum inconvenience to the general public with sufficient safety precautions.															

(7). Construction stage

Role of stakeholder	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1. Overall coordination of D&B project.															
2. Construction planning, scheduling and implementing construction work.															
3. Monitor the contractor's progress.															
4. Construction management, Monitoring and control.															
5. Material procurement, Specialist sub contract work allocation and coordination.															
6. Cost control during the construction period.															
7. Testing and commissioning of the works.															

(8). Operation stage

Role of stakeholder	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1. Utilisation of the building.															
2. Planning of furniture and															

equipment procurement.															
3. Assisting building user during initial occupation period.															
4. Review of project performance in use.															

(B) Rank the significance of **Enablers** for successful performance of roles of stakeholders.

Identified enablers	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1 Timely obtaining approvals from Government Authorities.															
2. In advance shifting of utilities & services															
3. Proper interpretation of the contract clauses & design drawings.															
4. Maintaining of the events closely with the Client and the Contractor.															
5. Study the document and the designs at the pre tender stage.															
6. Improve uncertainty of the D&B projects the means of stakeholders.															
7. Proper communication with all parties.															
8. Design to finalization at the															

Identified enablers	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
initial stage before the construction commence.															
9. Proper initiation of Employer's requirements.															
10. Select pre-qualified experience D&B contractor.															
11. Develop a clear understand of the project scope.															
12. Access contractor's proposal thoroughly.															
13. Limit the change of client's requirements during construction															
14. Comprehensive pre tender site investigation.															
15. Understand and commit to the achievement of the project objectives.															

(C) Rank the significance of **Barriers** for successful performance of roles of stakeholders.

Identified barriers	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1. Time, cost and quality control is a vital problem in D&B projects.															

Identified barriers	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
2. Design changes by the client in D&B projects.															
3. Lack of communication between Client and design builders.															
4. Tendering burden.															
5. Rapid changing market condition.															
6. Stream line of bureaucracy.															
7 Unnecessary Involvement of client.															
8. Single responsibility on contractor.															
9. Ambiguous clients brief and no communication of the client's precise wishes is conveyed to the contractor in D&B project.															
10. Lack of management expertise at the construction stage.															
11. Scarcity of construction material.															
12. Delaying obtaining donor concurrence.															
13. Changing of the scope during the construction period.															
14. Inappropriate decision taken at the															

Identified barriers	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
early stage of the project.															
15. Impracticable programme and planning of the project.															
16. Errors in tender document.															
17. Misinterpretation of client's requirements.															
18. Delay in design approval.															
19. Loss of professionalism.															
20. Technical problem.															

(D) Rank the significance of **causes** for **barriers** in successful performance of roles of stakeholders.

Identified causes for barriers	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1).Exceptional event or circumstance (Force Majeure).															
2). Delays in obtaining approvals, permits from related authorities.															
3).Lack of awareness of the nature of D&B contract by the parties															

Identified causes for barriers	Client					Consultant					Contractor				
4).Non availability of expert within the country.															
5).Design changes may happen as a result of failure of feasibility report and weakness of employer's requirements.															
6). Less experience in D& B contractors.															
7). Lack of experts in D&B contractors to manage the professionals.															
8). Lack of team efforts among the stakeholders.															
9). Skilled / unskilled labour shortage at the market.															

E) Rank the significance of **strategies** for overcome barriers in successful performance of roles of stakeholders.

Identified strategies for overcome barriers.	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1) Contract documents shall be sound & user friendly, identify the risk at pre-tender stage.															
2) Offer reasonable remuneration packages															

Identified strategies for overcome barriers.	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
for mitigate the leaving of experts.															
3) Avoid Design changes at the construction stage to control the time.															
4) Obtain experts' advice and continues research process to control the Time, Cost Quality of the project.															
5) Implement cost control systems and proper planning throughout the system.															
6). Regular meeting to be conducted with proper scheduling.															
7).Frequent coordination meetings to be arranged and proper documentation / reporting process to be established among parties.															
8). Improve and maintain good relationship among stakeholders to overcome the problem within the parties.															
9). Select past experienced team with similar projects.															
10). Need to monitor weather pattern.															

Identified strategies for overcome barriers.	Client					Consultant					Contractor				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
11). In advance booking materials.															
12). Proper procurement plan to be scheduled.															

APPENDIX C: RIBA PLAN OF WORK 2007

APPENDIX D: RIBA PLAN OF WORK 2013