

**CONSTRAINTS OF DESIGN AND BUILD SYSTEM IN
DIFFERENT PHASES OF BUILDING PROJECTS
IN SRI LANKA**

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DECLARATION

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ABSTRACT

Constraints of design and build system in different phases of building projects in Sri Lanka

Design and build has become the most popular method of procuring construction work and it gives more benefits and confidence to clients. Most researchers around the world have found that the design and build procurement method have more advantages than other procurement methods.

In Sri Lanka design and build procurement method has not widely using as expected. So it is important to find out the challenges or drawbacks of the design and build systems. This study investigates the constraints which are associated with the design and build specially in tender preparation and evaluation phase, design phase and construction phase. It then proposes recommendations on how the method can be improved in order to increase its use in Sri Lanka.

Survey data was collected from 54 respondents from the construction industry, including contractors, engineers, quantity surveyors, project owners, project managers, construction managers and architects in order to give a more balanced view of the problems. Questionnaires were the only method used to collect data from the respondents. Descriptive statistical analyses, hypothesis testing; using the Pearson correlation and outputs for regression analysis were conducted under the statistical analysis.

It is found that all three phases of building projects have numerous constraints when design and build system is used in building projects in Sri Lanka. Most of the impediments occurred due to inadequate knowledge of project owners, lack of manpower to help clients with technical issues and additionally there is insufficient knowledge to evaluate tenders. At the end of this research recommendation given on how to maximize the use of design and build procurement system in Sri Lanka building projects and detailed client's request for proposal was the most emphasized recommendation from respondent's results.

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LIST OF ABBREVIATIONS

| Abbreviation | Description |
|---------------------|---|
| D&B | Design and Build |
| BOQ | Bills of Quantities |
| SLIA | Sri Lanka Institute of Architects |
| IQSSL | Institute of Quantity Surveyors Sri Lanka |
| QS | Quantity Surveyors |
| RICS | Royal Institute of Chartered Surveyors |
| SL | Sri Lanka |

CHAPTER 1: INTRODUCTION

The first chapter of the thesis describes the background of the particular subject. It identifies the research gap and formulates the problem statement. And from the problem statement the research questions have been generated. Continuously sets out the aims and objectives, significance of the study, limitations, the scope of the study and all these together provide an overview of the structure of the thesis as well.

1.1 Background

The nature of building projects has changed dramatically in recent years with fundamentally a more project owners requesting shorter delivery period and an early indication of the total project estimate towards the beginning of the project. The ultimate goal of each participant of the project is a project success (Dang & Le-Hoai, 2016). There are many factors available to determine the success level of building projects. Those are completion of project within predetermined budget and time frame and final output is as per owner's taste while maintaining the quality (Ibrahim, Ammar & Carter, 2011).

The annual survey of Construction Industries 2013, conducted by the Department of Census and Statistics of Sri Lanka mentioned that building construction makes the highest value of work done among other sectors which is 51%. So it is obvious, construction industry plays a major role in the national economy. There are many factors highly influenced to determine the success of the building projects. Eshan, Bemanian and Mojtaba (2014) identified some of the factors, those are political changes, cultural traditions, social environment and human related factors and all these are normally not quite the same as nation to nation.

The D&B procurement system has seen a leading trend in the construction industry (Sonar & Molnar, 1997) and has been popular in the world in recent years (Chia & Chan, 2010). The D&B procurement system has seen considerable growth in many countries of the world and is considered a dominant procurement system. According to Suranga and Anne (2008) some researchers found, among other procurement

methods traditional procurement system is dominating the construction industry and the D&B procurement system is the next alternative option but less in current practice.

The traditional construction method itself has its own issues, because different parts of the project are responsible for different activities of designing and building, meaning construction process can be started after the completion of design. In D&B system, one organization is responsible to deliver both design and construction. Ogunsanmi (2016) found, the D&B procurement system can be classified in three different categories of time, cost and quality. In all these measures, several researchers, Ling and Kerh (2004); Songer and Molenaar (1997); Tulacz (2003) have found D&B performs better in terms of above mentioned performance indicators compared with alternative procurement types.

The growth and popularity of D&B are significantly high in countries like UK, France and Greece etc. Compared to other procurement methods, D&B method is broadly utilized in other parts of the world; whereas the traditional procurement method remains dominant in Sri Lanka (Suranga & Anne, 2008).

While the D&B procurement method has a number of benefits, it is also known to have some drawbacks. The general definition of D&B is one firm or organization takes full responsibility to do both design construction and complete delivery of a construction project. Design and build system is most suitable for large and complex projects and more importantly for specialized projects. It is found some special complex projects in Sri Lanka would have used D&B system due to special concern. Ndeugri and Turner (1994) study has proven that some constraints are associated with the D&B procurement method. It has been found that issues experienced during all stages at implementation level.

Problems are more intense with issues around human capital or lack thereof. These, coupled with the fact that the method is relatively new in many countries including Sri Lanka, and it is important to see the benefits and disadvantages of methods before choosing to make utilization of it. This is so on the grounds that, picking the correct procurement system is extremely vital for the accomplishment of any project.

This study examines the constraints of the D&B system in different phases of building projects in Sri Lanka, and the reasons why D&B has not made the sort of significant remarkable in the construction industry in Sri Lanka that it has made in other regions of the world. And from the findings, suggest some recommendations to increase its use in Sri Lanka.

Under the research approach, quantitative methods have been used to find the most serious problems that are associated with using D&B in the delivery of building projects. The questionnaire survey was the only data collection technique used for this research. Respondents from major construction professionals are requested to fill the survey, which was designed to investigate constraints associated with all three phases.

Descriptive statistical method, hypothesis testing and regression analysis were used to find how serious the problems are. Solutions generated from the research findings. The ultimate purpose of this research is to find out the current trend of the D&B system in Sri Lanka. To understand the sectors that makes use of D&B. Characteristics, benefits and mechanisms of D&B system. And more importantly analyze the constraints of tender preparation and evaluation stage, design stage and construction stage. And finally it evaluates and suggests the way to increase the use of the D&B procurement system in Sri Lanka.

1.2 Problem statement

Although D & B has many benefits, including time, cost and sometimes quality, its use as the construction procurement method of choice in Sri Lanka is not widespread, in the context of the percentage of projects that have been completed using it. This may be because the constraints associated with the D&B method in different phases of building projects are quite serious, although more attention has been given to the benefits. In the view of what have been said previously, this study is trying to identify the constraints associated with the D&B system in different phase of building projects and how serious these constraints are perceived.

More importance has been given to identifying the benefits of D&B whereas only a few researchers identified on the shortcomings of the method. If the barriers of the system are identified and solutions proposed, the use of the system will be greatly improved. Mosley and Bubshait (2019) suggest it's better to have an understanding of the effects of different types of procurement types which will improve the outcome of building projects. Moreover the employer agent either project manager or construction can be appointed any time of the D&B project. There is no particular stage, which an employer's agent is expected to be appointed.

Ling and Poh (2007) found if D&B Company appoints project manager or in-house employee that will reduce the fears of the client and this allows increasing the satisfaction when the final product is delivered. Dang and Le-Hoai (2016) found to meet the satisfaction of the project owner, the qualified project team and project managers should be employed to implement DB projects. Other than this most of the clients feel they need to have a certain level of influence to run the projects successfully. No particular studies have been conducted in Sri Lanka to understand the way of changing the construction environment in order to increase the use of D&B procurement system in Sri Lanka.

Rameezdeen, Rathnasabapathi, Amaratunga and RDG (2005) found that, the D&B procurement system had no significant change or growth in over the past decades. Studies were done in another part of regions too, so comparatively percentage is lower than those from studies conducted in other regions. The following section examines the trend of the use of advance features of procurement systems in Sri Lanka construction industry.

Table 1-1: Trend of the use of Construction Procurement Systems in Sri Lanka

| Procurement System | % use (Average) | | | | | |
|------------------------|------------------|---------|---------|---------|---------|---------|
| | 1977-81 | 1982-86 | 1987-91 | 1992-96 | 1997-00 | 2000-03 |
| Measure and Pay | 55 | 50 | 58 | 50 | 64 | 72 |
| Lump Sum | 12 | 10 | 8 | 7 | 10 | 5 |
| Prime Cost | 10 | 8 | 5 | 4 | 3 | 1 |
| Design and Build | 22 | 31 | 28 | 35 | 21 | 22 |
| Management Contracting | 1 | 1 | 1 | 1 | 1 | 0 |
| Joint Venture | 0 | 0 | 0 | 3 | 1 | 0 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |

Source (Shiyamini, Rameezdeen & Amaratunga, 2005)

Statement of research problems

- The D&B procurement system is not as broadly utilized in the construction industry in Sri Lanka as in other regions of the world, which could be because of the constraints associated with such a system.
- If the owner of the project appoints a project manager or construction manager to the project team from the beginning of the project implementation stage would reduce the risks and improve the quality of the project outcome.

From the problem statement, the following research questions emerge:

Question one

What are the constraints or limitations of the D&B system in different phases of building projects in Sri Lanka?

Question two

By What method of D&B environment is improved in order to increase its use in Sri Lankan construction industry?

1.3 Aim and objectives

The aim of this research is to investigate the constraints of the D&B system in different phases of building projects and more importantly, understand how they have dealt with such challenges in practice. The aim is achieved through the following objectives:

- Identify the current trend of the D&B procurement system in Sri Lanka.
- Find the constraints of the D&B system in tender preparation and evaluation phase, design phase and construction phase in building projects.
- Recommend the way how D&B system could be widely used in Sri Lanka construction industry.

1.4 Significance of the study

The D&B procurement system has many advantages as discussed above, mainly the fact that it will reduce the time of completion. Researchers Mosley and Bubshait (2019) found if we consider a DB system, it's constructed and delivered significantly faster than design bid and build system.

Tulacz (2003) found that D&B satisfies this request for quicker project delivery. So it is important to study and give adequate information to all construction professionals in Sri Lanka due to what reason D&B system is still not developed and what step could be taken in order to increase its use in Sri Lankan construction industry.

1.5 Limitations

Only the main definition of D&B is considered in this study, so that is the identified limitation of this research. Issues and solutions examined, the same company takes full responsibility for both design and construction. As such, the constraints of each D&B system in different phases of building projects type were not separately studied

and furthermore, a different report didn't investigate the challenges of different advance features of D&B system that would give more information to readers. Another important limitation of the study is limited to building projects only. So the constraints of the whole construction industry are not focused on this study.

1.6 Scope of the study

This study covers and focuses on the construction industry in Sri Lanka and targeted at key participants of D&B procurement. The respondents were chosen randomly from the construction industry from all parts of the country. The professions chosen are the major ones in the construction industry, including Engineers, Quantity Surveyors, Project Managers, Project Owners, Architects and Contractors. Survey mainly targeted those who have D&B experience. But some professionals those who do not have D&B experience also participated.

1.7 Structure of the research report

The rest of the dissertation is organized as follows; the literature review is presented in chapter two. It gives an introduction to procurement systems, by explaining all the procurement systems and how D&B is related to other procurement methods. And more importantly discusses the functioning of D&B and management problems. Chapter three discusses the methodology used for this dissertation, while chapter four presents the results and analysis. Final chapter five presents the research findings, recommendations and suggestions for further researchers.

CHAPTER 2: LITERATURE REVIEW

This chapter provides an in-depth introduction to all procurement systems in the construction context. It shall give better comprehension of D&B construction procurement technique and exactly how it's pertaining to other procurement methods. The barriers experienced are significantly paid off by giving the most likely procurement approach to deliver any certain project. And finally this chapter discusses about the constraints of the D&B system in different phases when used in the building industry.

2.1 Definition of procurement in the building context

Procurement involves all the processes involved in the construction industry as well as trying to make the idea of the client into reality (Davidson & Mohsin, 1987). There are two different ways to consider this; first of all, the owner and in some instances his team must choose the contractual nature or sort of framework that will be utilized to accomplish his goal. Secondly, the selection of the construction team is known as the bidding process.

The above definition is simple, but can effectively affect the whole process; such procurement has a large number of simple methods and procedures. Davidson and Mohsini (1992) describe the procurement of all agreements and procedures that link the gap between the owner's opinion and the actual assessment of the project. There are some variations of each category that are desirable for certain cases of building projects.

2.2 Trends in procurement systems

It is crucial to decide on the procurement that is right for the success of any construction project, and it's also practically essential to select the procurement that's right too. Smith et al (2004) describes other than decision to build the identification of procurement type is very critical for the client. It should be ensured that the procurement method chosen to meet the specific needs of the client is sufficient.

In addition, the advantages of the particular procurement system cannot be achieved if improperly implemented, and if the wrong type of project is used to procure, the barriers will increase. According to client's specific requirements and interest, there are plenty of procurement methods available. Nevertheless the most suitable procurement contract type might be either separate the functions of D&B or integrate them.

Masterman (1992) has categorized three different types of procurement systems. These include; the separated and co-operative systems, the integrated procurement systems and the management-oriented procurement systems.

2.2.1 Separated and co-operative procurement systems

These schemes are too recognized as traditional' systems. The principal characteristics of these systems are that composite design and building process and lack of integration across this boundary (Cox & Townsend, 1998). On this system the owner of the project will hire an independent consultant on fee basis, who takes full responsibility for tender documentation that are vying with the bids are held from the contractors. After onwards successful tenders will form a contract with a client. This work will be done by supervisory consultants. The main contractor's influence and contribution are minimum for the design work (Rowlinson, 1999). The advanced features of this separated procurement system are lump sum, measure and pay and prime cost.

In lump sum contract the price for the all works agreed before the works begin meaning the contractor is at high risk. These contracts render maximum price certainty before the start, provided that client's requirements are fully specified (Turner, 1997). This procurement is system also one of the famous system in Sri Lankan building construction industry.

Measure and pay contracts are often used where the work happens to be substantially designed but final details have not finalized. The tender documentation is according to provided drawings, specification of the project and bills of quantities. The method of payment to the contractor is in accordance with the work done as measured after the physical completion.

However, even if the overall time is short for this method, there is a disadvantageous lack of price determination during the contract period. This method is widely used in both private and public sectors. This system has transparency and accountability so due to this advantage, this procurement system usage is more in the public sector.

The three features of the prime cost contract are cost plus contracts, target cost contracts and fee contracts. From the agreed contract sum, the prime cost contractor only gets what he spent on and also the profit. This is most suitable for the scope of the work is not fully defined during the bidding time.

The main benefit of this system is due to the non-developed contract sum at the early stage of the project, there is no contractual commitment of the contractors to reduce the final cost. The popular method of the public sector in the construction industry in Sri Lanka is the prime cost arrangement. The public sector contributes mainly to the substantial increase in the housing sub-sector.

2.2.2 Integrated procurement system

Integrated procurement system is referred as D&B system. The main feature of this system is one organization responsible for both design and construction. This means there is only one contractual agreement between the main contractor and the owner of the project and hence single point reference. Although the main contractor had taken full responsibility of the project, he would have appointed specialized technical person to assist the quality of the project (Cox and Townsend, 1998). The most common features of this system are package deal, turnkey, develop and construct.

It has been widely accepted that the main advantage of this system is closer integration of design and construction (McDermott, 1999). According to some research study results that compared to separate procurement systems, integrated systems offer less overall time. Also, overall economic planning solutions are possible through these systems. Here the main contractor is fully in charge of every aspect of the project, so due to that the project owner will receive the proper indication of how much the total project cost will be as early in advance. However, this method is generally not recommended to procure for aesthetically important buildings.

2.2.3 Management-Oriented Procurement System

The principal characteristics of this procurement system are there is no longer link with management and design and construction function. Both are two different aspects. The basic aspect of this arrangement is the separation of management functions of design and construction. In this procurement type, client will have a contract with an external organization, which is fully responsible for the management and coordination of design and construction of the entire project. The advanced features of this system are management contracting and construction management.

Comparatively overall design and construction time is usually short with these systems (Turner, 1997). Various researchers (Lam and Chan, 1994) suggest different concepts regarding the cost reliability of the arrangement. Various researchers provide varying ideas on the reliability of cost prepared. Large scale projects and technically challenging projects are suitable for this procurement type. In the Sri Lankan context, very few projects are undertaken through this procurement system and most of them are very large scale projects.

2.3 Things to consider when choosing a procurement method

As already mentioned above, selection of the most appropriate procurement system is important for the success of building projects. Almost all projects are unique in the construction industry and have unique features for everyone. Therefore, the procurement procedure for a project should be decided by the key elements around a project. Ashworth (2006) states that only a few factors that should be considered by clients in deciding which type of procurement system to use. Owner of the project should use the process facing minimal restrictions during construction work. Owner of the project should implement some of the technics or process in order to reduce the constraints. Following are some of these factors.

- 2.3.1 Time target

Some of the projects must be completed quickly and hence the time frame is restricted. Design and construction should be done simultaneously using integrated

systems as D&B, hence the construction begins before the end of the design, which reduces the construction period (Songer et. al, 1997). Currently Sri Lanka is facing this situation as it races to complete housing projects and condominium projects on time.

- 2.3.2 Financing problems

The type of financing and institutional financing for any project is the most important. When financiers requesting the project cost before the construction starts, it becomes useful for the owner, in which the owner will put more attention to know the total project cost (Mohammed, 2005). In such cases, it is best to use an organization that combines design and construction so that they will be in charge for the entire project

- 2.3.3 Size and complexity of the project

The size of the project and complexity are the most important factors to be considered when determining the suitability procurement system to the particular project. McCaffer (2001) found that the traditional procurement system is useful for small scale and traditional type buildings were as integrates contract type is useful for technically challenging and complex projects.

- 2.3.4 Knowledge of the owner

This is very important, the client and his project team should have adequate knowledge regarding building industry and more importantly procedures of different procurement types. Then only they would achieve the full benefit from the particular procurement type. As Ling and Phng (2005) found the well-organized request for proposal is necessary before starting the tender process in D&B project. This accomplishment is possible if the client knows well about his requirements and needs and what he expects of the final end product to achieve.

- 2.3.5 Legal issues

In most of countries around the world, the legal procedures are tough and have many restrictions to procure every type of projects, especially purchasing public ones. So due to this client and project team must have adequate knowledge regarding laws and regulation before entering into a contract. There is a law in China, where only one organization must take full responsibility of the project from start to end.

2.4 Definition of Design and Build

The D&B procurement system has been in the industry for a long time back. Sanger and Molner (1996) described it as the oldest purchase method, which temporarily disappeared during the Renaissance due to the expertise of various activities in the industry, but again in the 1970s due to rising inflation and increasing project demand and early completion of the projects, again emerged firmly. D&B is one of the famous construction delivery system, where one single organization is responsible for design and construction. This is called a single point reference.

Songer et al. (1997) expresses D&B as a construction project procurement system in which a single entity or consortium is allowably in control of both design and construction. Since one company takes full charge of the project, it becomes easier for the client to approach the particular company for he needs to know any aspects of the project. Besides this, a teamwork, communication and general coordination must be straightforward as only one concern is responsible for furnishing the whole project.

The main difference between D&B procurement systems and other procurement type is, in the D&B system contractor team takes full responsibility for designing the building up to complete the construction process, whereas in other procurement type owner's team takes fully in-charge of designing the project.

2.5 Project types are suitable for D&B systems

This section discusses the most suitable type of project for D&B in order to obtain the benefits of the method to be realized. It is very important to understand the obstacles that apply to various project types. And also an appropriate project contract is established to avoid multiple problems in the project, in order to select a correct project team.

Ling and Lau (2002) have found that D&B is not suitable for disconnected projects. Generally, D&B is not good for projects types with different packages many sub phases. The reason is, if there is any sub phase, the management and team must be divided and cannot provide full attention and focus on the whole project. It should be made sure the output of every single sub phase is similar in terms of quality aspects. Some researchers have concluded that for some reason D&B may be more suitable for smaller projects; however, they may be more complicated in nature.

The D&B project contractor can handle both design and construction work. This means that he has inherited a complete design and is favored by a more constructive design than a contractor who wants to build it. This means when designing the building, D&B contractors will be more innovative because the same organization that does the construction. Moreover, such innovations can only be created if the design is made.

2.6 Design and build usage in different sectors

It is very important to know if projects belong to particular sector it would be better procured using D&B. It can expose some of the problems that could be faced and be prepared in advance to deal with them.

D&B dominated the private sector in the beginning, but over time, it began to dominate the private sector too. Benefits of Public Sector of D&B procurement system started to spread in the private sector also. Akintoye (1994) finds that 1991 in United States, 21% of the construction projects being procured through the private sector and only 12% procured through public sector projects.

Hanscomb (2004) conducted a survey of how D&B was used in public and private sectors in different countries and used in other sectors of the economy. It was revealed in the study, which included the areas of retail, education, medical, and road and rail construction. However, the most efficient use of D&B globally is the manufacturing, distribution and warehousing.

2.7 Nature of D&B in Sri Lanka

The evidence of less usage of the D&B system in Sri Lanka is, D&B is largely limited in building projects in Sri Lanka and less use in infrastructure projects. Large projects are undertaken in the building industry and D&B firms are also increasing in number in the building industry. So D&B firms are establishing due to the advantage of the D&B system over the other procurement system. This is one of the reasons to encourage projects to procure using this method in Sri Lanka.

In building industry as per constructive view, quantity surveyors are deciding the procurement type. However, Quantity Surveyor's role is offered by the team of professional as the building team in professional organizations. These professional organizations represent consortium organization, service firm in the building industry.

2.8 Use of D&B in Sri Lanka

There is a contradiction among construction professionals that, which sectors and type of projects are more relevant for D&B projects. However, in the study by Grobler and Pretorius (2002) found, as per the contractor's view traditional procurement system was most suitable for public sector projects whereas D&B procurement system were suitable for private sector projects. Contractors and designer's point of views are different most of the times. Contractors claimed D&B procurement method is better for large and complex projects; as per designer's opinion traditional method is the best one. A study has been made to identify the type of the project and those projects belong to which sector. From the list, its clear water

supply project and large scale residential projects are the most widely used projects in D&B in Sri Lanka.

- High rise Apartment in Colombo city valued Rs.700 million- Private Sector
- Provision Water supply project valued Rs.3 billion – Public Sector
- Modern Residence Apartment in Colombo city valued Rs.2641 million – Private Sector
- Waste Utilization Plant in eastern province valued Rs.1400 million – Private Sector
- System Rehabilitation for new reduction in Colombo city valued Rs. 3 trillion and 180 billion – Public Sector

From the project list it is identifiable both private and public sectors are procuring the projects using D&B system. Also the cost of the contract sum also varies, from minimum range to big scale. The results of this study suggest that Sri Lanka has the potential to become a big-budget projects in the future, so most of the projects will procure using D&B system, considering the advantages of the D&B procurement method.

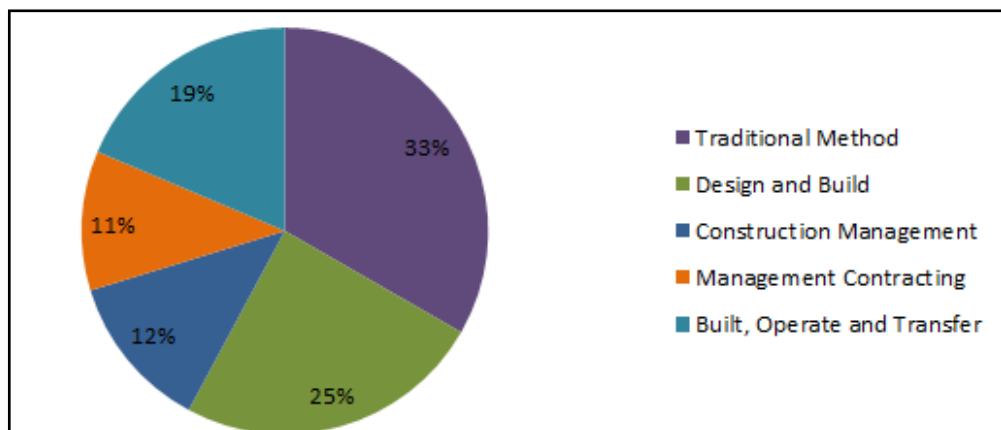


Figure 2-1: 2018 survey results of trend of procurement systems in Sri Lanka

Source: Developed by the author

Figure 2.1 indicates the 2018 survey result of trend of procurement systems in Sri Lanka. According to the research conducted, the traditional procurement method dominates the Sri Lankan construction industry with 33% usage rate. D&B has recorded a usage rate of 25%. Construction management procurement system usage rate is 12%. The management contract usage rate is 11%. Whereas Built, operate and transfer usage rate is 19%. From the finding that could say, the growth of D&B is not up to the level which was expected. Starting from the year of 1977 and up to now the traditional procurement system remains the leading procurement system in Sri Lanka construction industry.

By exploring the survey results, objective 1 has been achieved, which identifies the current trend of the D&B procurement system in Sri Lanka in building projects. As discussed in the previous segments of the research study, there are numerous advantages of D&B system. And many researchers found, this method is more suitable for large scale technically challenged projects. Due to these reasons it is necessary to identify the constraints of the D&B system in Sri Lanka building projects.

2.9 Use of D&B in Sri Lanka and other regions

The issue of skills shortage in Sri Lanka has been documented in construction and other engineering industries. Compared to other procurement types, D&B will reduce the project delivery time, which will be discussed later. Despite the many advantages that D&B possesses as a construction procurement method, compared to other regions of the world, in Sri Lanka the growth and use of D&B is not fast enough. Based on the research conducted by Rameezdeen and Ratnasabapathy (2005), the traditional procurement system especially measure and pay system dominated the construction industry of Sri Lanka. In Sri Lanka most of the public sectors procuring using traditional method. The record shows, usage rate of D&B system was 20-35% during the year 1977 to 2003. Again in 2018 there was not much significant change in usage rate of D&B system which is 33%. But in the 2018 survey, it shows other than traditional procurement contract, management contracting and construction

management procurement systems also started to influence in the building industry of Sri Lanka.

The growth and adoption of D&B system becoming faster worldwide, especially Europe and America, with very satisfactory results. Konchar and Sanvido (1998) found that in United States compared to early 80s' and 90s' there is an extraordinary growth of D&B system. Likewise in UK, nearly 425 of construction projects are procuring using D&B system (Kassim & Shamsaddin, 2004).

According to a study conducted by the Building and Construction Authority (2006) in Singapore that from 1997 to 2006 only 20% of construction works were procured using D&B system. Chan, Chan and Lam (2004) also found in Asian country including Hong kong the use of D&B is significantly less. Their study suggests that the slow growth of D&B in Asia is responsible for severe government control of construction activities in region. However, there is a recent decline in government control of institutions that have made significant changes in the economic landscape in the region (China Statistics Press, 2002) and has made the entire construction industry.

Compared with another continent, the use of D&B in Asia is comparatively slow in the process. This section concludes that D&B is not as widely used in Sri Lanka as in other regions, especially Europe.

2.10 Characteristics of the D&B system

Identification of the characteristics of the D&B procurement system is very important. It shall project owners to judge the appropriate procurement type for their project. D&B has the distinctive features and is distinguished as a construction procurement method. The features that are mentioned below are relevant for the D&B procurement system only and those features make D&B system different from the other procurement methods:

2.10.1 Early identification of cost and time

In the D&B project, the contractor will be involved from the start of the project, and the owner will be able to know the full cost of the project. In this procurement type, the price is set in advance because the only contractor takes the whole responsibility for designing and building the project. Or even most of the cases the contract sum set during the initial stage. This method is totally different from traditional and other procurement types where after the completion of design work only the tender processes will begin. In this scenario, the client will not know the contract sum in the early stage of the project.

2.10.2 More precise estimation of cost and time

This is an important feature of D&B projects because an experienced contractor will know how much time and how much money to spend. As this is done, the owner does not make much difference to the scope. However, during the changes, Mohamed (2005) finds that there are enough preparations to evaluate changes in D&B projects, thus making a minimum impact on the cost of the project as well as defined time frame.

2.10.3 Well defined scope of the work

In D&B projects, the design team has much responsibility and involve for all aspects of the project, whereas owner has less influence on the project which has been commissioned. This means the owner must clearly state his needs and requirements from the very start, and request for proposals consist of the client's brief or his scope of works. Actually, this Request for Proposal should clearly mention what his client's requirements are how he expect his final outcome to be as well. Songer et al. (1997) find that most critical part of D&B project is well designed scope of work. If the owner has proper knowledge about the construction industry, they would be able to define their goals and it is for this reason that Ndekugri and Church (1996) found client without construction industry knowledge should stay away from such D&B project or must find some other alternative.

2.10.4 Contractors capabilities on both design and construction

In D&B contract unlike other contract types the whole responsibility for designing and building has been given to him. In this sense he might have more pressure and works to carry out the works. Stillman (2002) found D&B contractor has many roles like design, construction as well as their integration. Suppose if the contractor is willing to outsource the design phase of the project, it is still a problem to carry out the work without proper design knowledge. Kassim and Shamsaddin (2004) find that one of the major issues with D&B projects is that main contractor does not have adequate knowledge to balance with both design and construction.

2.11 Advance features of D&B

It is critical to find out about advance features of D&B contracts so project owners can select the appropriate option for their project. D&B has evolved over time, its definition is now expanding and many other projects can be procured using the method. Many problems during project implementation can be avoided, by selection of appropriate contract form which suits the client. It is very important to know about the various types of D & B contracts so that you can choose the most suitable option for the project owners. D & B have evolved over time, and the definition of D&B has been expanded now.

Most of the projects started to procure using the system. A lot of problems and issues could be avoided if the client selects the best contract in project implementation stage. When planning any project, two things are very important; the type of contract and the structure of the organization owner wishes to choose to carry out his work. A major advantage of the D&B system is that the owner has the ability to create a single contract with the main contractor and therefore only one point of reference. Even though there are some advanced features of D&B contract. It might be different from the key definition of a D&B procurement system.

Rowlinson (1999) identified major three features of D&B contract which were discussed below.

- Pure Design & Build
- Integrated Design & Build
- Fragmented Design and Build.

Akintoye (1994) identifies the following six forms of design and build;

- Traditional Design & Build
- Package deal (including turnkey)
- Design and manage
- Design, manage and construct
- Novation Design & Build
- Develop and construct.

The main study of D&B system categorized into two main categories those were mentioned above. Rowlinson (1999) categorizes in a very broad manner, Akintoye (1994) breaks D&B down in a less broad manner. A close-up view of both researchers' categorization reveals Akintoye's six forms fit into Rowlinson's three categories identified with the exception of novation design and build.

2.11.1 Pure design and build

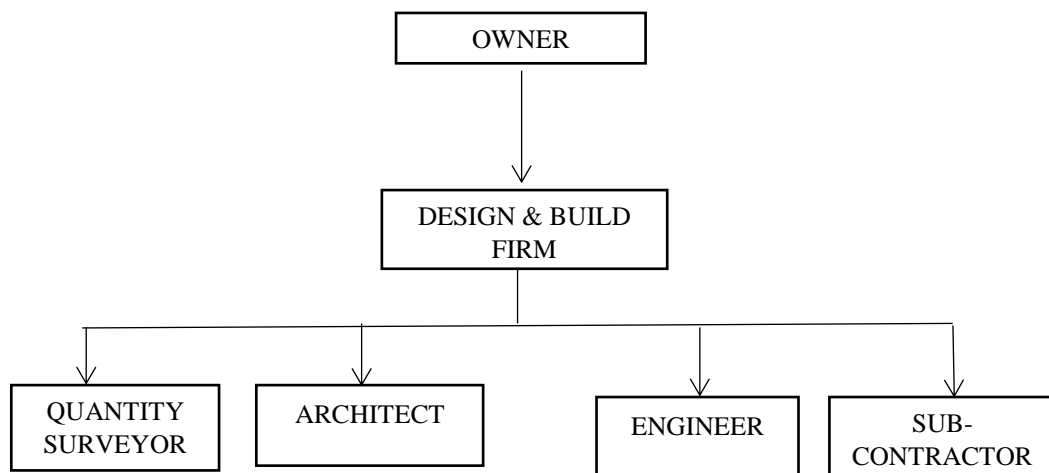


Figure 2-2: Pure D&B systems

Pure D&B reflects the original idea of D&B projects. Here the contractor is responsible for the entire functions both design and construction while producing the output that reflects the client's needs. Generally main contractor has all specialized team in his organization and when necessary arises, he would outscore sub-contractors for very specialized or hi-tech functions.

In pure D&B form only one type of tendering system is available, which is one stage tender where the owner will appoint only one main contractor to carry out the whole project work. Jansens (1999) suggests two types which include the single stage tender and two-stage tender.

2.11.2 Integrated design and build

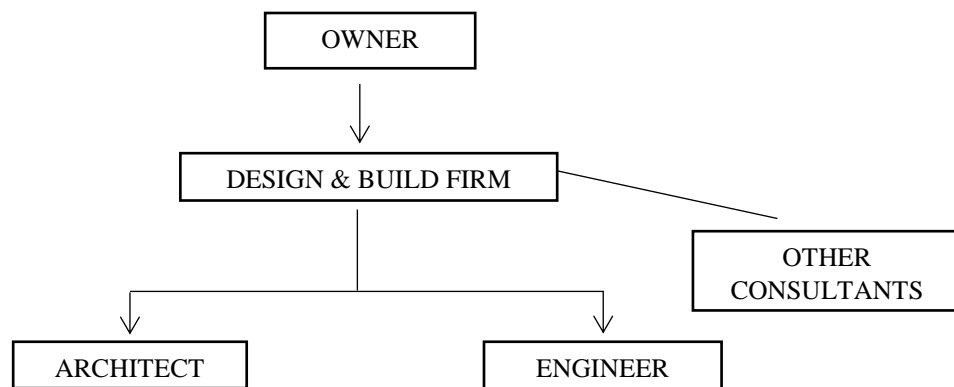


Figure 2-3: Integrated D&B system

With integrated D&B, the main contractor relies on sub-contractor because he does not have enough capacity and manpower to carry out all the major functions of the D&B project. In order to manage the project well, the main contractor and specialists should have better ongoing relationship. Design and manage and develop and contrast are the two main forms of integrated D&B contract.

2.11.3 Fragmented design and build

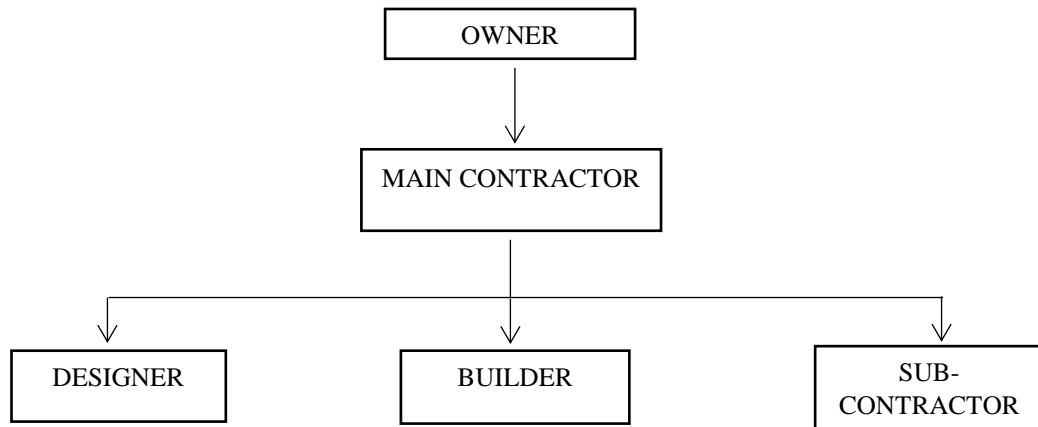


Figure 2-4: Fragmented D&B systems

In this form, the responsibility of the main contractor is management and coordination. In this case the main contractor accepts to carry out the work without in-house specialists and sub-contracts every specialized functions of the projects then after onwards main contractor should make sure everything goes properly in order to achieve the desired output.

Package deal and design manage and construct are the two main forms of fragmented D&B contract. Example for package a deal contract is turnkey projects where main contractor forms a partnership with several partners in order to do a standard work for clients.

Other category is design nag end contrast contract. This is quite similar to pure D&B form, but here the contractor is responsible for part or some of particular construction processes only. Though the contractor is not involved in the whole construction process, it's his duty to coordinate with other parties and functions. Sometimes subcontractors are appointed by the client so the main contractor usually does not have many relationships with them.

2.11.4 Novation design and build

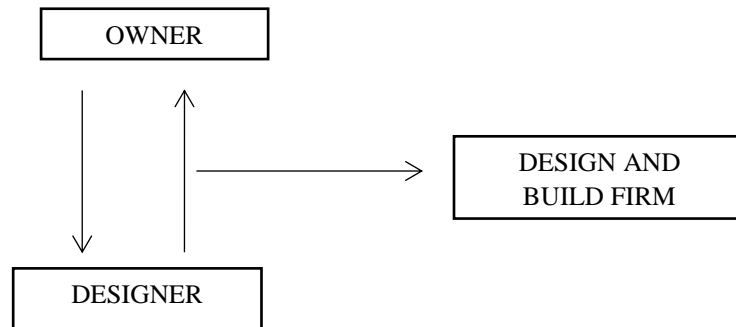


Figure 2-5: Novation D&B system

The owner of the project appoints architect or design team to fulfill the design work after the identification of client's needs. After that, the partly designed structure will be sent out for tender after the selection of the contractor the design team initially appointed by the client will be transferred to main contractor to work with his team. The Architect begins work as client's employee and ends up as an employee of the contractor. Also, after he joins the payment has to be made by the contractor. So compared to other hybrids here the responsibility for contractors in terms of designing is significantly less.

2.12 Advantages of D&B in building projects

Although the main purpose of this study is to identify the constraints of using D&B in Sri Lanka, it's important to look for the advantages of D&B the procurement method. If the barriers and challenges of the D&B procurement system identified it may become the most effective procurement method among other procurement types. Advantages of D&B the procurement system over the other procurement systems are numerous and many authors well identified that. The benefits of D&B in building projects are discussed below;

2.12.1 Shorter project time

Most of the times the research findings on D&B have shown the fundamental advantage of D&B contract type is shorter delivery period. Tulacz (2003) and Songer et al. (1997) find that compared to other procurement types D&B shorten the project delivery period. Ling and Kerh (2004) find generally D&B projects to be 12% faster than projects that use traditional methods. Completion of projects within a shorter time frame is important nowadays due to high competition among different sectors.

The lack of skills is most significant problem in Sri Lanka construction industry, so due to this problem projects couldn't be completed within targeted time.

2.12.2 Cost savings

When a company takes the whole responsibility of both D&B, its companies' responsibility to ensure the design is constructible, which means the design that could be practically possible to construct. Problems like a complicated and over designs are notable and avoidable and should come up with a design they know can be built.

The clients can plan well if they know about the project cost early in advance. Hanscomb (2004) finds that one reason for the development in the utilization of D&B is, owners are well known of project cost from the beginning of the project.

2.12.3 Single point of reference

This single point of reference is considered to be an important advantage in D&B procurement method. One organization is used to coordinating all aspects of construction work as a great benefit of this system. This is very important as it means that the project owner will know to whom he needs to approach when a problem arises. One organization is responsible for all risks, so it might be easier for clients to face any issues regarding claims and especially if he needs to proceed with a lawsuit.

One of the main advantages found by steering committee for construction in Singapore (1999) is that due to project integration reworks and errors could be notable and avoidable and it will lead to savings in cost and time. Using design and build does not simply mean the benefits of D&B could be achieved easily. Should

maintain some of the challenging factors like proper coordination among the team members. If it is lacking, then couldn't get the full benefit from this method. Kumaraswamy et al. (2005) has found that working group in D&B projects is extremely important to take benefit of these advantages.

2.12.4 Better quality

Should know about whether D&B leads better quality or not. Based on the research findings some are suggesting D&B offers are slightly better than the other procurement types and some researchers found when it comes to quality measures all procurement types offers the same quality. Konchar and Sanvido (1998) find that based on functionality D&B offer better performance, while quality aspect almost the same for both methods. However, Akintoye (1994) found that there is no major difference in terms of standard when any types of procurement in use, Gidado and Arshi (2004) against it with results that showed 54% of respondents agreed there is a huge difference in quality when the D&B procurement system in use.

2.12.5 Room for innovation and improvement

This is potential because D&B organization takes full responsibility of both design and construction, so opportunity is high for innovation and improvement due to one team takes full responsibility of the project (Cecil, 1983). This is possible for this contract type because only the main contractor could make changes when the constructability is enhanced.

2.13 The general mechanism of D&B systems

The D&B procurement project began with the idea and the concept of the owner, which was developed as a request for proposal. After preparation of the request for proposal, it was sent to the contractors along with other tender documents for the bidding and tender for the project. The major difference between traditional and D&B system is in the traditional method tender process will begin after the completion of the full design, whereas in D&B system, owner of the project is used to communicating with the contractors with only schematic design done before the

tender process began. Ling and Poh (2007) find that major problem with D&B system, both client and contractor should make important decision on the price of the partially completed design.

After the establishment of the request for proposal with the client that will be sent to potential contractors for bidding. Potential main contractors will submit their bids based on their understandings of the proposal request. Before a final selection client will go through the tender evaluation report with his specialized team. The tender for the entire project must be submitted using very little information, which is a problem area. It is quite different compared to the traditional method which is used to produce complete designs of tender.

There are some hybrids of D&B organization also. Based on the organization capacity either the whole work might be carried by one organization or subcontracted to design company. However, in this contract type there is only one agreement between client and main contractor. If main contractor appoints any other sub-contractors or design team, the client does not have any dealings with any others unless main contractor. The key benefit of this system is shorter delivery period. This could be possible, because only one firm takes full responsibility to design and construct the building. So the contractor is able to plan the work accordingly, even during the designing stage.

It is advantageous for this process and it can become a big troublesome area if it is not properly managed. Also, D&B firms should ensure the constructability of the work when they design, otherwise it will lead to rework as well as variations (Akintoye, 1994).

The main contractor should appoint a project manager or construction manager who is well knowledgeable and managed both design and construction in order to deliver the quality end product. Stillman (2002) suggest to make sure the smooth going of the project, the project owner should appoint project manager who is knowledgeable in both design and construction aspects. However, Horwitz (2001) highlights in reality only few professionals are knowledgeable in both fields in the construction industry. This gives a negative impact of D&B procurement projects in building industry.

The supervision of the construction work should be carried out by the project manager who has been appointed by the owner of the project, but Mckew (2001) finds there is a new trend in D&B, with owners appointing their own project managers to approve packages of work delivered and defend their interests. Ling and Poh (2007) find that appointing a project manager by the owner will reduce the fears of the client, especially if the client is not knowledgeable regarding construction process. Also, this will increase the confidence level of the owner.

2.14 The tender process in D&B contracts

As discussed previously, in D&B project main contractor takes full charge of both design and construction. The project owner has to be more careful than other professionals. Because he is not only selecting the suitable procurement method, but also involving to select the suitable contractor for the job. Client's influence is considerably less in D&B method than other procurement types. According to Songer et. al (1997) a request for proposal should contain client's need clearly which will allow to achieve the work in a perfect manner.

D&B project is more challenging for owners. The reason is they are required to have some procurement and contract knowledge about the construction industry. Otherwise, it will be a huge barrier for them. This point is additionally emphasized by Church and Ndekugri (1996) this method is not appropriate for the clients those who do not have any knowledge in the building construction industry.

2.15 Tender preparation and evaluation phase constraints in D&B

It is important to choose the best design and construction team because owner's influence is extensively less on D&B procurement systems compared to other construction procurement systems. Kumaraswamy et al. (2005) find that it is more critical for owners utilizing D&B procurement methods to get the precise contractor than those using other construction procurement systems. The reason is client cannot make any changes once the project is handed over to the main contractor. It, in this

way winds up critical for the client to choose an appropriate team that can convey his idea to reality.

This is because design and build owners have used more rigorous methods to select a contractor. Abi-Karam (2001) states that, the most challenging, risky work is, the selection of D&B project group. Ling and Poh (2007) supported it in its analysis, the evaluation process of D&B system is much harder than other procurement types, because in a D&B procurement system the bids are submitted for partially designed building.

2.15.1 Tender preparation constraints

Only the potential bidders set up their bids based on the client's requirements found in the Request for Proposal. The contractor will price the bid according to the information that he received from the client. So it is very crucial for owner to convey all his needs and requirements in the request for proposal. It is a not a possible task for the owner who does not have construction industry knowledge.

The scope work must be very detailed. It should contain all the specification and client's needs. The reason is final contractor selection is based on their bid submitted using a request for proposal. Since the final contractor is selected from the bids submitted, it is very crucial that the potential contractors submit the appropriate bids and the proper procedure to be used. Hence, the owners, if they are not sure about the technical aspects of the projects, should approach specialized professionals in order to get an advice.

Tendering practices used by D & B owners are numerous. And it is necessary each project type must adopt the process that suits its necessity. The complexity of the project, the type of the project, owner's background, cost and time are some of the major concerns owners should take into consideration for selection of the correct tender procedure.

2.15.2 Tender evaluation phase constraints

As already mentioned, selection of suitable contractor or team is very important for D&B projects. Chan et al, (2001) finds that the most important factors for D&B projects, the effective teamwork and the proper coordination, are the key to success in conjunction with the integration of the contractor. This implies evaluating tenders ought to be a vital procedure to all owners utilizing D&B systems. The procedures utilized should be such that all points of interest are considered, including the character of potential contractors. More detailed and strictly standardize, the evaluation process for D & B contract is needed more than other tendering systems.

When considering private and public sectors, the process is totally different. Al-Rashaid and Kartam (2005) defined that D&B system is more established in the public sector than the private sector, the reason behind is public sector procedures are complicated than private sector especially for D&B projects. This is because the procedures and regulations are not the same for both sectors to grasp the D&B project. For this, Wardani (2004) recommends client should spend adequate time to select the appropriate project team. The project owners those who are willing to do D&B projects should be dedicated to time, money and effort.

2.16 Design phase constraints

In traditional construction method the contractor's target and focus are about the construction of the building only because in this method there was a separate team appointed by client to assign with design. However, in integrated construction systems such as D&B, the contractor will have to carry out both functions. Not only in Sri Lanka, most of the countries in Asia, Contractors are not yet adapted to acquire design capabilities. Schwager and Sullivan (1991) found the major issue with D&B system is to carry out this method by contractors who do not have enough knowledge in designs

Additionally, the biggest negative impact on D&B system is, the end product is transformed to suit contractor's taste rather than client's concern. Therefore owner's intervention is deemed necessary in D&B projects. (Ling & Poh, 2007).

2.17 Construction phase constraints

Many project owners will want to know how their projects are progressing and how to meet their required standards. Unfortunately, D&B did not provide this option for most project owners. Because they have not been associated with the daily progress of the project, it is easy for them to decide contractor is the only person who could take advantage of them. Cecil (1983) states that project owner does not have any influence on their projects. This means D&B Company will use the advantages of the project owners whenever issues arise. It is necessary for the owners due to their less knowledge in the construction industry, it is recommended for them to hire knowledgeable people to convey their requests in contractual terms.

2.18 Contract management issues in D&B systems

The main benefit of D&B system is there is a one contract between main contractor and the client. However, due to the hybrids of D&B system, the main contractor can have an agreement with sub-contractor for particular functions of the projects. Also main contractor appoints separate design team, according to the complexity of the project. However the client has an agreement with main contractor only after handing over the project. Innovation D&B system the client appoints a design team to do some particular design work. And then after the selection of the main contractor the design team will be transferred to main contractor to work under his organization. This is one of drawback in D&B system that is a main contractor is not always ready to work with designers appointed by the client. Although some standard forms of contract exist in different regions published by various institutions, Chan and Yu (2005) have found that the significant nature of the construction industry makes it very crucial for each project with careful consideration of its contract specifications with all other parties. D & B is new to many parts, meaning that there are no standard contracts for D & B projects yet, so the problem is establishing ideal contracts in construction.

2.18.1 Contract between the owner and the main contractor

Only main contractor is in charge for both design and construction. And it is understandable there is only one agreement between client and the contractor. None of the hybrids of D&B procurement system allow the client to have contract between other professionals like other procurement systems. Jansens (1999) found, the reason behind different advance features of D&B system is, it indicates the capacity of owner's influence in design they like to have. And also it is not desirable to transfer partially design project to contractor with the design team. It is acceptable and lead to constraints as well. Ling and Lau (2002) categorized some of the contract types with the capacity of design input the owners like to have.

The schematic design constraints

In this stage, the client work together with an Architect to establish a schematic design for the project. This is one of the part of the request for proposal. After the design proposal it will sent to potential bidders for tendering. So here client for two contracts, first with design team or architect then with the main contractor. Sometimes client may have his own in-house design team, in that case there won't be any contracts with design team and that can be avoided.

Outline design

In outline design, the owner or his team will prepare only one outline design of the project and then this will be sent out to potential contractors for tendering. After onwards potential bidders have to submit their relevant project documents along with fully completed designs for tender evaluation purpose. However, this idea may be misleading because potential bidders need to submit the tenders with very little sketchy information.

Sketch a plan

Sketch is designed and planned by the design team according to client's requirements and interest. This will be sent for bid along with request for proposal. The only potential contractor asked to submit their design plans to evaluate, after this process

short listed contractors were asked to submit complete designs including prices. The contractor will be selected for the project. The information provided is usually very limited, and there is a risk for bidders to obtain incorrect information.

Turnkey

In turnkey project type, there is no designs submitted with the scope of work or request for proposal. From start to end of the project, contractors have complete design and full control over the entire project and therefore the client is having only one agreement with the main contractor. Even though plenty of advantages to this system, there is a risk associated with D & B projects in general, which the contractor completes the project as per his own taste than to that of the owner.

2.18.2 Contractual Liability of D&B system

Because the contracts in construction are usually consistent with a specific project, the responsibility of each project or part of the project depends on the contractual approach. Generally the main contractor's liability is depends on the amount of client's influence in the project. If owner takes more liability then the main contractor may have less liability to bear. Chan and Yu (2005) categorized two types of liabilities which were mentioned below.

Fitness for purpose

Responsible for industry in the UK, it is expected that their main contractor will use 'due care and skill' to carry out their work. It is largely accepted that the final end put delivered by the contractor ought to be completely illustrative of the concise provided by the owner and furthermore be helpful for the reason for which it was expected.

Reasonable skill and care

In some countries including Hong Kong reasonable skill and care were established to evaluate the project. This option is quite different from the fitness for purpose, here the situation and condition of the contractor will be analyzed and make sure he delivers best end put with in his power.

2.19 Management issues at project implementation (design and construction phases) level in D&B

There are most significant credits in D&B projects. Those are shorter deliver period and early determination of project cost. Such as planning, coordination, correspondence and collaboration must be in a proper way before start the construction with half way completed design. Here D&B procurement system is totally different other procurement system. The construction of the D&B system began before end of the design, while rest of the procurement systems construction will begin after the design part completed. So this section explain the management issues at project implementation level in D&B system.

2.19.1 Issues in planning and scheduling

In D&B project, the contractor takes full responsibility of design and construction of the entire building so the owner must clearly define his requirements in the scope of work or request for proposal. Then only it will be easier for main contractor to plan and schedule his work accordingly in advance before the construction begun.

So the planning and scheduling is based on some of important components which were discussed below;

Sequence and duration of activities identified

Time is one of the important factor in D&B projects. Should follow the right sequences in order to maintain the proper timing. This problem has been further enhanced by the fact that construction may start before design is completed. Recognizing long lead actions should be initiated early so that they do not interfere with the progress of the later operations and therefore slow down the project pace. This is more complicated to form both design and construction activities in proper time sequences. It is important to keep a schedule for each member of the team to get the desired outcome. If there are any sub-contractors hired by the owner or main contractor to make any specific work, the project manager should be advised to communicate the schedule itself. It can be incorporated into a whole project plan.

Regular project meetings

In spite of the fact that the main contractor has full responsibility for the construction of the building, some of the advance features of the D&B system allows the owner to give approval some of the work packages when project undergoing. This has to be discussed during the formal regular meeting between main contractor and the client or his representatives. Should make sure regular meetings are happening between design team members and construction team and also between main contractor and sub-contractor. It is often easier when it is said that outsourcing and designing companies which include different teams in the organization. While the load of meetings is too much to integrate design and construction in one, it is very important to keep everybody on the same page.

Permit issues

Because there is very limited time left for D&B projects, securing a permit in time is become very challenging and serious issue. It takes quite a long period to get the approval from the relevant authorities. It is necessary to make sure all the approvals are ends with in a certain time period. However, it must be acknowledged that there is a time delay for certain approvals. So be prepared to face that circumstance. There is a possibility that entire project will be delayed when the activities goes on the critical path. In Sri Lanka Building Planning Approval and Land Sub Division Planning Approval should be done via respective area Local Authorities

2.19.2 Communication and information distribution constraints

Gold (2003) indicates there is a significant benefit in D&B project which is productive communication between different professionals. And the reason is only one organization in charge for all both design and construction. But always couldn't expect the same situation. There is a possibility for communication barriers among different parties in D&B projects. Some of the owners have complained, their progress of the project is being kept in dark.

Many group of people involve in D&B projects, so those parties require different information for different tasks. How they deal with different parties will have an

impact on final output of the project. An information manager must ensure that all related information are properly prepared, compiled and circulated (Ling & Lau, 2001). Furthermore, each group must be appointed by a member to cope with the information, so there is no vague and confusing. Generally the communication in D&B projects in between the owner of the project and contractor or else with other team members which were mentioned below.

The owner and contractor

The main limitation of D&B project is after the influence by the main contractor, the owner is set back from the project. The more liabilities goes to the main contractor (Ling & Poh, 2007). It is very important for the owner to intervene in D&B system, so that the owner can see how the project is progressing.

Various team members

Communicating with team members is very effective. In D&B, the construction begins before the design is completed, meaning that good communication to the two teams is very important. If the correct information is not available on issues like design and scope, the construction team will be devastating by building the wrong structure.

2.19.3 Coordination issues between various teams

Effective teamwork is very important to get the desired results for D & B contracts. In the D&B projects, design and construction groups are generally coordinated to integrate a large group, in contrast to each group individually managed traditional procurement methods. So it is essential to properly manage and coordinate teams to avoid problems (Schwager & Sullivan, 1991). D & B project teams are usually more difficult to manage than being large and include various experts. Team members in D&B projects should trust each other, and due to the changes in the subject matter, they should work together for a common goal so as to provide timely responses and revisions to a well-coordinated team for the purpose.

2.20 Summary of findings from Literature

This chapter gave a brief introduction about what is procurement and mainly discussed three types of procurement systems, which are, separated and co-operative procurement systems, integrated procurement system and management oriented procurement system. After onwards discussed the important factors when choosing the procurement type in building projects. Following by D&B procurement system's characteristic, advance features, mechanism and advantages were explained. Finally constraints of tender preparation and evaluation phase, design phase and construction phase were identified. From the literature some of the main features were identified and were indicated below, those are.

- D&B procurement system is still very limited in Sri Lanka building projects.
- Numerous drawbacks exist when D&B is in use. Some are very particular in Sri Lanka context.
- There are constraints identified in all phases of project implementation, including tender management, contract management, planning, design and construction.

D&B procurement system is still not widely utilized due to these constraints experienced. So the following chapters will discuss about the serious of the identified constraints and find a way to increase its use in Sri Lanka building industry.

CHAPTER 3: METHODOLOGY

3.1 Introduction

The third chapter of the research study incorporates with numerous subdivisions. The goal and ultimate purpose of this chapter is to clarify how to conduct the research in a suitable way. The segments of the chapter are conceptual framework, hypothesis development, operationalization and final research design. Under research design discussed about target population, sample size and techniques, data collection methods and data analysis tools and techniques. Conceptual framework includes dependent and independent variables. After identification of the variables developed hypothesis of the study. Development of the conceptual framework and the hypothesis gives the support to research methodology and based on those two major aspects, the research designed whether quantitative or qualitative approach is suited. This research study is full and fully based on quantitative method. Because it is used to quantify the problem by the way of generating numerical data that can be transformed into usable statistics. Also, it generalize results from a large sample population and it allows to examine the relationship between the two variables.

3.2 Conceptual framework

By simple definition, conceptual framework is the researcher's understanding the link with variables with others in particular research area. The conceptual framework is a systemised structure which helps understand the phenomenon of the entire study (Camp, 2001). The conceptual framework defines the connection between the primary concepts of a study in a perspective that is analytical. It is kind of a logical framework, which helps to provide a picture or visual view of how each idea of the study is interlinked with one another (Grant & Osanloo, 2014).

Researchers will obtain many advantages via conceptual framework. For instance, it helps the researcher to identify which phenomenon to study and investigated throughout the study (Grant & Osanloo, 2014). It is one of the basic visual views where researcher presents asserted remedies to his/her defined research problem

(Liehr & Smith, 1999; Akintoye, 2015). Akintoye (2015) describes that the ultimate use of conceptual frameworks is, it's useful when existing theories are not adequate to carry out the further research work. The research study conceptual framework is as follows;

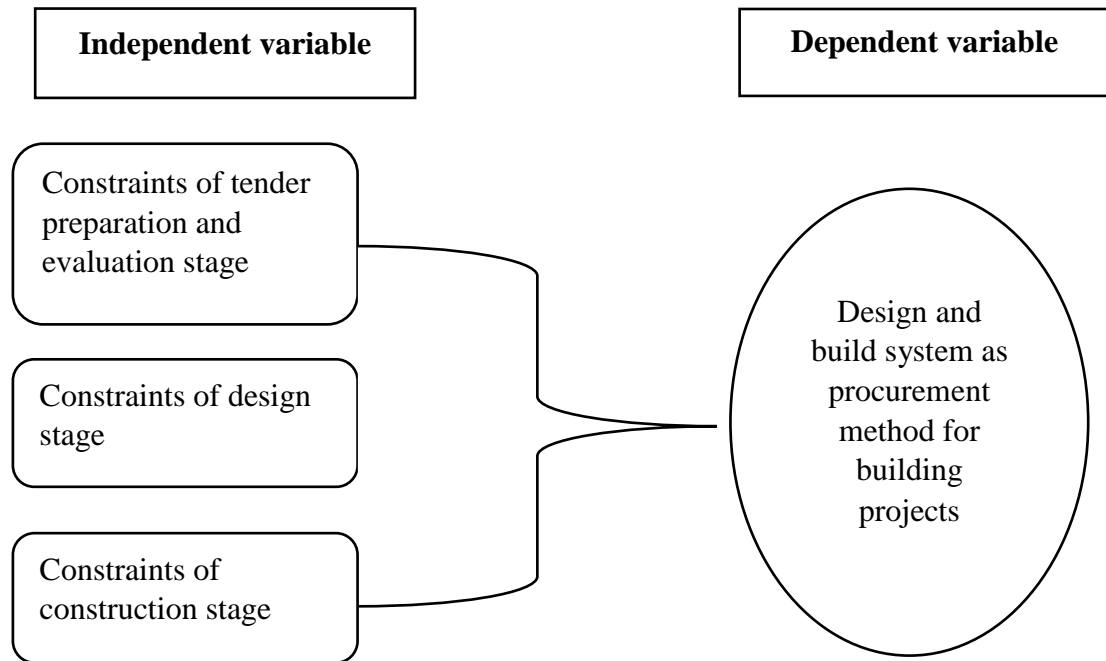


Figure 3-1: Conceptual framework

Source: Developed by the author

As mentioned earlier the above figure depicts the identified dependent and independent variables of the study. In this study, “Design and build system as a construction procurement method” is the independent variable, while “constraints of the tender preparation stage, constraints of the design phase and constraints of construction phase” are the dependent variable. In other words, “Constraints of all three phases” depend on “Design and build system.” The completed conceptual framework will lead to do the scientific research that will prove the relationship that has been illustrated.

3.3 Hypothesis Development

A hypothesis is a prediction of a relationship between dependent and independent variables. The simplest definition of hypothesis is stated about the solution of the problem. Through hypothesis testing either the statement could be accepted or rejected.

The hypothesis is kind of guess which explains what is going to happen in a particular situation and as well as condition. Generally a good hypothesis have to have some important characteristics, it includes a clear rationale, clear description based on the relationship among the variables of the research study. The following hypotheses have been formulated from the research problems and determined variables.

- H1a-There is a relationship between tender preparation and evaluation phase constraints and D&B system in building projects.
- H1b-There is no relationship between tender preparation and evaluation phase constraints and D&B system in building projects.
- H2a-There is a relationship between design phase constraints and the D&B system in building projects.
- H2b-There is no relationship between design phase constraints and the D&B system in building projects.
- H3a-There is a relationship between construction phase constraints and the D&B system in building projects.
- H3b-There is no relationship between construction phase constraints and the D&B system in building projects.
- H4a-There are serious challenges in the management of projects due to the non-deployment of project managers and other professionals in the projects.
- H4b-There are no serious challenges in the management of projects due to the non-deployment of project managers and other professionals in the projects.

In this study four sets of hypothesis identified. The use of hypothesis H1a to H3b is to test the relationship between the dependent variable of design and build system as a construction procurement method and independent variables of the constraints of the tender preparation stage, constraints of the design phase and constraints of the construction phase. And the last set of hypothesis is to give the recommendation to the research study as whether to include the project manager would improve the use of D&B system or not.

3.4 Operationalization

Table 3-1: Operationalization of the research

| Concept | Measurement indicator | Authors | Measurement Method |
|--|-------------------------------------|-------------------------------|---------------------------|
| Constraints of tender preparation and evaluation stage | Knowledge for scope preparation | Songer et al. (1997) | Likert scale (1-5) |
| | Manpower for scope preparation | Horwitz, (2001) | |
| | Information required in the RFP | Phng, (2005) | |
| | Knowledge to evaluate tender | Wardani, (2004) | |
| Constraints of design stage | Design knowledge | Songer et al. (1997) | Likert scale (1-5) |
| | Contractors lack adequate insurance | Mohamed, (2005) | |
| | Poor communication | Kassim and Shamsaddin, (2004) | |

| Concept | Measurement indicator | Authors | Measurement Method |
|---|----------------------------------|-------------------------------|---------------------------|
| | Design not taste of owner | Ling and Poh, (2007) | |
| Constraints of construction stage | Owners don't get the information | Mohamed, (2005) | Likert scale (1-5) |
| | Price uncertainty | Turner, (1997) | |
| | Delay | | |
| | Team coordination | Schwager and Sullivan, (1991) | |
| Design and build as a construction procurement method | Time | Chan, Lam and Scott, (2002) | Likert scale (1-5) |
| | Budget management | | |
| | Quality | | |
| | Functionality | | |

Source: Developed by the author

Operationalization is the process of strictly defining variables into measurable factors. The process defines fuzzy concepts and allows them to be measured, empirically and quantitatively. In the above table under concept column that mentioned 03 independent variables and 01 dependent. And for each variable constraint are the measurement indicators. Concept and measurement indicators are derived from the literature review. Likert scale was used to rank the position of each constraint.

3.5 Research design

The type of design used for this study is descriptive survey design. A descriptive study is focused on defining the frequency with somewhat identify the relationship among variables (Bryman & Bell, 2003). The design of the survey is structured questionnaire given to sample of population designed to gather specific information needed for the study and also structured interview among D&B experts in the construction industry. This descriptive survey design has numerous advantages: ease, reliability, and validity and simplicity. If the collected data are not appropriate to insert in the survey that could be removed easily since it's computerized. In descriptive analysis, bias could be prevented through operational definitions of variables, large size, purposive sampling technique, valid and reliable research tools and formal data collection tools. .

Questionnaires were sent to different professionals in the Sri Lankan construction industry, including client, contractor, project managers, construction managers, architects, quantity surveyors and engineers in order to get a balanced viewpoint. For this survey mainly targeted construction with D&B experience, but professionals those who has D&B knowledge also considered. Like developed countries in Sri Lanka also the contact details of constructional professionals published in their professional membership institute. Contact details of project and construction managers details obtained from company official websites. A list of Architects details gathered from the website of the Sri Lanka Institute of Architects (SLIA) and also from known Architects in Sri Lanka. Likewise Quantity Surveyor's contact information has been obtained from Quantity Surveyors Sri Lanka (IQSSL) website. Telecom published yellow pages were useful to get the contact the details of construction contractors.

The design of the Questionnaire is, the first section is about demographic information, where professionals must state their occupation, sector where do they work, years of experience and the awareness of the D&B procurement system. The second section is closed and open type questions. Constraints of all three construction phases will come under this section. Respondents must state their

ranking for each and every questionnaire. And they are free to put their comments if they identified any other constraints other than stated. Last section designed to obtain the recommendation from respondents.

3.5.1 Target population

The survey was sent to 75 Sri Lankan construction professionals and 54 responded. The respondent's rate was 72%. In order to get a balanced report the research concentrated on the Architects, Engineers, Quantity Surveyors, Contractors, Clients, Project Managers and Contract Managers.

3.5.2 Sample size and Techniques

The sampling technique considered for this study is purposive sampling. This refers as judgement sampling too. The researcher chooses just what needs to be known and sets out to find those who are willing to give information by virtue of knowledge or experience (Bernard, 2002). Purposive sampling technique will reduce the time for data collection and also it will allow gathering data from professional those who has relevant characteristics for to participate in the relevant survey.

3.5.3 Data Collection Method

According to Ngechu (2004) numerous techniques are available to collect data for research studies. In this regard, there are a selection of tools and instruments that provide influence for the data collection. Collection of data classified as primary and secondary data in statistics. This study has used two techniques under primary data collection. Another one is closed and open type questionnaire survey. Another type is a structured interview with experts with D&B experience. Conducted face to face interview as well interview over the telephone. The secondary data collected from books, journals, articles, newspapers and magazine.

Used Likert scale for questionnaire survey and it was invented by psychologist Rensis Likert. The study was developed by using survey monkey online survey software and sent via LinkedIn and emails to selected individuals who are currently working in Sri Lanka. Respondents were answering the questions within one month.

3.5.4 Data Analysis tools and techniques

To get an accurate output, it is important to use the appropriate data tools and technique. Analyses of the data are a combination of the variables. It is often involved to split the data into various categories. The data has been collected from the questionnaire survey and then entered in Excel sheet. Later in excel sheet data converted to SPSS software. SPSS software is one of the famous analytical software, especially for quantitative research. Four types of statistical analysis done in the research study. Those are validity and reliability testing descriptive analyses, hypothesis testing using Pearson correlation and regression analysis.

3.6 Chapter summary

This methodology chapter gave a clear idea about how to conduct the research, especially the way of collecting data. The importance of a conceptual framework and operationalization of the research has been discussed. Followed by the research technique, data collection, population, sample size and sampling technique were discussed. Altogether, this chapter provided the clear information before initiating the data analysis.

CHAPTER 4: DATA ANALYSIS AND FINDINGS

This data analysis and findings chapter considers the most important segments for this research study. This chapter mainly discusses the findings from 54 questionnaires completed by Sri Lanka construction professionals. The aim and purpose of this study was to identify the constraints using the D&B system in different phases of building projects as well as giving recommendation in order to improve the use of the D&B system in Sri Lanka.

The data from the questionnaire analyzed through statistical methods. Used SPSS version to analyse the data. The questionnaire designed with three main categories. Those are mentioned below:

Section A: Demographic information

Section B: Possible constraints in the design and build system in different phases of building projects in Sri Lanka

Section C: Design and build performance indicators

Section D: Recommendation

4.1 Profile Analysis of Respondents

The first section of the questionnaire designed for demographic information. Where respondents asked to the construction field, involvement in D&B projects, awareness of D&B projects, sectors involve in D&B projects and finally size of the D&B projects generally awarded per annum in the organization. The use of gathering demographic data is to make sure whether the individuals in a particular study are a representative sample of the target population for generalization purposes.

1. Respondents by profession

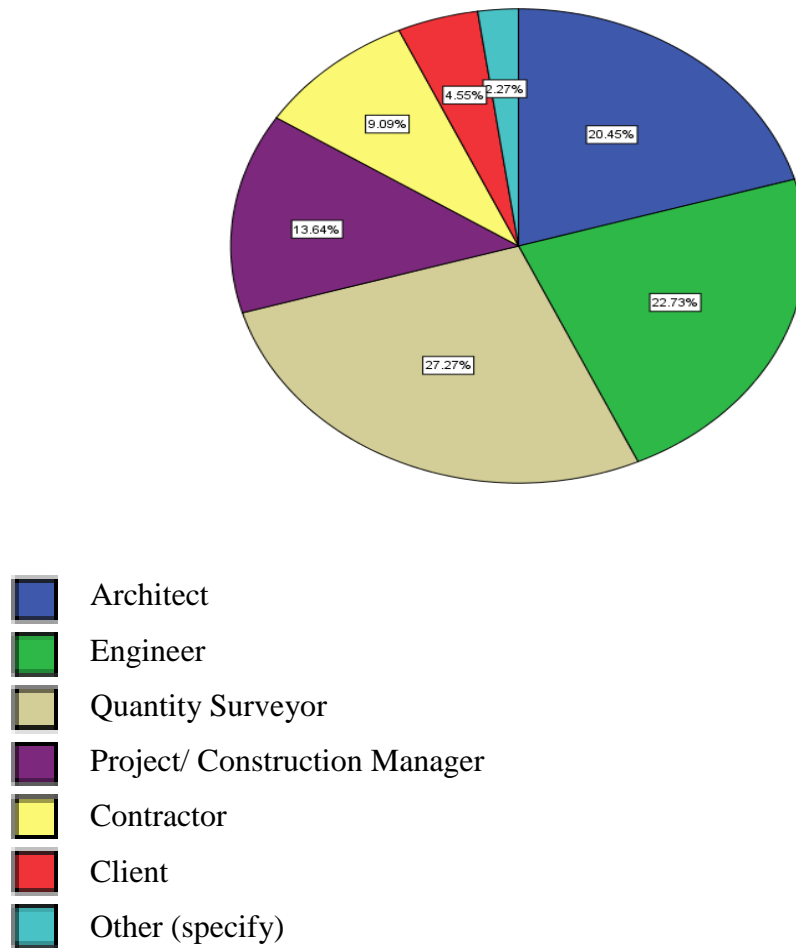


Figure 4-1: Respondents by profession

Source: Survey data

The research study conducted included employees who are in various professions. There were 20.45% working as an Architect. 22.73% working as an Engineer. 27.27% working as a Quantity Surveyor. 13.64% working as Project/ Construction Manager. 9.09% working as a contractor. 4.55% working as a Client. 2.27% working on various positions in the construction.

Due to the above findings, it can be identified that Quantity Surveyor profession is the major participation in this research study.

2. Respondents by sector

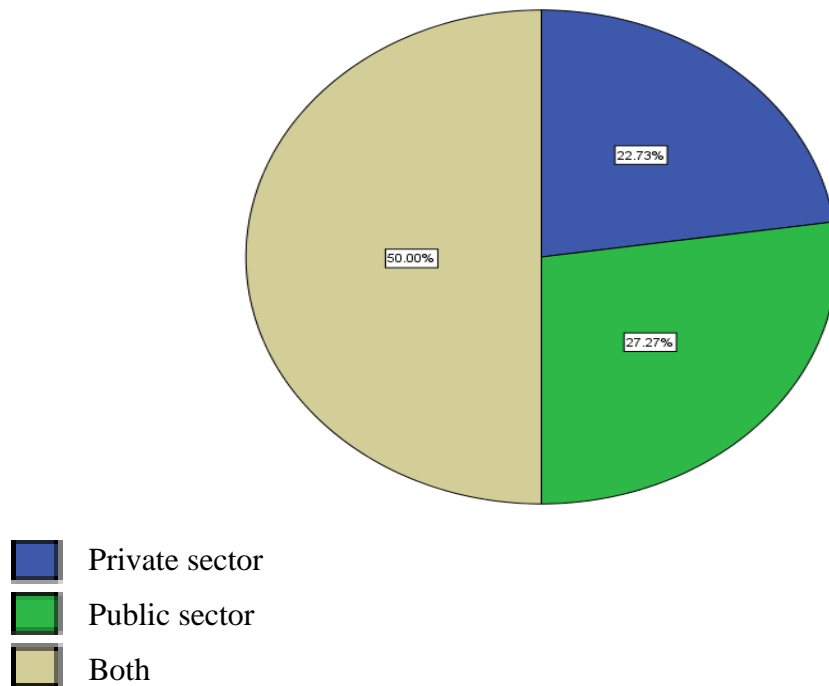


Figure 4-2: Respondents by sector

Source: Survey data

The study conducted for employees who are working in different sectors. There were 22.73% working in a private sector. 22.27% working in a public sector and 50% working in both private and public sectors.

Due to the above findings, it can be identified that private and public sectors working employees are major participants in this research study.

3. Type of organization

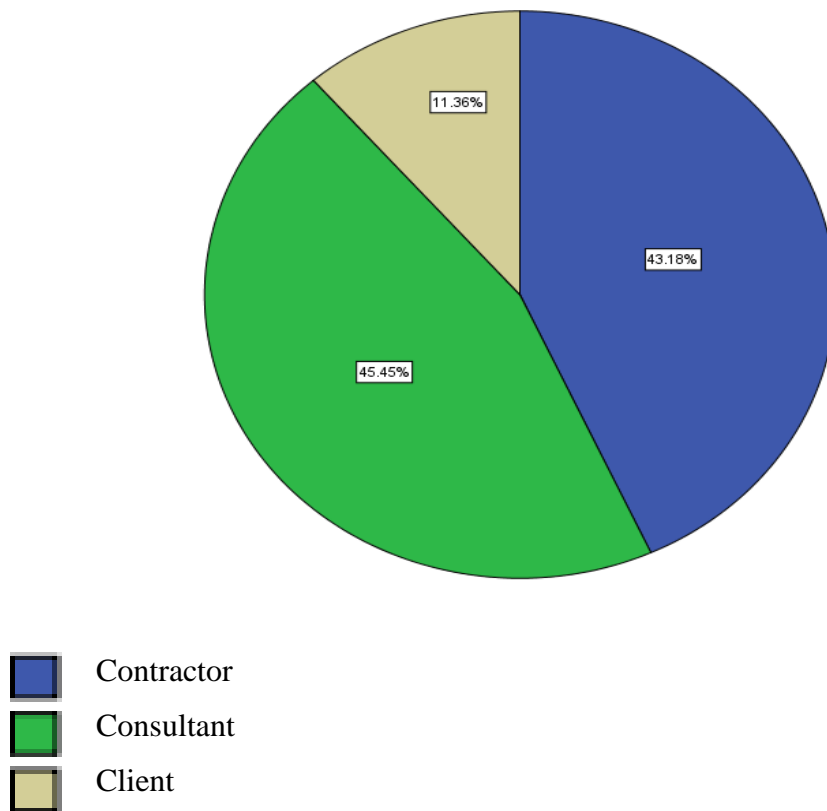


Figure 4-3: Type of organization

Source: Survey data

This research was conducted for employees those who are working as contractor, consultant and client organizations. There were 43.18% working in contractor organization. 45.45% working in consultant organization and 11.36% working in Client organization.

Due to the above findings, it can be identified that those majority of participants are working in the client organization.

4. Length of experience in construction.

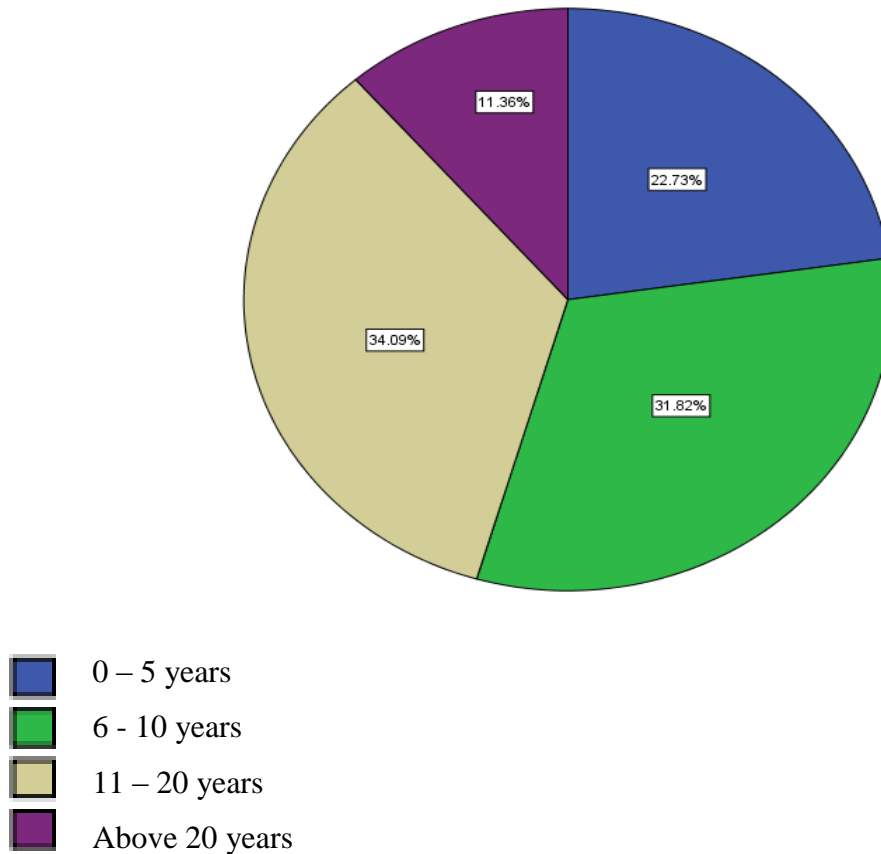


Figure 4-4: Own length of experience in construction

Source: Survey data

The research study is to assess how many years the employees work in their organization. There were 22.73% having below five years of working experiences. 31.82% were having 6-10 years of working experience and 34.09% were having 11-20 years of working experience and 11.36% were having above 20 years of working experiences.

Most participants in this research have participated that they have been working in construction industry for more than twenty years.

5. Involved in design and build projects

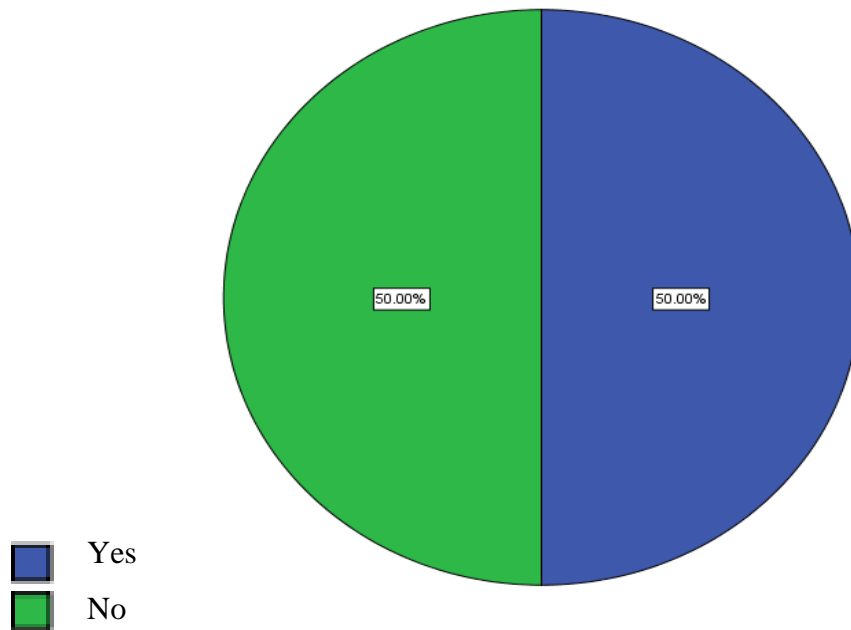


Figure 4-5: Involvement in design and build projects

Source: Survey data

The research study conducted for employees is to find out their involvement in D&B projects. According to the survey data findings half of the respondents are involved in D&B and another half never involved in D&B.

Half of those who participated in this study were found to have not D&B experience, but assuming they have D&B procurement system knowledge and included in the analysis.

6. Awareness of design and build contracts

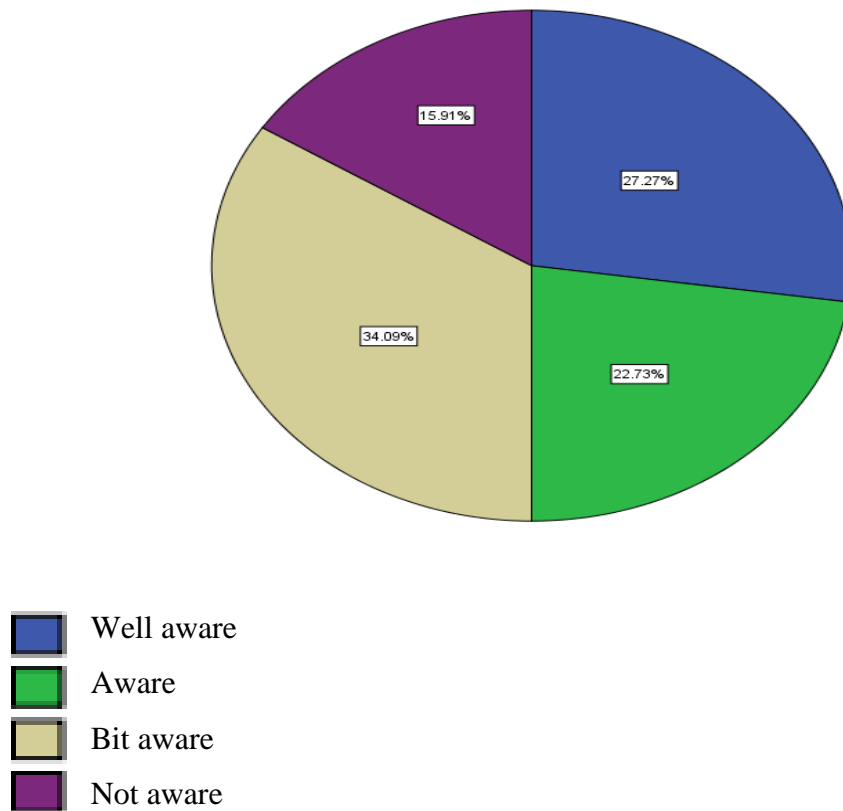


Figure 4-6: Awareness of design and build contracting

Source: Survey data

The research study conducted for employees to identify the awareness about D&B contracting. According to the survey data findings, 27.27% were well aware about the D&B contracting. 22.73% aware of D&B contracting. 34.09% bit-aware of D&B contracting. There were 15.91% unaware of D&B contracting.

So for analysis out of 100% that used 84.09% respondent's answers of those who are aware of the D&B procurement system and omitted 15.91 respondents ranking since they are not aware of D&B system. The purpose is to make sure the findings are valid and reliable.

7. Sectors involvement in design and build projects

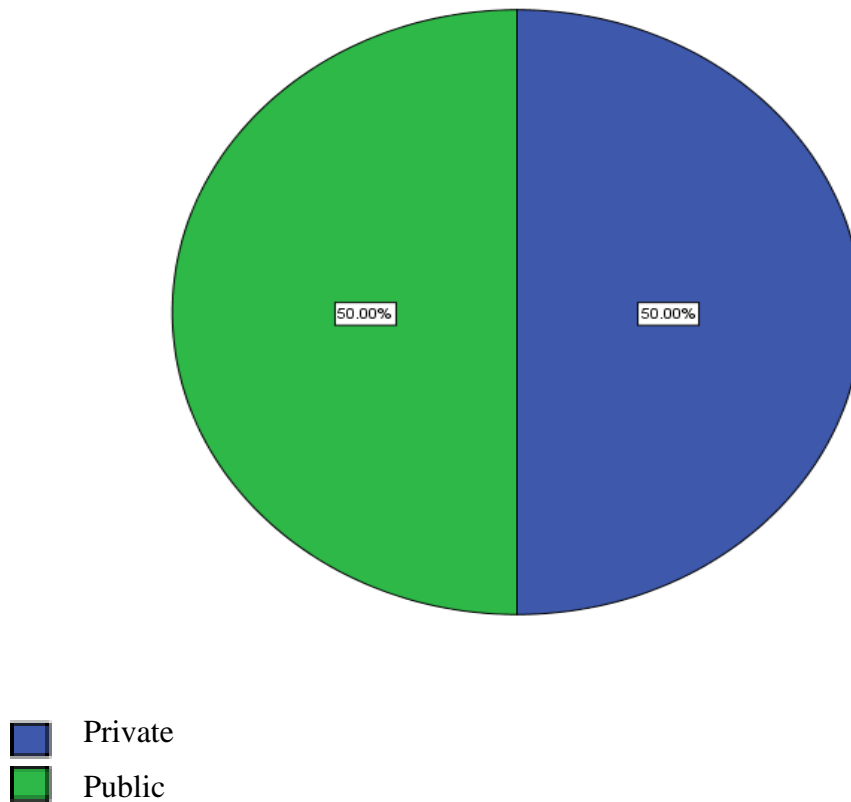
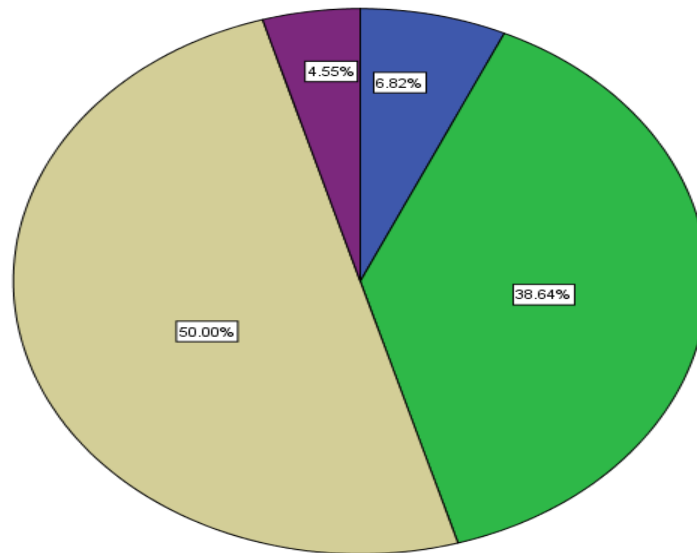


Figure 4-7: Sectors involvement in design and build projects

Source: Survey data

The research study conducted for employees to identify which sector of the D&B procurement method is mostly involved. Due to the above findings, it can be identified that private and public sector involvement is 50% each of the D&B procurement system.

8. The size of the design and build project is generally awarded per annum in the organization







-  Medium size project/ Less than 1,000 Mn
-  Large size project/ Between 1,000 Mn to 5,000 Mn
-  Very large size project/ Between 5,000 Mn to 10,000 Mn
-  Mega project/ More than 10,000 Mn (10 Billion)

Figure 4-8: Size of the design and build project is generally awarded per annum in the organization

Source: Survey data

The research study conducted for employees who are working in different size of D&B projects. There were 38.64% working in a medium size project. 50% working in a large size project. There were 4.55% working in a very large size project and 6.82% were working in a mega project.

Due to the findings, it is found most of the participants are working in very large size project the value is between 5,000 Mn to 10,000 Mn.

4.2 Reliability and Validity Analysis of the study

Cronbach's alpha reliability testing designed to measure the internal consistency of the items which are mentioned in the questionnaire. For cronbach's alpha reliability coefficient normally the range should be between 0 and 1. The highest limit of alpha is 1. If the alpha value is closer to 1.0 the greater which means the internal consistency of the items in the scale. Based upon the formula $\alpha = \frac{rk}{[1 + (k - 1) r]}$ where k is the number of items considered and r is the mean of the inter-item correlations the size of the alpha is determined by both the number of items in the scale and the mean inter-item correlations. George and Mallery (2003) found the following rules of thumb: " $\alpha > .9$ – Excellent, $\alpha > .8$ – Good, $\alpha > .7$ – Acceptable, $\alpha > .6$ – Questionable, $\alpha > .5$ – Poor, and $\alpha < .5$ – Unacceptable".

As the value of alpha is partially dependent upon the number of items in the scale, it should be noted that this has diminishing returns. The reasonable target of alpha value is in between 0.7 to 0.8. Moreover, that while a high value for Cronbach's alpha specifies good internal consistency of the items in the scale, it usually does not indicate that the scale is unidimensional.

4.2.1 Constraints of tender preparation and evaluation phase

Table 4-1: Reliability statistics for constraints of tender preparation and evaluation phase

Reliability Statistics

| Cronbach's Alpha | N of Items |
|------------------|------------|
| .801 | 7 |

Source: Survey data

According to the analysis, the Cronbach's Alpha was received and it shows 0.801 for level of constraints of tender preparation and evaluation phase, which indicates the recognition level (>0.5) of internal consistency of the items in the scale. Based on α value that could say questionnaire is reliable and valid.

4.2.2 Constraints of Design phase

Table 4-2: Reliability statistics for constraints of design phase

Reliability Statistics

| Cronbach's Alpha | N of Items |
|------------------|------------|
| .789 | 7 |

Source: Survey data

According to the analysis, the Cronbach's Alpha was received and it shows 0.789 for level of constraints of the design phase, which indicates the recognition level (>0.5) of internal consistency of the items in the scale. Based on α value that could say questionnaire is reliable and valid.

4.2.3 Constraints of construction phase

Table 4-3: Reliability statistics for constraints of construction phase

Reliability Statistics

| Cronbach's Alpha | N of Items |
|------------------|------------|
| .753 | 7 |

Source: Survey data

According to the analysis, the Cronbach's Alpha was received and it shows 0.753 for level of constraints of the construction phase, which indicates the recognition level (>0.5) of internal consistency of the items in the scale. Based on α value that could say questionnaire is reliable and valid.

4.2.4 Design and Build system in building projects

Table 4-4: Reliability statistics for Design and Build as a construction procurement system

Reliability Statistics

| Cronbach's Alpha | N of Items |
|------------------|------------|
| .729 | 7 |

Source: Survey data

According to the analysis, the Cronbach's Alpha was received and it shows 0.729 for level of design and build system in construction phase, which indicates the recognition level (>0.5) of internal consistency of the items in the scale. Based on α value that could say questionnaire is reliable and valid.

4.3 Descriptive Statistics of Sample Profile

The research study was conducted for construction industry employees and there were 54 employees in the different categories who involved in the research study. The use of descriptive statistics is, it describes the key features of the results in a particular research. It is used to analyze and represent previously collected data. It includes frequency counts, ranges (high and low scores or values), means, modes, median scores and standard deviations.

Further, SPSS software used to calculate descriptive statistics and each question of the questionnaire which shows the independent and dependent variables. The frequencies command can be used to determine quartiles, percentiles, measures of central tendency (mean, median, and mode), measures of dispersion (range, standard deviation, variance, minimum and maximum), measures of kurtosis and skewness, and create histograms. The descriptive statics analyses used for the research study and below table depicts the descriptive statics analysis.

4.3.1: Descriptive statics analysis of constraints of tender preparation and evaluation phase

Table 4-5: Descriptive statics analysis for constraints of tender preparation and evaluation phase

Descriptive Statistics

| | N | Minimum | Maximum | Mean | Std. Deviation |
|------------------------|----|---------|---------|------|----------------|
| TE1 | 54 | 1 | 5 | 3.93 | 1.065 |
| TE2 | 54 | 2 | 5 | 3.80 | .668 |
| TE3 | 54 | 1 | 5 | 3.18 | .995 |
| TE4 | 54 | 1 | 5 | 3.66 | .834 |
| TE5 | 54 | 2 | 5 | 3.52 | .954 |
| TE6 | 54 | 1 | 5 | 3.78 | 1.011 |
| TE7 | 54 | 2 | 5 | 3.42 | .795 |
| Valid N (list wise) | 54 | | | | |

Source: Survey data

The above table shows all 54 respondents participated in this survey. The maximum score scored for this survey is 5 and the minimum is 1. The average is closer to each constraint. Constraints no. 6 has the high standard deviation value that indicates data points which are spread out over a large range of values. Also the table indicates that statics mean, standard deviation for constraints of tender preparation and evaluation phase related questions are in agreed level.

Due to the above results, that sample respondent sensed that tender preparation and evaluation phase increase constraints of using the D&B procurement system in building projects.

4.3.2 Descriptive statics of constraints of design phase

Table 4-6: Descriptive statics analysis for constraints of design phase

Descriptive Statistics

| | N | Minimum | Maximum | Mean | Std. Deviation |
|------------------------|----|---------|---------|------|----------------|
| D1 | 54 | 1 | 5 | 3.95 | 1.056 |
| D2 | 54 | 2 | 5 | 3.80 | .668 |
| D3 | 54 | 1 | 5 | 3.20 | 1.002 |
| D4 | 54 | 1 | 5 | 3.11 | .829 |
| D5 | 54 | 1 | 5 | 3.43 | .979 |
| D6 | 54 | 2 | 5 | 3.89 | .852 |
| D7 | 54 | 2 | 5 | 3.37 | 1.014 |
| Valid N (list wise) | 54 | | | | |

Source: Survey data

The above table shows all 54 respondents participated in this survey. The maximum score scored for this survey is 5 and the minimum is 1. The average is closer to each constraint. Constraints no. 1 has the high standard deviation value that indicates data points which are spread out over a large range of values. Also the table indicates that statics mean, standard deviation for constraints of design phase related questions are in agreed level.

Due to the above results, that sample respondent sensed that design phase increase constraints of using the D&B procurement system in building projects.

4.3.3 Descriptive statics for constraints of construction phase

Table 4-7: Descriptive statics analysis of constraints of construction phase

Descriptive Statistics

| | N | Minimum | Maximum | Mean | Std. Deviation |
|------------------------|----|---------|---------|------|----------------|
| C1 | 54 | 2 | 5 | 3.73 | .817 |
| C2 | 54 | 1 | 5 | 3.80 | .895 |
| C3 | 54 | 1 | 5 | 3.23 | 1.056 |
| C4 | 54 | 1 | 5 | 3.73 | .817 |
| C5 | 54 | 2 | 5 | 3.22 | 1.014 |
| C6 | 54 | 1 | 5 | 3.79 | .833 |
| C7 | 54 | 1 | 5 | 3.37 | 1.024 |
| Valid N (list wise) | 54 | | | | |

Source: Survey data

The above table shows all 54 respondents participated in this survey. The maximum score scored for this survey is 5 and the minimum is 1. The average is closer to each constraint. Constraints no. 3 has the high standard deviation value that indicates data points which are spread out over a large range of values. Also the table indicates that statics mean, standard deviation for constraints of construction phase related questions are in agreed level.

Due to the above results, that sample respondent sensed that construction phase increase constraints of using the D&B procurement system in building projects.

4.3.4 Descriptive statics for design and build system in building projects

Table 4-8: Descriptive statics analysis for design and build as a construction procurement method

Descriptive Statistics

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---------------------|----|---------|---------|------|----------------|
| DB1 | 54 | 1 | 5 | 3.1 | .984 |
| DB2 | 54 | 1 | 5 | 3.45 | 1.009 |
| DB3 | 54 | 1 | 5 | 2.98 | .948 |
| DB4 | 54 | 1 | 5 | 3.20 | 1.092 |
| DB5 | 54 | 1 | 5 | 3.22 | .895 |
| DB6 | 54 | 1 | 5 | 3.37 | .878 |
| DB7 | 54 | 1 | 5 | 3.84 | 1.024 |
| Valid N (list wise) | 54 | | | | |

Source: Survey data

The above table shows all 54 respondents participated in this survey. The maximum score scored for this survey is 5 and the minimum is 1. The average is closer to each constraint. Performance indicator no. 4 has the high standard deviation value that indicates data points which are spread out over a large range of values. Also the table indicates that statics mean, standard deviation for D&B as a construction procurement method related questions are in agreed level.

Due to the above results, that sample respondent sensed that key performance indicators increase D&B procurement system in building projects.

4.4 Testing Hypothesis: using the Pearson Correlation

The correlation coefficient test is one of the famous statistic test to determine the strength between two variables. The analysis of correlation analysis performs to analyse the relationship between the independent and dependent variables. This test allows to decide whether the value of the population correlation coefficient ρ is “close to 0” or “significantly different from 0” based on the sample correlation coefficient r and the sample size n . If the test concludes that the correlation coefficient is significantly different from 0, could say that the correlation coefficient is “significant”. And the other way around if the test concludes that the correlation coefficient is not significantly different from 0 (it is close to 0), we could say that the correlation coefficient is “not significant”. In hypothesis testing if the significant value is less than the predetermined significant level then could reject the null hypothesis. So the ultimate purpose of the hypothesis test is to determine which statement is best supported by the sample data.

4.4.1 Constraints of tender preparation and evaluation phase

Table 4-9: Correlation -Tender preparation and evaluation phase constraints

Correlations

| | | Tender Preparation Constraints | Design and Build Procurement |
|---|---------------------|--------------------------------|------------------------------|
| Tender Preparation and evaluation phase constraints | Pearson Correlation | 1 | .912** |
| | Sig. (2-tailed) | | .000 |
| | N | 54 | 54 |
| Design and Build Procurement | Pearson Correlation | .912** | 1 |
| | Sig. (2-tailed) | .000 | |
| | N | 54 | 54 |

** . Correlation is significant at the 0.01 level (2-tailed).

Source: Survey data

H1a- There is a relationship between tender preparation and evaluation phase constraints and D&B as a procurement method for building projects

A Pearson correlation test was done to determine the relationship between tender preparation and evaluation phase constraints and D&B procurement system. In this test, Pearson correlation coefficient, r , is 0.912 and that is statistically ($p=0.005$). Due to the analytical study, null hypothesis is failed to accept and the hypothesis is validated and there was a strong, positive correlation between tender preparation and evaluation constraints and D&B as a procurement method for building projects, which was statistically significant ($r=0.912$, $n=54$, $p=0.05$)

4.4.2 Constraints of design phase

Table 4-10: Correlation –Design phase constraints

| Correlations | | Design Phase Constraints | Design and Build Procurement |
|------------------------------|---------------------|--------------------------|------------------------------|
| Design phase constraints | Pearson Correlation | 1 | .908** |
| | Sig. (2-tailed) | | .000 |
| | N | 54 | 54 |
| Design and Build Procurement | Pearson Correlation | .908** | 1 |
| | Sig. (2-tailed) | .000 | |
| | N | 54 | 54 |

** . Correlation is significant at the 0.01 level (2-tailed).

Source: Survey data

H2a- There is a relationship between design phase constraints and D&B as a procurement method for building projects

A Pearson correlation test was done to determine the relationship between design phase constraints and D&B procurement system. In this test, Pearson correlation coefficient, r , is 0.908 and that is statistically ($p=0.005$). As per analytical study, null hypothesis failed to accept and the hypothesis is validated and there was a strong, positive correlation between design phase constraints and D&B as a procurement

method for building projects, which was statistically significant ($r=0.908$, $n=54$, $p=0.05$)

4.4.3 Constraints of construction phase

Table 4-11: Correlation – Construction phase constraints

| Correlations | | Construction Phase Constraints | Design and Build Procurement |
|--------------------------------|---------------------|--------------------------------|------------------------------|
| Construction phase constraints | Pearson Correlation | 1 | .903** |
| | Sig. (2-tailed) | | .000 |
| | N | 54 | 54 |
| Design and Build Procurement | Pearson Correlation | .903** | 1 |
| | Sig. (2-tailed) | .000 | |
| | N | 54 | 54 |

** . Correlation is significant at the 0.01 level (2-tailed).

Source: Survey data

H3a- There is a relationship between Construction phase constraints and D&B as a procurement method for building projects

A Pearson correlation test was done to determine the relationship between construction phase constraints and D&B procurement system. In this test, Pearson correlation coefficient, r , is 0.903 and that is statistically ($p=0.005$). As per the analytical study, null hypothesis failed to accept and the hypothesis is validated and there was a strong, positive correlation between construction phase constraints and D&B as a procurement method for building projects, which was statistically significant ($r=0.903$, $n=54$, $p=0.05$)

4.5 Outputs for Regression Analysis

Regression analysis is a quantitative research method and it is used when the research study includes analyzing and modeling many variables, where the rapport contains a dependent variable and more independent variables. The main purpose of regression analysis is, it will form a relationship by identifying which independent variables have an influence on dependent variables. In restricted circumstances, regression analysis can be used to infer causal relationships between the independent and dependent variables.

4.5.1 The effect of constraints for tender preparation and evaluation phase of the D&B as a procurement method for building projects

Table 4-12: Regression analysis- tender preparation and evaluation phase constraints

Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|-------------------|----------|-------------------|----------------------------|
| 1 | .912 ^a | .832 | .828 | .88471 |

a. Predictors: (Constant), Tender Preparation and evaluation phase constraints

Source: Survey data

According to the data analysis under the model test, correlation is 0.912 and it shows that high correlation between the independent variable of tender preparation and evaluation phase constraints and dependent variable of D&B as a procurement method for building projects. R Square value (the "R" Column) depicts that how much of the total difference of independent variable on dependent variable. It shows 83.2% of total variation in the dependent variable.

Table 4-13: ANOVA- Tender Preparation and evaluation phase constraints

ANOVA^a

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|-------|------------|----------------|----|-------------|---------|-------------------|
| 1 | Regression | 163.035 | 1 | 163.035 | 208.293 | .000 ^b |
| | Residual | 32.874 | 52 | .783 | | |
| | Total | 195.909 | 53 | | | |

a. Dependent Variable: D&B as a procurement method for building projects

b. Predictors: (Constant), Tender Preparation and evaluation phase constraints

Source: Survey data

The above table depicts that ANOVA performance of the data analysis and the significant value of the table is 0.000, which is less than 0.05(0.000 < 0.05), and it indicates that null hypotheses is failed to accept and the impact on tender preparation and evaluation phase constraints D&B as a procurement method for building projects.

Table 4-14: Coefficient analysis- Tender Preparation and evaluation phase constraint

Coefficients^a

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|-------|---|-----------------------------|------------|---------------------------|--------|------|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 0.657 | .862 | | 3.081 | .004 |
| | Tender Preparation and evaluation phase constraints | .844 | .058 | .912 | 14.432 | .000 |

a. Dependent Variable: D&B as a procurement method for building projects

Source: Survey data

According to the data analysis, Coefficients of Regression Analysis shows the above table and it's estimated the regression coefficient value is: β_0 (Constant) is 0.657 and

β_1 (Coefficient for X) is .844. It shows tender preparation and evaluation constraints give the influence on D&B as a procurement method for building projects.

4.5.2 The effect of design phase constraints and D&B as a procurement method for building projects

Table 4-15: Regression analysis- design phase constraints

Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|-------------------|----------|-------------------|----------------------------|
| 1 | .994 ^a | .988 | .988 | .25521 |

a. Predictors: (Constant), D&B as a procurement method for building projects

Source: Survey data

According to the data analysis, the model summary shows the below table and correlation shows 0.994 and it shows that a high correlation between the independent variable of design phase constraints and dependent variable of D&B as a procurement method for building projects. R Square value (the "R" Column) depicts that how much of the total difference of independent variable on dependent variable. It shows 98.8% of total variation in the dependent variable.

Table 4-16: ANOVA-Design phase constraints

ANOVA^a

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|-------|------------|----------------|----|-------------|----------|-------------------|
| 1 | Regression | 221.446 | 1 | 221.446 | 3400.051 | .000 ^b |
| | Residual | 2.735 | 52 | .065 | | |
| | Total | 224.182 | 53 | | | |

a. Dependent Variable: D&B as a procurement method for building projects

b. Predictors: (Constant), Design Phase constraints

Source: Survey data

The above table depicts that ANOVA performance of the data analysis and the significant value of the table is 0.000, which is less than 0.05 ($0.000 < 0.05$), and it

mentions that null hypotheses failed to accept and the impact of design phase constraints and D&B as a procurement method for building projects.

Table 4-17: Coefficient analysis-Design phase constraints

Coefficients

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|----------------------------|-----------------------------|------------|---------------------------|--------|------|
| | B | Std. Error | Beta | | |
| (Constant) | .304 | .249 | | 1.222 | .228 |
| 1 Design Phase constraints | .984 | .017 | .994 | 58.310 | .000 |

a. Dependent Variable: D&B as a procurement method for building projects

Source: Survey data

According to the data analysis, Coefficients of Regression Analysis shows the above table and it's estimated the regression coefficient value is: β_0 (Constant) is .304 and β_1 (Coefficient for X) is .984. It shows design phase constraints give the influence on D&B as a procurement method for building projects.

4.5.3 The effect of construction phase constraints and D&B as a procurement method for building projects

Table 4-18: Regression analysis- construction phase constraints

Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|-------------------|----------|-------------------|----------------------------|
| 1 | .989 ^a | .977 | .977 | .35039 |

a. Predictors: (Constant), Construction phase constraints

Source: Survey data

According to the data analysis, the model summary shows the below table and correlation shows 0.989 and it shows that high correlation between the independent variable of construction phase constraints and dependent variable of D&B as a procurement method for building projects. R Square value (the "R" Column) depicts

that how much of the total difference of the independent variable on the dependent variable. It shows 97.7% of total variation in the dependent variable.

Table 4-19: ANOVA- Construction phase constraints

ANOVA^a

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|-------|------------|----------------|----|-------------|----------|-------------------|
| 1 | Regression | 224.003 | 1 | 224.003 | 1824.532 | .000 ^b |
| | Residual | 5.156 | 52 | .123 | | |
| | Total | 229.159 | 53 | | | |

a. Dependent Variable: D&B as a procurement method for building projects

b. Predictors: (Constant), Construction phase constraints

Source: Survey data

The above table depicts that ANOVA performance of the data analysis and the significant value of the table is 0.000, which is less than 0.05(0.000 <0.05), and it mentions that null hypotheses is failed to accept and the impact on construction phase constraints and D&B as a procurement method for building projects.

Table 4-20: Coefficient analysis- Construction phase constraints

Coefficients

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|-------|--------------------------------|-----------------------------|------------|---------------------------|--------|------|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | .290 | .342 | | .848 | .401 |
| | Construction Phase constraints | .989 | .023 | .989 | 42.715 | .000 |

a. Dependent Variable: Construction Phase constraints

Source: Survey data

According to the data analysis, Coefficients of Regression Analysis shows the below table and it's estimated the regression coefficient value is: β_0 (Constant) is.290 and β_1 (Coefficient for X) is. 989. It shows construction phase constraints give the influence on D&B as a procurement method for building projects.

4.6 Analysis for Recommendation

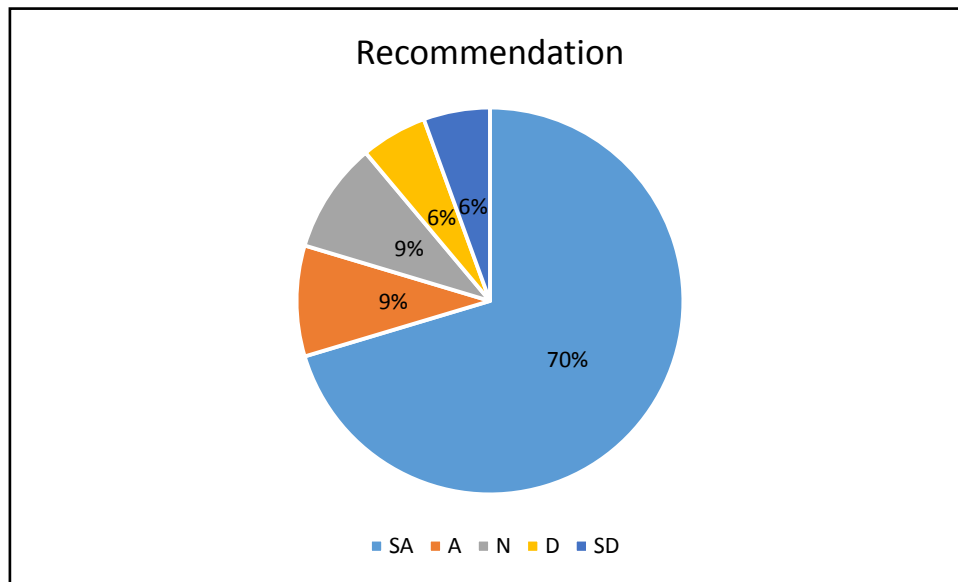


Figure 4-9: Percentage distribution analysis for recommendation

Source: Developed by the author

Above figure 4.9 depicts the respondents' survey results for recommendation question. The recommendation question is "If the owner of the project appoints a project manager or construction manager to the project team from the beginning of the project implementation stage would reduce the risks and improve the quality of the project outcome". From the respondents' answers that could say 70% of respondents strongly agreed the above statement. 9% of respondents agreed the statement. So it's clear more than 75% participants accepted, that it would be better to appoint a project manager or specialized profession by the client from the beginning of the projects and it will be automatically reduced the fear of the owner and improve the quality of the end product. And also requested to specify their own views on how to improve the use of the D&B system in Sri Lanka building industry. Those were summarized and mentioned in the next chapter.

4.7 Summary of the chapter

This chapter was a major part of the research study. From the questionnaire survey that analyzed constraints of the D&B system in different phases of building projects in Sri Lanka, as well analyzed the recommendation. Also, respondents are requested to specify their comments other than what already indicated in the questionnaire. There were independent and the dependent variables statistically calculated and evaluated in this chapter. Especially the relationship between independent and depend variables were analyzed and accordingly the final findings revealed that those independent variables have a high positive relationship of the dependent variable.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The final chapter presents the main conclusion and recommendations of the research. The research has examined the constraints of the D&B procurement system in tender preparation and evaluation phase and conclusion phase of building projects. The aim of this research is to investigate the constraints of the D&B system in different phases of building projects and more importantly, understand how they have dealt with such challenges in practice. The chapter reviews how well this has been accomplished in consideration of the objectives and questions set out in chapter 1 of this research. And recommendation has been developed from the conclusion and research finding. Followed by addressing some of the limitations faced during the research study. Finally, suggested some research topic for further research.

Achieved Objective 01

Identify the current trend of the D&B procurement system in Sri Lanka.

The ultimate purpose of this research is to identify the constraints of the D&B procurement system in Sri Lanka building projects. Before moving to identification should prove the current trend of D&B procurement in Sri Lanka. According to a survey done by researchers Rameezdeen, Rathnasabapathi and Amaratunga and RDG (2003) they found the period from 1977 to 2003 the use of D&B procurement system is comparatively low compared to other procurement types. But they suggested in the future they could expect booming of D&B projects. So structured questionnaire was distributed to Sri Lankan construction professionals in order to identify the current use of the D&B procurement system. From the analysis findings, it is again proven D&B system is not significantly improved in the Sri Lanka construction industry. So objective 1 has been achieved by identifying the current trend of the D&B procurement system in Sri Lanka.

Achieved Objective 02

Find the constraints of the D&B system in tender preparation and evaluation phase, design phase and construction phase in building projects.

Constraints will lead the construction industry in to negative path. So identification of constraints was required before suggesting the method of increasing the use of the D&B procurement method in the Sri Lankan construction industry. As mentioned in the previous chapters constraints are kind of challenges. So by refereeing many research articles, books and journals that found what are constraints of the D&B system in different phases of building projects.

Constraints of D&B procurement method in construction industry are a vast area. So the analyze has been further narrowed down to identify the constraints, particularly in three main stages of construction process, those are tender preparation and evaluation phase, design phase and construction phase. The main problems faced in tender preparation and evaluation phase are very limited knowledge to prepare a request for proposal by the owners, client does not have enough manpower to assist him with tender preparation and evaluation and the provided detailed information on the scope of work is not enough to carry out the work in a perfect manner. Constraints found in the design and construction stage is generally contractors do not have both design and construction knowledge. It would lead to bad impact on the project. Researchers Schwager and Sullivan (1991) discovered that most designs and build contractors attempt to deal with both design and construction with no real capabilities. Having very limited communication between both design and construction teams within the design and build organization was also featured as a noteworthy constraint. From the analysis results it has been found there are plenty of constraints experienced when D&B is used as the procurement method at all stages of building projects in Sri Lanka.

Achieved Objective 03

Recommend the way how D&B system could be widely used in Sri Lanka construction industry.

From the literature review and discussions with experts in D&B projects that found inclusion of project manager or construction manager of the client would reduce the fear of the owner as well as improve the quality of the end product. This has been added to the questionnaire survey and respondents were requested to put their ranking in order to identify the recommendation of the research study.

Based on their results it is found that project manager's appointment is very much needed to the design team from the initial stage of the building projects. There were only very few respondents with a maximum number of below three meaning more than 90% respondents agreed that including a project manager would increase the project outcome of design and build projects. It is project manager's responsibility to help client with technical issues around preparing the request for proposal and evaluating and selecting the contractor. Ling and Poh (2007) project owners should appoint right professionals, from the beginning of the project because they are lacking with construction knowledge.

5.2 Research findings

The aim and the objectives were achieved for this research study. Hypothesis 1 to 3 were set as follows. There are numerous constraints in tender preparation and evaluation phase, design phase and construction phase of the D&B procurement system. This was accomplished by many of constraints that are identified throughout the project.

The purpose of the last set of hypothesis is to find out how useful if the owner of the project appoints project manager or construction manager to the design team from an early stage of building projects. This was accomplished by every single respondents highly agreed this statement. And also they specified project manager's appointment is important in order to achieve high quality end product and as well as reduce the risk factor.

5.3 Conclusion

The main objective of this study is to identify the constraints when the D&B procurement system is being in use in Sri Lanka construction industry. From the results of the study, the problems have proved to be at all stages. The most serious problem found is lack of human resources, especially with both design and construction knowledgeable professionals in the building industry. Client is struggling to draft a request for proposal including all his requirements and do the evaluation and choose the appropriate contractor. These all have proven the use of the D&B procurement system which is far behind in Sri Lanka compared to other regions like Europe and North America due to the non-availability of technical assistance to project owners.

The important part of this research is to give proper recommendations on how to overcome the problems highlighted. To this effect, most of the respondents generally accepted that including project manager or construction manager of the client would reduce the fear of the owner as well as improve the quality of the end product. This is consistent with results found by Ling and Poh, 2007 in a study done in Singapore. Owner of the project doesn't have enough confidence to run the D&B projects because they feel it is not good to run the project without knowledgeable project team members.

5.4 Recommendations

The recommendations mentioned in this section were obtained from respondents questionnaire findings. In a questionnaire survey last table designed for recommendation section where respondents were placed with their ranking and allowed to specify their own views. So the first recommendation obtained from questionnaire results and other additional recommendations is obtained from the respondent's point of view. The respondents seem to have emphasized following important points.

- 5.3.1 Project owners should include their project managers in design and build projects

All the clients don't have adequate construction knowledge. So respondents thought if hired a project manager during project implementation stage will reduce the fears of owners and also could expect better output of the project. As such success of Design and Build project could be achieved by the appointment of project manager following the system theory applied to project organization.

- 5.3.2 Clear communication between all parties

From the respondents point of view communication is the biggest barrier between the team members. Proper communication should start from the beginning of the project. All the members of the project teams must have a clear idea about where and from whom that can get required information. So to avoid this issue both design and construction team must have closer communication throughout the project.

- 5.3.3 Proper planning

One of the most important characteristic of D&B project is shorter delivery period. Proper planning should be done in order to achieve this particular characteristic. So from the beginning of the project, enough time must be spent planning the process as a whole. Also, overlaps must be notable and avoided in order achieve the perfection of the project. First of all the client must ascertain that design and build is the most appropriate procurement method for his project. For D&B projects client's influence is significantly less compared, to all other procurement systems especially traditional procurement method. For all these reasons, appoint the right team is also most important for the success of the project.

- 5.3.4 Well prepared client's request or Request for Proposal

In a Request for Proposal client should include all his needs, interest and all the specifications of the required outcome he desires in the brief that he sends out to for the out to contractors for tendering. Unlike other procurement systems, D&B project owner does not have enough knowledge regarding construction and the procedures

so it is very important to add all his requirements at the beginning of the project. This might avoid issues of poor functionality of the end product, poor quality, cost and time overruns. It is suggested that owners with minimal knowledge, especially on the technical aspect should seek help from the specialized person or must stay away from this particular projection system.

5.5 Limitations of the Research

This research has the couple of restrictions amid the completion of the project. The scope of this research is mainly based on Design and Build Projects and more especially concerned about building projects only. The questionnaires were send-off by using Survey monkey software and via emails to Sri Lankan construction professionals. The surveyor was only for those who are working on the Sri Lankan building projects, especially Architects, Quantity Surveyors, Engineers, Project Managers, Contractors and Clients. Many of the construction organizations still not practiced design and build procurement method in Sri Lanka. So the knowledge of design and build procurement system is still new to some of the construction professionals, and most of them are practicing/studying on this procurement method. Moreover, the survey is limited and difficult to find books, journals and articles in the relevant topic area during the limited time of research handover. There were very limited researches done after a 2015 year period. Also problems faced with access to databases such as, Canadian, American, Australian, African and Asian. And faced huge problems to access data from different language journals like Chinese, German language etc.

5.6 Suggestions for further researches

This study focused on the constraints of three different phases of building projects in Sri Lanka, particularly in tender preparation and evaluation phase, design phase and construction phase. They're however some of the areas have not been explored, and can be done in the future. These include the following;

- Firstly, identify how D&B procurement system projects perform among various sectors of the economy. Because the procedure, administration and documentation method is different from sectors to sectors. So before choosing the procurement type, it's better to have an idea regarding various sectors procedures. It would be beneficial to the society if further study investigates on the above mentioned topic.
- Secondly, this study finds that project owners should appoint a project manager to be part of the process which will improve the project outcome and reduce the project risk. So it could be better to study about the roles of the project manager for D&B projects.

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APPENDICES

Appendix 1

Questionnaire 1

University of Moratuwa

M.Sc. /PG Diploma in Project Management 2015/2016

Research Survey

IDENTITY THE TREND OF THE USE OF CONSTRUCTION PROCUREMENT SYSTEMS IN SRI LANKA CONSTRUCTION PROJECT

Executed by: M. A. M. Anitra

1. What is your Organization's area of specialization?

- Building construction
- Civil Engineering
- A Combination of building & civil engineering
- Other (Please specify).....

2. How long has your organization been involved in the Sri Lankan construction industry?

- 0 - 5 years
- +5 – 10 years
- Over 10 years

3. Comparatively what is most common procurement used in the project involved. Please rank the frequency of the each in a priority order.

| | High | ←—————→ | | | Low |
|-------------------------------|------|---------|---|---|-----|
| • Traditional Method | 1 | 2 | 3 | 4 | 5 |
| • Design and Build | 1 | 2 | 3 | 4 | 5 |
| • Construction Management | 1 | 2 | 3 | 4 | 5 |
| • Management Contracting | 1 | 2 | 3 | 4 | 5 |
| • Built, Operate and Transfer | 1 | 2 | 3 | 4 | 5 |

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Appendix 2

Questionnaire 2

Dear Valuable Participant:

My name is Anitra Anthany and I am a post graduate student at University of Moratuwa. For my final project, I am examining the constraints of using Design & Build system in different phases of building projects in Sri Lanka. Since you are involving in Sri Lankan construction industry, I request you to participate in this research survey by completing attached questionnaire.

All your filled answers and information are confidential. To ensure that please don't mention your name and title of your organization where you work. You will need only 10 minutes to fill the whole set of questionnaire. The conclusion will draw based on your survey answers, so please take time and answer all questions genuinely.

Thank you for your consideration in regards this. The collected data will provide useful information regarding the possible constraints of Design and Build procurement method and suggest measure to promote design and build system in different phases of building projects in Sri Lanka. Completion and return of the questionnaire will indicate your willingness to participate in this study. Your early responses would be highly appreciated since I have to undergo the dissertation with a tight -time schedule. If you any questions to clarify don't hesitate to contact me at the number listed below.

Thanking you in advance.

Sincerely,

M.A.M. Anitra
MSc 2nd Year Student,
Department of Building Economics,
University of Moratuwa.
Tel; 076-3573030
E-mail- anitra712@gmail.com

Research supervisor
Dr. Kapila Devapriya
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University of Moratuwa

M.Sc. /PG Diploma in Project Management 2015/2016

Research Survey

**THE CONSTRAINTS OF USING DESIGN AND BUILD SYSTEM IN
DIFFERENT PHASES OF BUILDING PROJECTS IN SRI LANKA**

Project executed by: M. A. M. Anitra

Section A: Demographic Information

(Please choose and tick the most appropriate box (x))

A.1 Please specify your profession

- Architect
- Project owner
- Engineer
- Quantity Surveyor
- Project/ Construction Manager
- Contractor
- Other (please specify) _____

A.2 Please specify the field you are working

- Private sector
- Public sector
- Both

A.3 Type of your organization

- Contractor
- Consultant
- Client

A.4 Please indicate your own length of experience in construction.

- 0 – 5 years
- 6 - 10 years

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- 11 – 20 years
- Above 20 years

Knowledge awareness of design and build projects

A.5 Did you involve in design and build projects

- Yes
- No

A.6 Are you aware about design and build contracting

- Well aware
- Aware
- Bit aware
- Not aware

A.7 In which sector design and build projects mostly involved in

- Private
- Public

A.8 Size of the design and build project your organization is generally awarded per annum

- Medium size project/ Less than 1,000 Mn
- Large size project/ Between 1,000 Mn to 5,000 Mn
- Very large size project/ Between 5,000 Mn to 10,000 Mn
- Mega project/ More than 10,000 Mn (10 Billion)

Section B: Possible constraints in the design and build system in different phases of building projects in Sri Lanka

Constraints refer stakeholders from construction industry facing most common issues associated with three different phases of D&B system.

Phase 1: Constraints in tender preparation and evaluation phase

(Please choose and tick the most appropriate box (x))

Below mentioned are some identified problem that are associated with tender preparation and evaluation stage. Please kindly suggest how seriousness the problems are.

***Level of seriousness: 1= strongly agree (SA); 2= Agree (A); 3= Neutral (N); 4= Disagree (D); 5= strongly disagree (SD)**

Table 1: Tender preparation and evaluation phase constraints

| | *Level of seriousness | | | | |
|--|------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| | SA | A | N | D | SD |
| | 1 | 2 | 3 | 4 | 5 |
| 1.1 Clients they do not have enough adequate knowledge to prepare scope of work or Request for Proposal (RFP) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 1.2 Clients lack manpower to assist him with technical issues during project implementation stage | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 1.3 Due to limited information in the initial stage couldn't come up with detailed scope of work | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 1.4 Lack of adequate knowledge to evaluate tenders | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 1.5 High cost for tender preparation and evaluation process | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 1.6 Spending more time on tender preparation and evaluation | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 1.7 Client's doesn't have previous experience with design and build projects | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Phase 2: Constraints in design phase

(Please choose and tick the most appropriate box (x))

Below mentioned are some identified problem that are associated with design stage. Please kindly suggest how seriousness the problems are.

***Level of seriousness: 1= strongly agree (SA); 2= Agree (A); 3= Neutral (N); 4= Disagree (D); 5= strongly disagree (SD)**

Table 2: Design phase constraints

| | *Level of seriousness | | | | |
|--|------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| | SA | A | N | D | SD |
| | 1 | 2 | 3 | 4 | 5 |
| 2.1 Contractors usually doesn't have both design and construction knowledge | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2.2 Contractors often fail to secure adequate insurance to cover both design and construction | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2.3 There is no proper communication between design team and construction team | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2.4 Usually design not fulfill owner's taste or interest | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2.5 lack of risk evaluation in the task of identification of relevant problems to solve | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2.6 Time taken to get the approval from the local authorities | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2.7 Specialists professionals involvement is less | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Phase 3: Constraints in construction phase

(Please choose and tick the most appropriate box (x))

Below mentioned are some identified problem that are associated with construction stage. Please kindly suggest how seriousness the problems are.

***Level of seriousness: 1= strongly agree (SA); 2= Agree (A); 3= Neutral (N); 4= Disagree (D); 5= strongly disagree (SD)**

Table 3: Construction phase constraints

| | *Level of seriousness | | | | |
|---|------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| | SA | A | N | D | SD |
| | 1 | 2 | 3 | 4 | 5 |
| 3.1 Due to client's less involvement they usually don't get adequate information regarding progress of the project | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3.2 Price are unstable due to increase in change orders | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3.3 Client's get enough time to give approval to design which would lead to delay of the construction project | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3.4 Client feel dissatisfaction of standard of service during the construction period | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3.5 Client's expectation does not meet Contractors service quality performance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3.6 Client's get enough time to give approval to design which would lead to delay of the construction project | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3.7 Team size is bigger so the coordination also hard. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Section C: Design and build performance indicators

This section investigates performance indicators of time, budget, quality, functionality, safety, human resources and satisfaction are having issues when design and build procurement system is in use in the construction industry.

(Please choose and tick the most appropriate box (x))

***Level of seriousness: 1= strongly agree (SA); 2= Agree (A); 3= Neutral (N); 4= Disagree (D); 5= strongly disagree (SD)**

Table 4: Performance indicators on design and build projects

| | *Level of seriousness | | | | |
|--|------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| | SA | A | N | D | SD |
| | 1 | 2 | 3 | 4 | 5 |
| 1.1 Time management is still a problem in design and build projects | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 1.2 Budget management still poses a problem in design and build projects | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 1.3 Quality issues still arise in design and build projects | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 1.4 Functionality is still a problem in design and build projects | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 1.5 Safety and security is still a problem in design and build projects | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 1.6 Lack of manpower to assist client is still a problem in design and build projects | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 1.7 Satisfaction of client is still a problem in design and build projects | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Section D: Recommendation

This section analyzes whether including a project manager or construction manager to the design team would improve the quality of the output of design and build procurement system or not.

(Please choose and tick the most appropriate box (x))

***Level of seriousness: 1= strongly agree (SA); 2= Agree (A); 3= Neutral (N); 4= Disagree (D); 5= strongly disagree (SD)**

Table 5: Effect of including a project manager or Client’s adviser

| | *Level of seriousness | | | | |
|---|------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| | SA | A | N | D | SD |
| | 1 | 2 | 3 | 4 | 5 |
| If owner of the project appoint a project manager or construction manager to the project team from the beginning of the project implementation stage would reduce the risks and improve the quality of the project outcome. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Other ways to improve the design and build process (Please specify) | | | | | |

Appendix 3 – Respondent’s results for demographic information

| Respondents | Professional | Sector | Type of the organization | Experience | Involve design and build | Aware about design and build | Sector involve design and build | Size of design and build projects |
|-------------|--------------|--------|--------------------------|------------|--------------------------|------------------------------|---------------------------------|-----------------------------------|
| | A1 | A2 | A3 | A4 | A5 | A6 | A7 | A8 |
| 1 | 1 | 1 | 2 | 4 | 1 | 1 | 1 | 1 |
| 2 | 3 | 1 | 2 | 4 | 1 | 1 | 2 | 2 |
| 3 | 1 | 2 | 3 | 4 | 1 | 1 | 1 | 3 |
| 4 | 2 | 3 | 3 | 3 | 1 | 1 | 2 | 4 |
| 5 | 4 | 2 | 3 | 3 | 1 | 1 | 1 | 3 |
| 6 | 4 | 3 | 3 | 2 | 1 | 1 | 1 | 1 |
| 7 | 4 | 3 | 3 | 1 | 1 | 2 | 2 | 3 |
| 8 | 3 | 3 | 1 | 1 | 1 | 2 | 1 | 2 |
| 9 | 3 | 3 | 1 | 3 | 1 | 2 | 1 | 3 |
| 10 | 2 | 3 | 1 | 3 | 1 | 2 | 2 | 2 |
| 11 | 3 | 3 | 1 | 1 | 1 | 2 | 2 | 3 |
| 12 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 4 |
| 13 | 7 | 3 | 2 | 3 | 2 | 3 | 2 | 3 |
| 14 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 |
| 15 | 3 | 1 | 2 | 1 | 2 | 3 | 2 | 3 |
| 16 | 3 | 1 | 2 | 1 | 2 | 3 | 2 | 2 |
| 17 | 3 | 1 | 2 | 2 | 2 | 3 | 2 | 3 |
| 18 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 |
| 19 | 3 | 3 | 2 | 2 | 2 | 4 | 2 | 3 |
| 20 | 2 | 3 | 2 | 4 | 1 | 4 | 2 | 2 |
| 21 | 2 | 3 | 2 | 1 | 1 | 4 | 1 | 3 |
| 22 | 1 | 3 | 2 | 2 | 2 | 4 | 1 | 2 |
| 23 | 2 | 2 | 2 | 2 | 1 | 4 | 1 | 3 |
| 24 | 1 | 1 | 2 | 2 | 1 | 4 | 2 | 2 |
| 25 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | 3 |
| 26 | 1 | 2 | 2 | 2 | 1 | 3 | 1 | 2 |
| 27 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 3 |
| 28 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 2 |
| 29 | 4 | 2 | 2 | 4 | 2 | 3 | 2 | 3 |
| 30 | 4 | 3 | 1 | 2 | 2 | 2 | 2 | 1 |

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| Respondents | Professional | Sector | Type of the organization | Experience | Involve design and build | Aware about design and build | Sector involve design and build | Size of design and build projects |
|-------------|--------------|--------|--------------------------|------------|--------------------------|------------------------------|---------------------------------|-----------------------------------|
| 31 | 4 | 3 | 1 | 3 | 2 | 3 | 2 | 2 |
| 32 | 2 | 3 | 1 | 3 | 2 | 1 | 2 | 3 |
| 33 | 3 | 2 | 1 | 3 | 2 | 4 | 2 | 2 |
| 34 | 1 | 3 | 1 | 3 | 2 | 3 | 1 | 3 |
| 35 | 2 | 2 | 1 | 3 | 2 | 1 | 1 | 2 |
| 36 | 3 | 3 | 1 | 1 | 1 | 2 | 1 | 3 |
| 37 | 1 | 3 | 1 | 1 | 1 | 3 | 1 | 2 |
| 38 | 5 | 3 | 1 | 1 | 1 | 1 | 1 | 3 |
| 39 | 5 | 3 | 1 | 3 | 1 | 1 | 1 | 2 |
| 40 | 5 | 1 | 1 | 3 | 1 | 3 | 1 | 3 |
| 41 | 5 | 1 | 1 | 1 | 1 | 2 | 1 | 2 |
| 42 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 3 |
| 43 | 6 | 3 | 2 | 3 | 1 | 3 | 1 | 3 |
| 44 | 6 | 2 | 1 | 3 | 1 | 2 | 1 | 3 |
| 45 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 46 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 2 |
| 47 | 3 | 2 | 1 | 3 | 1 | 1 | 1 | 3 |
| 48 | 3 | 2 | 1 | 3 | 1 | 2 | 1 | 1 |
| 49 | 1 | 1 | 2 | 4 | 2 | 3 | 1 | 2 |
| 50 | 2 | 3 | 2 | 4 | 2 | 4 | 2 | 3 |
| 51 | 4 | 3 | 1 | 2 | 1 | 2 | 2 | 3 |
| 52 | 4 | 1 | 1 | 3 | 1 | 2 | 1 | 2 |
| 53 | 1 | 1 | 2 | 3 | 2 | 1 | 1 | 1 |
| 54 | 1 | 2 | 3 | 4 | 1 | 2 | 2 | 3 |

Respondent's results for tender preparation and evaluation phase constraints

| Respondents | TE1 | TE2 | TE3 | TE4 | TE5 | TE6 | TE7 |
|--------------------|------------|------------|------------|------------|------------|------------|------------|
| 1 | 4 | 4 | 4 | 3 | 5 | 5 | 4 |
| 2 | 4 | 4 | 4 | 3 | 4 | 5 | 4 |
| 3 | 2 | 4 | 4 | 1 | 5 | 5 | 4 |
| 4 | 4 | 3 | 4 | 3 | 5 | 4 | 3 |
| 5 | 4 | 4 | 4 | 4 | 4 | 3 | 4 |
| 6 | 4 | 3 | 3 | 4 | 3 | 3 | 3 |
| 7 | 4 | 4 | 3 | 4 | 3 | 4 | 4 |
| 8 | 3 | 4 | 4 | 2 | 5 | 4 | 4 |
| 9 | 3 | 2 | 3 | 4 | 5 | 4 | 2 |
| 10 | 2 | 5 | 3 | 4 | 5 | 4 | 5 |
| 11 | 3 | 3 | 2 | 3 | 3 | 5 | 3 |
| 12 | 3 | 4 | 3 | 4 | 4 | 4 | 4 |
| 13 | 4 | 4 | 2 | 3 | 4 | 4 | 4 |
| 14 | 1 | 3 | 2 | 3 | 3 | 5 | 3 |
| 15 | 3 | 2 | 2 | 3 | 3 | 5 | 2 |
| 16 | 3 | 4 | 2 | 3 | 4 | 5 | 4 |
| 17 | 5 | 4 | 4 | 5 | 4 | 5 | 4 |
| 18 | 5 | 4 | 3 | 5 | 5 | 5 | 4 |
| 19 | 5 | 4 | 1 | 5 | 5 | 4 | 4 |
| 20 | 3 | 4 | 4 | 4 | 5 | 3 | 4 |
| 21 | 5 | 4 | 3 | 4 | 5 | 4 | 4 |
| 22 | 4 | 4 | 5 | 4 | 3 | 3 | 4 |
| 23 | 4 | 3 | 4 | 4 | 3 | 5 | 3 |
| 24 | 5 | 5 | 4 | 4 | 3 | 4 | 5 |
| 25 | 4 | 4 | 2 | 4 | 4 | 3 | 4 |
| 26 | 4 | 4 | 2 | 4 | 4 | 5 | 4 |
| 27 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 28 | 4 | 4 | 2 | 4 | 4 | 4 | 4 |
| 29 | 5 | 3 | 2 | 4 | 5 | 5 | 3 |
| 30 | 4 | 3 | 3 | 4 | 4 | 5 | 3 |

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| Respondents | TE1 | TE2 | TE3 | TE4 | TE5 | TE6 | TE7 |
|-------------|-----|-----|-----|-----|-----|-----|-----|
| 31 | 5 | 3 | 2 | 4 | 2 | 5 | 3 |
| 32 | 4 | 3 | 4 | 4 | 4 | 5 | 3 |
| 33 | 5 | 4 | 4 | 4 | 5 | 3 | 4 |
| 34 | 5 | 4 | 1 | 4 | 5 | 3 | 4 |
| 35 | 5 | 4 | 4 | 4 | 4 | 4 | 4 |
| 36 | 5 | 5 | 3 | 4 | 4 | 2 | 5 |
| 37 | 5 | 4 | 4 | 4 | 3 | 2 | 4 |
| 38 | 5 | 4 | 4 | 4 | 4 | 3 | 4 |
| 39 | 5 | 4 | 4 | 4 | 5 | 4 | 4 |
| 40 | 5 | 4 | 4 | 4 | 3 | 5 | 4 |
| 41 | 5 | 5 | 4 | 4 | 4 | 4 | 5 |
| 42 | 2 | 4 | 4 | 3 | 5 | 4 | 4 |
| 43 | 3 | 4 | 4 | 3 | 4 | 5 | 4 |
| 44 | 2 | 4 | 2 | 1 | 5 | 5 | 4 |
| 45 | 5 | 4 | 2 | 3 | 4 | 4 | 3 |
| 46 | 5 | 5 | 3 | 4 | 5 | 4 | 4 |
| 47 | 5 | 5 | 2 | 5 | 5 | 5 | 5 |
| 48 | 4 | 4 | 3 | 4 | 4 | 5 | 4 |
| 49 | 4 | 4 | 3 | 5 | 3 | 3 | 5 |
| 50 | 4 | 5 | 4 | 4 | 3 | 2 | 4 |
| 51 | 3 | 5 | 5 | 5 | 4 | 4 | 5 |
| 52 | 4 | 3 | 3 | 3 | 5 | 5 | 3 |
| 53 | 5 | 4 | 4 | 3 | 4 | 5 | 3 |
| 54 | 3 | 5 | 5 | 4 | 5 | 4 | 4 |

Respondent's results for design phase constraints

| Respondents | D1 | D2 | D3 | D4 | D5 | D6 | D7 |
|--------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 1 | 4 | 4 | 4 | 3 | 3 | 5 | 4 |
| 2 | 4 | 4 | 4 | 3 | 3 | 5 | 4 |
| 3 | 2 | 4 | 4 | 1 | 3 | 5 | 4 |
| 4 | 4 | 3 | 4 | 3 | 5 | 5 | 5 |
| 5 | 4 | 4 | 4 | 4 | 4 | 5 | 5 |
| 6 | 4 | 3 | 4 | 4 | 5 | 5 | 5 |
| 7 | 4 | 4 | 3 | 4 | 5 | 4 | 4 |
| 8 | 4 | 4 | 4 | 2 | 4 | 3 | 4 |
| 9 | 3 | 2 | 3 | 4 | 5 | 4 | 3 |
| 10 | 2 | 5 | 3 | 4 | 5 | 3 | 4 |
| 11 | 3 | 3 | 2 | 3 | 5 | 4 | 5 |
| 12 | 3 | 4 | 3 | 4 | 5 | 5 | 3 |
| 13 | 4 | 4 | 2 | 3 | 4 | 4 | 4 |
| 14 | 1 | 3 | 2 | 3 | 4 | 3 | 5 |
| 15 | 3 | 2 | 2 | 3 | 3 | 5 | 2 |
| 16 | 3 | 4 | 2 | 3 | 3 | 4 | 2 |
| 17 | 5 | 4 | 4 | 5 | 3 | 5 | 4 |
| 18 | 5 | 4 | 3 | 5 | 4 | 3 | 3 |
| 19 | 5 | 4 | 1 | 5 | 4 | 2 | 3 |
| 20 | 3 | 4 | 4 | 4 | 4 | 2 | 4 |
| 21 | 5 | 4 | 3 | 4 | 5 | 2 | 4 |
| 22 | 4 | 4 | 5 | 4 | 5 | 2 | 5 |
| 23 | 4 | 3 | 4 | 4 | 5 | 4 | 4 |
| 24 | 5 | 5 | 4 | 4 | 3 | 5 | 4 |
| 25 | 4 | 4 | 2 | 4 | 3 | 4 | 3 |
| 26 | 4 | 4 | 2 | 4 | 4 | 2 | 3 |
| 27 | 4 | 4 | 4 | 4 | 4 | 4 | 3 |
| 28 | 4 | 4 | 2 | 4 | 4 | 3 | 4 |
| 29 | 5 | 3 | 2 | 4 | 5 | 5 | 3 |
| 30 | 4 | 3 | 3 | 4 | 5 | 2 | 3 |

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| Respondents | D1 | D2 | D3 | D4 | D5 | D6 | D7 |
|--------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 31 | 5 | 3 | 2 | 4 | 5 | 4 | 3 |
| 32 | 4 | 3 | 4 | 4 | 5 | 5 | 4 |
| 33 | 5 | 4 | 4 | 4 | 4 | 5 | 3 |
| 34 | 5 | 4 | 1 | 4 | 4 | 5 | 3 |
| 35 | 5 | 4 | 4 | 4 | 4 | 4 | 2 |
| 36 | 5 | 5 | 3 | 4 | 3 | 4 | 3 |
| 37 | 5 | 4 | 4 | 4 | 3 | 3 | 3 |
| 38 | 5 | 4 | 4 | 4 | 4 | 4 | 2 |
| 39 | 5 | 4 | 4 | 4 | 4 | 2 | 5 |
| 40 | 5 | 4 | 4 | 4 | 5 | 2 | 2 |
| 41 | 5 | 5 | 4 | 4 | 5 | 3 | 4 |
| 42 | 2 | 4 | 4 | 4 | 4 | 4 | 2 |
| 43 | 3 | 4 | 4 | 3 | 4 | 5 | 2 |
| 44 | 2 | 4 | 2 | 1 | 4 | 5 | 4 |
| 45 | 3 | 5 | 5 | 5 | 4 | 4 | 5 |
| 46 | 4 | 4 | 3 | 4 | 4 | 5 | 4 |
| 47 | 5 | 5 | 2 | 5 | 2 | 3 | 5 |
| 48 | 4 | 4 | 5 | 4 | 5 | 2 | 4 |
| 49 | 5 | 3 | 2 | 5 | 3 | 4 | 5 |
| 50 | 4 | 5 | 5 | 4 | 4 | 5 | 4 |
| 51 | 3 | 4 | 4 | 5 | 2 | 4 | 5 |
| 52 | 5 | 2 | 3 | 3 | 3 | 2 | 3 |
| 53 | 4 | 3 | 2 | 3 | 5 | 3 | 3 |
| 54 | 3 | 4 | 5 | 5 | 4 | 4 | 5 |

Respondent's results for construction phase constraints

| Respondents | C1 | C2 | C3 | C4 | C5 | C6 | C7 |
|-------------|----|----|----|----|----|----|----|
| 1 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 2 | 4 | 4 | 4 | 4 | 4 | 5 | 4 |
| 3 | 2 | 4 | 4 | 1 | 4 | 4 | 4 |
| 4 | 4 | 3 | 4 | 3 | 4 | 3 | 5 |
| 5 | 4 | 4 | 4 | 4 | 4 | 3 | 2 |
| 6 | 4 | 3 | 4 | 4 | 5 | 3 | 3 |
| 7 | 4 | 4 | 4 | 4 | 3 | 4 | 5 |
| 8 | 4 | 4 | 4 | 2 | 3 | 5 | 3 |
| 9 | 3 | 2 | 3 | 4 | 4 | 3 | 5 |
| 10 | 2 | 5 | 3 | 4 | 3 | 4 | 3 |
| 11 | 3 | 3 | 2 | 3 | 5 | 2 | 2 |
| 12 | 3 | 4 | 3 | 4 | 4 | 5 | 1 |
| 13 | 4 | 4 | 2 | 3 | 3 | 4 | 4 |
| 14 | 1 | 3 | 2 | 3 | 5 | 3 | 4 |
| 15 | 3 | 2 | 2 | 3 | 4 | 2 | 5 |
| 16 | 3 | 4 | 2 | 3 | 3 | 3 | 5 |
| 17 | 5 | 4 | 4 | 5 | 2 | 5 | 3 |
| 18 | 5 | 4 | 3 | 5 | 4 | 4 | 5 |
| 19 | 5 | 4 | 1 | 5 | 5 | 2 | 4 |
| 20 | 3 | 4 | 4 | 4 | 2 | 5 | 2 |
| 21 | 5 | 4 | 3 | 4 | 3 | 3 | 3 |
| 22 | 4 | 4 | 5 | 4 | 5 | 4 | 3 |
| 23 | 4 | 3 | 4 | 4 | 5 | 4 | 5 |
| 24 | 5 | 5 | 4 | 4 | 4 | 5 | 4 |
| 25 | 4 | 4 | 2 | 4 | 3 | 5 | 2 |
| 26 | 4 | 4 | 2 | 4 | 5 | 3 | 3 |
| 27 | 4 | 4 | 4 | 4 | 4 | 2 | 5 |
| 28 | 4 | 4 | 2 | 4 | 2 | 3 | 4 |
| 29 | 5 | 3 | 2 | 4 | 3 | 5 | 5 |
| 30 | 4 | 3 | 3 | 4 | 1 | 5 | 2 |

Degree of Master of Science

| Respondents | C1 | C2 | C3 | C4 | C5 | C6 | C7 |
|--------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 31 | 5 | 3 | 2 | 4 | 2 | 4 | 3 |
| 32 | 4 | 3 | 4 | 4 | 5 | 4 | 3 |
| 33 | 5 | 4 | 4 | 4 | 4 | 5 | 5 |
| 34 | 5 | 4 | 1 | 4 | 3 | 3 | 5 |
| 35 | 5 | 4 | 4 | 4 | 5 | 2 | 5 |
| 36 | 5 | 5 | 3 | 4 | 4 | 3 | 4 |
| 37 | 5 | 4 | 4 | 4 | 5 | 2 | 4 |
| 38 | 5 | 4 | 4 | 4 | 5 | 5 | 5 |
| 39 | 5 | 4 | 4 | 4 | 3 | 5 | 4 |
| 40 | 5 | 4 | 4 | 4 | 5 | 4 | 4 |
| 41 | 5 | 5 | 4 | 4 | 4 | 4 | 2 |
| 42 | 2 | 4 | 4 | 4 | 5 | 3 | 2 |
| 43 | 3 | 4 | 4 | 3 | 4 | 4 | 3 |
| 44 | 2 | 4 | 2 | 1 | 3 | 5 | 2 |
| 45 | 3 | 5 | 1 | 5 | 5 | 5 | 3 |
| 46 | 3 | 3 | 2 | 3 | 4 | 4 | 2 |
| 47 | 3 | 2 | 4 | 2 | 4 | 4 | 5 |
| 48 | 4 | 5 | 5 | 5 | 5 | 3 | 5 |
| 49 | 5 | 2 | 3 | 2 | 3 | 5 | 4 |
| 50 | 5 | 5 | 3 | 5 | 5 | 4 | 5 |
| 51 | 5 | 4 | 5 | 4 | 4 | 3 | 5 |
| 52 | 4 | 3 | 4 | 3 | 5 | 3 | 4 |
| 53 | 4 | 2 | 5 | 2 | 4 | 5 | 5 |
| 54 | 3 | 5 | 2 | 5 | 3 | 5 | 3 |

Respondent's results for Design and Build for the Procurement of Building projects

| Respondents | DB1 | DB2 | DB3 | DB4 | DB5 | DB6 | DB7 |
|--------------------|------------|------------|------------|------------|------------|------------|------------|
| 1 | 4 | 4 | 4 | 3 | 4 | 3 | 4 |
| 2 | 4 | 4 | 4 | 3 | 4 | 3 | 4 |
| 3 | 4 | 3 | 2 | 3 | 4 | 3 | 2 |
| 4 | 4 | 3 | 4 | 3 | 4 | 5 | 4 |
| 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 6 | 5 | 3 | 3 | 4 | 4 | 5 | 3 |
| 7 | 5 | 4 | 3 | 4 | 4 | 5 | 3 |
| 8 | 3 | 4 | 4 | 2 | 4 | 4 | 4 |
| 9 | 3 | 2 | 3 | 4 | 3 | 5 | 3 |
| 10 | 2 | 3 | 3 | 4 | 3 | 5 | 3 |
| 11 | 3 | 3 | 2 | 3 | 2 | 5 | 2 |
| 12 | 3 | 4 | 3 | 4 | 3 | 5 | 3 |
| 13 | 4 | 4 | 2 | 3 | 2 | 4 | 2 |
| 14 | 1 | 3 | 3 | 3 | 2 | 4 | 3 |
| 15 | 3 | 2 | 3 | 3 | 2 | 3 | 3 |
| 16 | 3 | 4 | 3 | 3 | 2 | 3 | 3 |
| 17 | 5 | 4 | 3 | 5 | 4 | 3 | 3 |
| 18 | 5 | 5 | 3 | 5 | 3 | 4 | 3 |
| 19 | 3 | 4 | 4 | 5 | 1 | 4 | 4 |
| 20 | 3 | 4 | 4 | 4 | 4 | 4 | 4 |
| 21 | 4 | 4 | 3 | 4 | 3 | 5 | 3 |
| 22 | 4 | 4 | 5 | 4 | 5 | 5 | 5 |
| 23 | 4 | 3 | 4 | 4 | 4 | 5 | 4 |
| 24 | 5 | 5 | 4 | 4 | 4 | 3 | 4 |
| 25 | 5 | 4 | 2 | 4 | 2 | 3 | 2 |
| 26 | 4 | 4 | 2 | 4 | 2 | 4 | 2 |
| 27 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 28 | 4 | 4 | 2 | 4 | 2 | 4 | 2 |
| 29 | 5 | 3 | 2 | 4 | 2 | 5 | 2 |
| 30 | 4 | 3 | 3 | 5 | 3 | 5 | 3 |

Degree of Master of Science

| Respondents | DB1 | DB2 | DB3 | DB4 | DB5 | DB6 | DB7 |
|--------------------|------------|------------|------------|------------|------------|------------|------------|
| 31 | 4 | 5 | 2 | 5 | 2 | 5 | 2 |
| 32 | 4 | 3 | 4 | 5 | 4 | 5 | 4 |
| 33 | 5 | 4 | 4 | 5 | 4 | 4 | 4 |
| 34 | 5 | 4 | 4 | 4 | 1 | 4 | 4 |
| 35 | 5 | 4 | 4 | 4 | 4 | 4 | 4 |
| 36 | 5 | 5 | 3 | 4 | 3 | 3 | 3 |
| 37 | 4 | 4 | 4 | 4 | 4 | 3 | 4 |
| 38 | 5 | 4 | 4 | 4 | 4 | 4 | 4 |
| 39 | 3 | 4 | 5 | 4 | 4 | 4 | 5 |
| 40 | 5 | 4 | 5 | 4 | 4 | 5 | 5 |
| 41 | 5 | 5 | 5 | 4 | 4 | 5 | 5 |
| 42 | 2 | 4 | 5 | 3 | 4 | 4 | 5 |
| 43 | 3 | 4 | 4 | 3 | 4 | 4 | 4 |
| 44 | 3 | 4 | 2 | 3 | 2 | 4 | 2 |
| 45 | 4 | 4 | 5 | 3 | 1 | 4 | 5 |
| 46 | 4 | 5 | 4 | 3 | 2 | 4 | 4 |
| 47 | 2 | 3 | 5 | 3 | 4 | 2 | 5 |
| 48 | 5 | 2 | 4 | 4 | 5 | 5 | 4 |
| 49 | 3 | 4 | 5 | 5 | 3 | 3 | 5 |
| 50 | 4 | 5 | 4 | 5 | 3 | 4 | 4 |
| 51 | 2 | 4 | 5 | 5 | 5 | 2 | 5 |
| 52 | 3 | 2 | 3 | 4 | 4 | 3 | 3 |
| 53 | 5 | 3 | 3 | 4 | 5 | 5 | 3 |
| 54 | 4 | 4 | 5 | 3 | 2 | 4 | 5 |

Respondent's results for Recommendation

| Respondents | Allowing a project owner or client to add a project manager to the construction team will facilitate the issues faced during project implementation and consequently allay some of the fears of owners |
|--------------------|--|
| 1 | 4 |
| 2 | 4 |
| 3 | 5 |
| 4 | 4 |
| 5 | 5 |
| 6 | 3 |
| 7 | 5 |
| 8 | 5 |
| 9 | 4 |
| 10 | 4 |
| 11 | 5 |
| 12 | 3 |
| 13 | 2 |
| 14 | 5 |
| 15 | 4 |
| 16 | 4 |
| 17 | 5 |
| 18 | 3 |
| 19 | 3 |
| 20 | 4 |
| 21 | 4 |
| 22 | 4 |
| 23 | 5 |
| 24 | 3 |
| 25 | 5 |
| 26 | 4 |

| Respondents | Allowing a project owner or client to add a project manager to the construction team will facilitate the issues faced during project implementation and consequently allay some of the fears of owners |
|--------------------|--|
| 27 | 4 |
| 28 | 4 |
| 29 | 4 |
| 30 | 4 |
| 31 | 5 |
| 32 | 5 |
| 33 | 5 |
| 34 | 5 |
| 35 | 5 |
| 36 | 5 |
| 37 | 4 |
| 38 | 4 |
| 39 | 3 |
| 40 | 4 |
| 41 | 4 |
| 42 | 4 |
| 43 | 5 |
| 44 | 5 |
| 45 | 5 |
| 46 | 4 |
| 47 | 5 |
| 48 | 4 |
| 49 | 5 |
| 50 | 3 |
| 51 | 5 |
| 52 | 4 |
| 53 | 3 |
| 54 | 3 |