

**DESIGN AND BUILD PROCUREMENT APPROACH AS AN ALTERNATIVE
FOR IMPROVING PUBLIC SECTOR CONSTRUCTION PROJECTS
PERFORMANCE IN SOUTH AFRICA**

by

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DECLARATION

I, Nyiko Jeffrey Gudlhuza hereby declare that this research is my own original work. It is being submitted in fulfillment of the requirements for the award of the degree of Master of Science in Engineering at the University of the Witwatersrand, Johannesburg. I declare that this work has not been submitted by the author for the award of any degree or examination in this or any other university.

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ABSTRACT

Design and build procurement approach is a construction procurement method where the contractor takes responsibility for the design and construction work usually for a lump sum price. The design and construction contracts are combined into a single contract in a design and build procurement approach, which in turn saves time by avoiding the need for a second procurement stage. Despite the advantages that the design and build procurement approach offers, there is limited use of the approach in the public sector in South Africa. The research project investigated the use of the approach in South Africa's public sector. Major factors limiting the use of the approach as well as areas that could be enhanced in order to address perceived challenges of the approach have been investigated. The study adopted a quantitative approach to the research. A survey method was undertaken and involved the use of self-administered questionnaire for data collection. The sample comprises a total of 50 respondents in the public sector who were involved in managing construction projects. The research was confined to survey questionnaires sent through emails.

The study revealed that 40% of the public sector officials do not deliver their projects using the design and build procurement approach. A further 31% of public sector officials implement only between 1-10% of their projects using the design and build procurement approach. Furthermore, the study revealed that lack of knowledge is the main factor limiting the use of design and build procurement approach in the public sector. Design and build procurement approach can be enhanced in the areas of procuring and contracting the design and build contractor. The conclusion from the study is that design and build procurement approach can be an alternative that can contribute to accelerating delivery of infrastructure construction projects in the public sector and ensure successful delivery of projects.

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CHAPTER 1: INTRODUCTION

1.1 Background

Design and build procurement approach (also known as design-build) is a construction procurement approach where the contractor takes responsibility for the design and construction in accordance with the client's brief¹ usually for a lump-sum price. Ghadamsi (2016) argues that design and build procurement approach is classified as one of the integrated forms of procurement methods, whereby the client provides his/her requirements and needs for the specified project and signs contract with only one organization, namely the contractor. This organization is responsible for the design, supervision and construction services of the project (Ghadamsi, 2016). Pricing for design and build contracts can take a form of cost reimbursement or fixed price basis. This approach may also be on the basis of competition or negotiation (Ilori and Talukhaba, 2016).

Context

There has been an increase in infrastructure budget spend in South Africa's public sector from R48,8 billion in 1998/99 to R236,2 billion in 2017/18 financial years. In 2019, the Finance Minister indicated that spending on public infrastructure will total R865 billion over 3 years. The Finance Minister further highlighted the current infrastructure implementation challenges and a need for a shift in policy and direction in the delivery of infrastructure (2019 Budget Review). Various construction procurement methods are at the disposal of public sector officials for the delivery of this infrastructure with the design-bid-build being common in the construction industry. It is time that the public sector seriously considers accelerating and improving infrastructure implementation through the use of the design and build procurement approach.

There is a research gap that exists in the area of design and build procurement approach which this research project aims to contribute to. There has been limited research in the area of design and build procurement approach in South Africa. In 2002, Grobller and Pretorius undertook an evaluation of design and build procurement approach for building and civil engineering projects in South Africa. In 2010, Mfongeh researched on the constraints of using design and build for the procurement of construction projects in South Africa. Recent research on the subject has been conducted by Ilori and Talukhaba. In 2016 and 2017 they researched on the practise of design and build procurement approach in South Africa which led to publication of the outcomes in the International Journal of Construction Supply Chain Management (Ilori and Talukhaba, 2017). It is evident from the research conducted that there was no

¹ Known as employer's requirements

specific research focus on the practise of design and build procurement approach in the public sector.

Design and build procurement approach

“Design-build system is when both design and construction are included in a single contract between the owner and the contractor either on a lump-sum or cost-plus basis e.g. housing and industrial constructions or an arrangement where one contracting organization takes sole responsibility, normally on a lump sum fixed price basis, for the bespoke design and construction of a client’s project. The fundamentals of this procurement method are that the responsibility for design and construction lies with one organization and project carried out to meet the needs of the client” (Ilori and Talukhaba, 2016, p 204).

Design and build procurement approach can thus be defined to be a procurement approach which is present when a substantial amount of building is accomplished under a single contract, covering both the design and building of the project (Ilori and Talukhaba, 2016). Borowiec *et al.* (2016) define design and build as an alternative project delivery method that executes a single contract for both the design and construction, such a contract is awarded on a basis of the lowest bidder or best value proposal.

There are various construction procurement systems that exist. Thwala and Mathonsi (2012) distinguish between traditional procurement system and non-traditional procurement systems. According to Thwala and Mathonsi (2012), the traditional method has been in existence for a long time and has been the only choice available for most clients of the construction industry for many years. Borowiec *et al.* (2016) argue that design-bid-build is the more traditional method of project delivery. In the traditional procurement method, the client enters into an agreement with the design consultant to carry out the design work and prepare contract documents. Once the design phase is completed, the contractor is then appointed based upon the client’s design. Basically, this approach separates design from construction processes.

Design and Build procurement approach fall under the category of non-traditional procurement systems (integrated procurement system). The same contractor is meant to design and construct the project meaning that a closer collaboration is required in the process and all risk is allocated to the contractor (Thwala and Mathonsi, 2012).

Ilori and Talukhaba (2016) highlight the history of the design and build procurement approach and states that the system started to be used during the 1900s in America and that the system was extensively used for many industrial and power projects of the 1970s and 1980s. A design-build institute of America

was set up during the mid-1990s as a result of the extensive use of the approach. The approach experienced tremendous growth of its use whereby 5% of all construction projects in 1991 to over one-third in the mid-1990s were using the design and build procurement approach.

Grobber and Pretorius (2002) conducted a survey on procurement systems in South Africa. The participants included public and private sector clients as well as designers and contractors. According to their findings (i.e. percentage by weight of the procurement method), the traditional procurement method had the highest percentage usage by weight (62%), followed by design and build procurement approach (28,6%) and construction management at risk (1,4%). Other procurement method accounted for 8% usage by weight (Oshungade and Kruger, 2015).

The extent of the use of design and build procurement approach in South Africa's public sector is an area that has not been researched adequately. There are however several construction projects such as the Nelson Mandela Bridge and the Gautrain Rapid Rail Link that have been implemented using the design and build procurement approach.

A study conducted by FMI (2018) revealed that between 2013-2017, design and build procurement approach accounted for 39% share and is anticipated to represent up to 44% (\$323.6 billion) of construction spending in the assessed segments by 2021. According to Molenaar and Franz (2018), in 1998 the Construction Industry Institute (CII) published a report benchmarking the performance of various project delivery systems in the U.S. The report examined data from over 350 projects. These projects were of varying size, sector, complexity and location that were all completed in the mid-1990s. The findings revealed that design and build projects performed well more than both construction-manager at risk (CMR) and designed-bid-build project delivery systems in terms of unit cost, cost and schedule growth, and all metrics relating to the speed of delivery. This study was updated in 2018 using a new sample of 212 contemporary projects and it was found that design and build projects are still delivered faster and with greater reliability in cost and schedule performance (Molenaar and Franz, 2018). The study further revealed the following over the 20-year period (i.e. from 1998 to 2018):

- Cost performance - design and build projects were 1.9% less expensive than CMR on a cost per square foot basis and 0.3% less than design-bid-build. Design and build projects saw 2.4% less cost growth than CMR and 3.8% less than design-bid-build.
- Schedule Performance - design and build projects saw 3.9% less schedule growth than CMR and 1.7% less than design-bid-build. Design and build projects were 13% faster than CMR during the construction

phase and 36% faster than design-bid-build.

- Design through final completion - design and build projects were delivered 61% faster than CMR and 102% faster than design-bid-build (Molenaar and Franz, 2018).

New contractual models have emerged in the UK from the 1990s as well as early 2000s. These models are alliance contracting, prime contracting and outcome based contracting models. According to Sanderson (2016), the models are conceptually distinct though they share certain defining characteristics. All the models, to an extent, shift risk from the client to the service provider and seek to incentivize the service providers to look for innovative ways to achieve projects performance such as improved integration, value for money and other project performance goals (Sanderson, 2016). The UK and U.S based approaches have not gained traction in South Africa. Various public sector entities have begun implementing projects using the design and build procurement approaches. There is therefore a necessity to further investigate the implementation of this approach in South Africa's public sector.

Three features of the design and build procurement approach are evident namely: client's requirements and proposal from the contractor; price; and roles and responsibilities. Murdoch and Hughes (2008), point out that the first of the essential features of a design and build contract is that the employer (client) approaches a contractor with a set of requirements defining the overall project needs and scope. The second critical feature of design and build procurement approach is the price, also known as the guaranteed maximum price. The third significant feature of design and build procurement approach is that the contractor takes on the overall responsibility. There is therefore no independent certification role in the contract Murdoch and Hughes (2008).

Ghadamsi (2016) undertook a study that looked at the criteria for selecting the design and build. A total of 44 authors were identified and given criteria to select from. Notably 30% of the authors selected the single point responsibility as the main criteria for selecting the design and build approach. This was followed by 27% who selected the design and build due to the advantage of reducing costs. Effective communication amongst project team members is another advantage of the approach. Titmus (1982), argues that traditional competitive tender processes (traditional procurement approach) often result in a project executed from an atmosphere of "them and us" hence it is losing favour (Ilori and Talukhaba, 2016).

Another advantage of the design and build procurement approach is that of time saving especially as it relates to early start on site. The early start in design and build procurement approach is attractive especially to public sector as

clients need to start spending their budget within a short time of the money being allocated. According to Borowiec *et al.* (2016), time saving in design and build procurement approach is realised when the design-build contractor starts construction during the design phase. The commencement of construction in the design phase allows for both processes, which are independent of each other in design-bid-build, to progress simultaneously.

Buildability (also known as constructability) of the facility due to early engagement of the contractor is another advantage of the design and build procurement approach. The design and build process increases the opportunities for harnessing the benefit of the contractor's experience during the design stages of the project.

Common criticism of design and build is that the approach is inflexible in dealing with variations. It is always difficult to deal with variations in design and build approaches. Murdoch and Hughes (2008), argue that a client who wishes to reserve the right to alter requirements during the construction process should not use design and build. Furthermore, the approach is not conducive to the client's selection of specialist selected/nominated subcontractors.

The main legislation that regulates public procurement in South Africa is the Constitution of the Republic of South Africa, 1996. Other applicable legislation relevant to the design and build procurement approach include the Construction Industry Development Board (CIDB) Act 38 of 2000. The CIDB recommends various forms of contract of which both FIDIC and NEC3 caters for design and build procurement approach (i.e. allow for design by contractor).

1.2 Problem formulation

The traditional approach to construction procurement has led to several delays in implementing construction projects in South Africa. In most cases, there is substantial time gap from the time the professional (design) team is appointed to the time the design is complete and the contractor is appointed to carry out the works. Borowiec *et al.* (2016), point out to the fact that in the traditional design-bid-build project delivery method, the employer (client) is required to begin a new procurement process once the design of a project has been completed. The design and construction contracts are combined into a single contract in a design and build procurement approach, which in turn saves time by avoiding the need for a second procurement stage.

Table 1 below highlights five (5) projects implemented by Johannesburg Development Agency with regard to design team appointments and the time it took to appoint a contractor once the design was completed.

Table 1: Sample of JDA Construction Projects

Project Name and description	All consultants appointed	Contractor appointed	Time difference in months
Brixton Social Cluster Phase 1: Multi-purpose sports and recreation complex	29 July 2016	12 October 2017	15 months
Florida Health Care Facility	27 May 2016	05 June 2017	12 months
Westbury Transformation Development Centre	31 July 2015	04 November 2016	15 months
Noordgesig Social Cluster 1B	01 April 2016	05 June 2017	14 months
Peterson Park Multi-Purpose Center	24 March 2016	28 November 2016	8 months

Source: JDA Website (2018).

As outlined earlier, the design and build procurement approach has an advantage of "early start". The time that is usually lost between design and site handover can thus be used productively in a design and build procurement approach.

Problem Statement

There is limited use of design and build procurement approach in the public sector in South Africa despite all the benefits that this procurement approach offers. A survey conducted by Grobblers and Pretorius (2002) revealed that only 11% public sector participants confirmed using the design and build procurement approach. The limited use of the design and build procurement approach is due to the following:

- The late introduction of this procurement system into the South African construction industry compared to other countries especially in Europe has led to the current limited use of the approach (Ilori and Talukhaba, 2016).
- The second reason is that of perception; South Africa being a developing country where information about this procurement method is still lacking, clients may view design and build projects in a certain way influenced by their level of understanding of the method (Ilori and Talukhaba, 2016).

1.3 Aims and Objectives

The aim of the research was to investigate the use of design and build procurement approach in South Africa's public sector as well as to investigate the major factors limiting the use of the approach. The objective was to identify

aspects of design and build procurement approach that could be enhanced in order to address the limitation of the approach.

Research Question

The research aimed at investigating the following:

- To what extent is the design and build procurement approach currently used in South Africa's public sector?
- What are the major factors limiting the use of the design and build procurement approach in south Africa's public sector?
- Can design and build procurement approach be enhanced to address perceived challenges of the approach?
- To what extent can design and build procurement approach as an alternative contribute to accelerating delivery of infrastructure construction projects in the public sector and ensure successful delivery of projects?
- to what extent can design and build procurement approach ensure successful delivery of projects?

1.4 Significance of the study

According to Wadeley (1991), research should make a contribution and be beneficial in one form or another. This research contributed to scholarly literature by investigating the potential of design and build procurement approach as an alternative to improving public sector projects performance. The respondents targeted in this research were experienced senior public sector officials and construction project managers. These public sector officials possess a certain degree of expertise in the subject matter and their input provides the case for generalization of the findings made in the research. Notably, previous research on the subject tended to focus on general stakeholders in construction such as contractors, professional teams and clients. This research is more beneficial to public sector stakeholders as the focus is on design and build projects or the absence thereof, within the public sector.

Recommendations made if implemented could see an increase in projects being implemented using the design and build procurement approach within the public sector. The study has highlighted further areas of future research regarding design and build procurement approach in the public sector.

This study is significant as it will go a long way in addressing the limited knowledge and understanding of the design and build procurement approach as an alternative construction procurement approach that could lead to

successful project implementation. The better understanding of this approach will in turn enable all practitioners in the public sector to use the design and build procurement approach in their construction projects. Furthermore, the evaluation and documenting thereof of case studies and other research material will contribute to better implementation of the design and build procurement approach by all practitioners in the construction sector. Finally, this research will stimulate further debate and engagement amongst academics and professionals in the construction sector.

1.5 Delimitation

The study focused on design and build projects in the public sector only. No comparisons were made with design and build projects implemented by the private sector as part of the study. The study covered only public sector construction projects in South Africa. Respondents to the research questionnaire were chosen from national, provincial, local governments, public universities as well as parastatals. In an attempt to answer the research questions, the study considered public sector departments / entities who have undertaken design and build projects as well as those who have not worked with design and build procurement approach.

1.6 Assumption

The questionnaires survey was chosen as a research strategy for this research project. An assumption has been made that the majority of the respondents will interpret the questionnaire the same way and that only a negligible number will interpret the questionnaire differently. It was further assumed that the respondents will be free to express their perceptions and the challenges and/or successes encountered in implementing construction projects using both traditional as well as Design and Build approaches.

1.7 Research methodology

The study adopted a quantitative approach to the research. The quantitative approach aspect of the research assisted in confirmation of the hypothesis tested. Kumar (2011) indicates that quantitative research methods falls under a broad heading of descriptive research, which has three (3) types namely, observation studies, correlation research and survey research.

This study adopted the survey research approach. Survey research (also known as normative or descriptive survey), is described by Kerlinger (1973) as a study of either small or large populations where a sample is chosen of a particular population with the aim of discovering the relative incidence, distribution and interrelations.

The approach undertaken involved the use of self-administered questionnaire for data collection. The research population comprised all identifiable public sector officials involved in infrastructure projects in terms of development and management of infrastructure. The sample comprises a total of 50 respondents in the public sector. two techniques being the purposive and snowball sampling were chosen in order to reach these participants. The officials in the following public sector organisations were targeted:

- National government departments
- Provincial departments
- Parastatals
- Universities
- Municipalities and municipal owned entities

All the questionnaires have been distributed to the participants using electronic mail. A list of the key questions circulated is attached to this document as an Annexure. The data collection procedure involved issuing of a formal request letter to all potential participants. For the purpose of the research project, two key ethical issues were considered which are consent and confidentiality.

The literature review process undertaken included accessing both primary and secondary sources. The primary literature sources included journals, conferences, dissertations/theses, occasional papers and government publications and reports. Secondary sources accessed included websites, newspapers and magazines.

1.8 Structure of the research report

Chapter 2: Literature review

The international as well as local experiences of the design and build procurement approach were explored in the literature review chapter. Furthermore, various construction procurement approaches were contrasted with the design and build procurement approach. The design and build procurement approach was discussed in relation its history, features, advantages and its disadvantages. Legislative framework for design and build procurement approach in South Africa was also explored in the literature review. After the compilation of the literature material, the information was critically reviewed and systematically analysed to identify common issues, differences as well as criticism raised.

Chapter 3: Research methodology

In this chapter the research paradigm has been briefly discussed together with the justification for the quantitative approach adopted for this research. The survey methodology, the research population as well as the sample and sampling technique utilised have been outlined in the chapter. The data collection procedure and data analysis process has been explored and explained. Finally, commonly recognised ethical considerations have been outlined in the chapter.

Chapter 4: Finding and analysis

This chapter present the findings and analysis of the research. Firstly, detail sample profile has been discussed followed by highlights and detail analysis of the findings. The research questions have also been revisited in this chapter and a conclusion drawn.

Chapter 5: Conclusion and recommendations

This chapter present the overall conclusion of the research project. Recommendations have been made which are based on the findings and conclusion of the research report. Limitations of the study are further outline in this chapter. Finally, recommendations for future research have also been outlined in the chapter. These recommendations are aimed at enhancing the body of knowledge for the design and build procurement approach.

CHAPTER 2: LITERATURE REVIEW

2.1 Construction procurement systems

According to Naoum and Egbu (2015), it is undeniable in construction management that a project is regarded as successful if the project is completed within the scheduled time, within budget and set quality as well as achieving a notable level of client satisfaction. To an increasing extent, the achievement of these criteria has been associated with the problem of procurement method for construction. Naoum and Egbu (2015) argue therefore that the selection of the appropriate method can shape the success of the project. According to the Design-Build Institute of America (DBIA) (2014), the choices of project delivery system and procurement approach by clients (or employers) strongly influence project results. These choices form the foundation of how the project will be developed, procured and executed, and how the key project stakeholders will communicate and relate to each other throughout the project life cycle.

The challenges facing construction processes have led to the construction industry exploring various alternative methods of construction procurement such as design and build procurement approach, management contracting and construction project management. These challenges relate to separation of design from construction; lack of integration; lack of effective communication; uncertainty; changing environment, changing clients' priorities and expectations, and increasing project complexity and economic changes (e.g. inflation and recession).

There are various definitions of a procurement system. Love and Gunasekaran (1998), define a procurement method as an organisational system that assigns specific responsibilities and authorities to people and organisations and defines the relationships of the various elements in the construction of a project. Naoum and Egbu (2015), define procurement system as a mechanism for linking and coordinating members of the building team throughout the building process in a unique systematic structure, both functionally (via roles, authority and power) and contractually (via responsibilities and risks). The main aim in this regard is to deliver a project that meets its objectives and fulfill the client criteria and expectations. There are various construction procurement systems that exist. Thwala and Mathonsi (2012), distinguish between the traditional procurement system and the non-traditional procurement systems.

2.1.1 Traditional procurement systems

According to Oladinrin *et al.* (2013), the traditional procurement method is that procurement method which offers the clients three separate sequential tasks of design, bid, and build. According to Borowiec *et al.* (2016), design-bid-build is

the more traditional method of project delivery and it comprise of two procurement phases. The first procurement phase pertains to the appointment of a design team required to prepare the project's construction documents. These construction documents then become the property of the employer once design work is complete.

In the second procurement phase, the employer initiate processes to contract a construction firm based on design specification. Borowiec *et al.* (2016), argue that in the second procurement phase uses design documents that are complete, which allows for the employer to closely estimate both the project costs and total project duration. Notably, the second procurement phase adds to the project additional overall projected delivery time, as well as associated costs such as staff and administration costs. Borowiec (2016), clearly unpack these processes in line with the current industry practices.

The client then enters into a contract with the successful contractor for the assembly of the project elements. The client is under two contractual obligations, which are the design professional and the contractor. This approach separates design from construction processes. In certain instances, the contractor can be allocated the responsibility for the design of temporary works. The poor influence the contractor has over the design, cost and risk allocation is considered one of the main disadvantages of this approach (Thwala and Mathonsi, 2012).

2.1.2 Non-traditional procurement systems

Masterman (2002), argues that the non-traditional procurement systems are a diversified contemporary procurement system that not only considers design and construction, but also considers financing, operating and facility management. Thwala and Mathonsi (2012), identify three different types of non-traditional procurement systems. These procurement systems are outlined below:

- i. Integrated procurement system – Where one organisation, usually but not exclusively the contractor, takes responsibility for the design and construction of the project, in theory at least. The client deals with only one organisation. Design and build procurement approach falls under this category of integrated procurement system. The same contractor is meant to design and construct the project meaning that a closer collaboration is required in the process and all risk is allocated to the contractor.
- ii. Management-oriented procurement system – Under a management-oriented procurement system, the management of the project is carried

out by an organisation working with the design and other consultants to produce the designs and to manage the physical operations which are carried out by contractors. Management Contracting (MC) and Construction Management (CM) fall under this category. The basic principle in both MC and CM is that one contractor manages a series of different “works” contractors.

- iii. Collaborative and discretionary procurement system – Under a collaborative system the client lays down a framework for the overall administration of the project within which the discretion exists to use the most appropriate of all the procurement systems. According to Cartlidge (2002), in a collaborative procurement system quantity surveyors play an integral role by providing a wide range of services, which include contractual issues; it also offers quantity surveyors an opportunity to act as independent advisors within the system (Thwala and Mathonsi, 2012).

2.2 Design and build procurement approach defined

According to Ghadamsi (2016), design and build procurement approach is classified as one of the integrated forms of procurement methods, whereby the client provides his/her requirements and needs for the specified project and signs contract with only one organization, namely the contractor. This organization is responsible for the design, supervision and construction services of the project.

Various authors have provided definitions for the design and build procurement approach. Ilori and Talukhaba (2016), define design and build procurement approach as an approach that is present when a substantial amount of building is accomplished under a single contract, covering both the design and building of the project. According to Richard (1975), design and build procurement approach (also known as design-build) refers to a situation when a client contracts with a single firm in both design and construction. On the other hand, Harold (1976) defines design and build to be a procurement approach which is present when a substantial amount of building is accomplished under a single contract, covering both the design and building of the project (Ilori and Talukhaba, 2016).

Balogun (1992), defines design and build procurement approach as a contract in which a building contractor does some or all of the design work and produces the building without delays especially in cases where the contract was negotiated. Ellis (1990), argues that design and build procurement approach has an advantage to other procurement methods as the contractor’s knowledge

of the building process is incorporated in the design process since both design and construction work are carried out by a single contractor.

2.3 History of design and build procurement approach

According to Minchin (2013), design and build procurement approach is considered as one of the most favored project delivery methods in the engineering and construction industry. The approach has gained its popularity from its time and cost saving reputation, reduced conflicts and enhanced communication between project participants (Minchin *et al.*, 2013).

According to Murdoch and Hughes (2008), this procurement approach was originally found in industries as diverse as shipbuilding and microelectronics. Murdoch and Hughes (2008) argue that before the emergence of architecture as a profession, pre-industrial society used to procure buildings by a process of design and build procurement approach. It was a separation of the responsibility for construction (also referred to as fabrication) from the responsibility of design that led to the emergence of what is known today as traditional or general contracting.

Masterman (1996) argues that the design and build procurement approach is probably the oldest in the world. He pointed out that Master builders were providing buildings to meet the client's individual needs long before architecture became independent consultants where they now design and monitor construction work of the contractor as independent organizations. This is what today is known as the traditional procurement method. He further argues that the design and build procurement approach is a return to a former system which re-emerged in the post-war USA mainly for industrial and commercial projects.

Masterman (1996) points out that during the post-war period, architects tended to ignore their code of practice which precluded them from becoming contractors and by the 1970s architects in America were involved in design and build procurement approach to the point where the American Institute of Architects was silently forced to acknowledge the trend and approve it.

According to Ilori and Talukhaba (2016), the system started to be used during the 1900s in America and that the system was extensively used for many industrial and power projects of the 1970s and 1980s. A design-build institute of America was set up during the mid-1990s as a result of the extensive use of the approach. The approach experienced tremendous growth of its use whereby 5% of all construction projects in 1991 to over one-third in the mid-1990s were using the approach. A study conducted in the U.S revealed that between 2013-2017, design and build delivery method accounted for 39% share of construction spending (FMI, 2018).

According to Hackett *et al.* (2007), design and build procurement approach emerged to be the most frequently used procurement method in the early 2000s in UK. The Royal Institution of Chartered Surveyors conducted an industry survey and established that design and build procurement approach was used to procure 42% of the total value of projects undertaken at that time.

2.4 Local trends - construction procurement in South Africa

Mbanjwa and Basson (2003), conducted an empirical survey that found the traditional procurement system was rated the most favoured form of procurement, followed by construction management ranked 2nd, management contracting ranked 3rd; design and build procurement approach (turnkey) ranked 4th; and design and manage including (build, operate and transfer) ranked 5th (Thwala and Mathonsi, 2012).

Ilori and Talukhaba (2016), conducted a survey regarding design and build procurement approach. The survey was based on stakeholders' opinion and indicated that design-build is not well practised in South Africa due to lack of understanding of the design-build procurement method. The study concluded that a better understanding of the practices of design and build procurement method will allow more clients to use this procurement route which has been proven to demonstrate superior performance in some types of projects (Ilori and Talukhaba, 2016). The extent of the use of design and build procurement approach in South Africa's public sector is an area that has not been researched adequately.

2.5 International trends - contracting models in the UK

There are various contractual models that have emerged in the UK from the 1990s as well as the early 2000s namely: alliance contracting, prime contracting and outcome based contracting models. According to Sanderson (2016), the models are conceptually distinct though they share certain defining characteristics. All the models, to an extent, shift risk from the client to the service provider and seek to provide incentives to the service providers to look for innovative ways to achieve projects performance such as improved integration, value for money and other project performance goals (Sanderson, 2016).

2.5.1 Alliance contracting

According to Chen *et al.* (2012), alliance contracting (also known as alliance partnering) is different from other partnership approaches due to the use of a single alliance contract between the client and the service provider delivering the project. The key element in this regard that differentiates the model from other partnership approaches is the use of a legally enforceable contract that foster unity amongst all parties. This may include a risk/reward shared incentive structure. According to Chew (2004), it is common for the client to pay alliance partners for their project costs and overheads, and then to implement a pain/gain share incentive structure. The performance of the partners is therefore judged collectively.

2.5.2 Prime contracting models

According to Sanderson (2016), in prime contracting models (also known as lead contracting), the client contracts with a service provider for the delivery of a contract that is likely to span a number of providers. The prime-contracting agent has responsibility for managing the supply chain and delivering the outcome specified by the client. Corrigan and Laitner (2012) explain that the model is based on the belief that clients should move away from micro-managing complex supply chains, and that moving this responsibility to a lead service provider will result in better integrated services.

Prime contracting originated as an approach in the construction and defense industries in the 1990s. There is evidence of the use of prime contracting in the Ministry of Defense contracts in the UK, in the general construction industry as well as in contracts for the provision of welfare services (Sanderson, 2016).

Numerous projects have been implemented in the UK using prime contracting. The Defense Estates is an agency of the Ministry of Defense (MOD) responsible for delivery of expert property, construction and estate management. According to MOD (2003), a "prime contractor" is defined as one having a single point responsibility for the management and delivery of a project using a system of incentivisation and collaborative working to integrate the activities of its supply chain members to achieve a project that is on time, within budget and is in accordance with the specified outputs and is fit for purpose (MOD, 2003).

According to MOD (2003), prime contracting as applied by the Defense Estate is different from more traditional forms of construction, including design and build procurement approach. The model adopted involves reliance upon an output specification rather than prescriptive and detailed constraints upon the contractor (MOD, 2003).

2.5.3 Outcome based contracting

According to Caldwell and Howard (2014), outcome-based contracting (also known as performance-based contracting), is a contractual form that emphasises performance outcomes rather than specifying the processes by which outcomes are to be achieved. This approach was implemented particularly in relation to the provision of public services in the UK (Sanderson, 2016). According to Selviaridis and Wynstra (2015), outcome-based contracting can be differentiated from other forms of contracting due to the following factors:

- Focus on outcomes rather than processes, resulting in the alignment of goals and incentives across supply chains;
- Increased risk and rewards for suppliers as performance achievement is related to financial bonuses and penalties;
- Emphasis on the co-production of outcomes through supplier interactions.

The research does not focus on the new UK procurement approaches as they have not gained traction in South Africa and are not yet common in South Africa's public sector.

2.6 Features of design and build procurement approach

Design and build procurement approach consist of three key features namely: client's requirements and proposal from the contractor, price, as well as roles and responsibilities.

Murdoch and Hughes (2008), point out that the first of the essential features of a design and build contract is that the employer (client) approaches a contractor with a set of requirements defining the overall project needs and scope. According to Hackett *et al.* (2007), the project brief is key to any design and build contract. There are therefore various forms that the brief can take. These forms may be an outline specification, a performance specification, drawings in varying degrees of detail or a combination of drawings and an outline specification. The design team is often appointed by the client (employer) to assist in compiling the project brief and prepare preliminary designs and costing before seeking a contractor (by competition or negotiation) to proceed on a design and build basis. The costing in this regard becomes important, as it is critical that contractors tender on a basis that the client knows is within the budget.

Based on the overall client requirements the contractor responds by submitting a proposal, such a proposal will include the design and building of the required facility. Murdoch and Hughes (2008), point out that once the client's requirements and the contractor's proposals match, the contract can be executed, and the contractor can proceed and implement the work based on the agreement. The contractor will be totally responsible for undertaking the design work outlined in the contractor's proposal, for constructing the facility, including co-ordination and integrating the entire process. This co-ordination, Murdoch and Hughes (2008) argue, it includes the appointment of consultants if the contractor does not have the necessary skills within its employ. The client may also choose to appoint consultants in order to monitor the various aspects of the work, but such consultants will not have a contractual role in the way that they would under traditional procurement approach.

According to Hackett *et al.* (2007), contractual arrangements vary in design and build procurement approaches. These contractual arrangements range from projects where the contractor offers to undertake the complete design and construction using his own construction staff and professional team (i.e. architects, engineers and surveyors), to projects where the employer appoints a design team to progress the design to a certain stage (often planning approval) and then the contractor is requested to tender on the basis of completing the design and constructing the facility.

The second critical feature of design and build procurement approach is the price, also known as the guaranteed maximum price. The guaranteed maximum price is a key advantage of the design and build procurement approach. This is attractive to employers as it provides cost certainty. Depending on the contract agreement, this is sometimes attractive to contractors as an incentive, as any savings made by completing the project for a price below the guaranteed maximum price may be shared between the client and the contractor (Murdoch and Hughes, 2008). As far as financial administration is concerned, the contractor is supposed to make applications for payment, using either the stage payment or periodic payment system. According to Hackett *et al.* (2007), valuations made by the contractor will include the valuation of applicable variations and must be priced according to valuation rules laid in the contract. In certain cases, the employer appoints a quantity surveyor as financial administrator, and retains the services of the quantity surveyor who has been involved in the preparation of the project brief (Hackett *et al.*, 2007).

The third significant feature of design and build procurement approach is that the contractor takes on the overall responsibility for the delivery of the project. The responsibility for the design, construction and the required performance of the facility or building to be constructed lies entirely with one party, which is the

contractor (Hackett *et al.*, 2007). There is therefore no independent certification role in the contract. Murdoch and Hughes (2008), explain that there is no architect or contract administrator to settle differences between the parties and there is no independent quantity surveyor responsible for preparing the basis upon which contractors tender. This therefore means that the contractor is responsible for everything in the project (Murdoch and Hughes, 2008).

Post-contract administration is equally important in this approach. Hackett *et al.* (2007), argue that though the contractor has total responsibility for undertaking the design and construction work, clients are advised to monitor the performance of the contractor in order to ensure that specifications are adhered to, as set out in the contracts documents, and that the workmanship is to the determined standard. The client's agent has reasonable access to the works and the client (employer) has powers to order the opening of covered work for testing should that be required.

2.7 Suitability of design and build procurement approach

The quality of the final constructed product is affected by how the design and build contracts are established. Hackett *et al.* (2007), argue that the use of the system must be also be based upon the client's expectations with regard to programme, cost in construction, cost in use, level of specification and quality of design over and above the type of building required. According to Hackett *et al.* (2007), design and build contracts are suitable for the following types of buildings:

- Standard building types where early return on capital investment outweighs considerations of design excellence
- Buildings using proprietary systems where the manufacturer of the system can become the main contractor,
- Building types within which some contractors became specialist. This might be specialist work with reference to, for instance, extremely highly serviced health care (or laboratory buildings) within which the quality justifies manufactory production.

According to Hackett *et al.* (2007), design and build contracts are not suitable for the following types of projects:

- Projects where architectural quality is of overriding importance to the client
- Projects where clients require a building tailored to their unique and special requirements
- Projects where there are complicated planning and environmental issues to be resolved
- Projects where complicated refurbishment or renovation work (particularly to heritage buildings) is required, as frequent and

unexpected variations often arise

- Projects where the brief cannot be defined, or the functioning of the building or facility is of great complexity. These would be instances where a protracted period of research and investigation is necessary at the outset and might continue once work has commenced.

According to Ghadamsi (2016), the circumstances in which this method is generally considered appropriate include the following:

- The client is not familiar with the construction process.
- The project is technically complex.
- There is a low likelihood of variations to the project.
- The client desires a single point of responsibility.
- The client desires a quick start to work on site.
- The client desires to prioritize either time, quality, price or value for money etc.
- The client desires an opportunity for effective direct communication/ interaction with contractors.
- The client desires an integration of the design and construction process.

Ghadamsi (2016) has undertaken a study that looked at the criteria for selecting the design and build procurement approach. A total of 44 authors were identified and given criteria to select from. Notably 30% of the authors selected the single point responsibility as the main criteria for selecting the design and build procurement approach. This was followed by 27% who selected the design and build procurement approach due to the advantage of reducing costs. These results are shown in Table 2 below.

Table 2: Design and build procurement approach selection criteria

Criteria for Selecting Design and Build Procurement Approach	Total Number of Authors in agreement	% of Authors
Quick delivery of construction processes	7	16%
Quick project commencement	6	14%
Effective communication between project parties	8	18%
Flexibility of design changes	5	11%
Single point of responsibility	13	30%
Less conflict between project team	9	20%
Complexity of design	9	20%
Transfer risks to contractor	8	18%
Reducing project cost	12	27%
Minimising project time	9	20%
Component and experienced contractor	5	11%
Working relationship between project team	3	7%
Planning and design project time	1	2%
Total number of authors		44

Source: Ghadamsi (2016)

Adnan *et al.* (2012) undertook a study to determine the primary factors which supported the successful application of design and build procurement approach in public universities. The study has looked at various factors considered in selecting design and build procurement approach by clients (i.e. public universities). Table 3 below indicates the findings of the study. Notably, the design liability to the contractor proved to be a critical factor in selecting the design and build procurement approach and was ranked 1st with an average index of 3.308. This was followed by the faster building time which was ranked 2nd with an average index of 3.192 and the complexity of the project ranked 3rd with an average index of 3.154.

Table 3: Factors considered in selecting design and build procurement approach by client

Variables	Average Index	Ranking
Design liability to the contractor	3.308	1
Faster building time	3.192	2
Complexity of the project	3.154	3
Reduce time for tendering process	3.154	4
Reliable completion time	3.077	5
Single point responsibility	2.923	6
Avoidance of risk	2.846	7
Flexibility of project team	2.846	8
Guaranteed quality	2.769	9
Minimise pre-tender cost	2.769	10
Reduces staffing level	2.692	11
Innovative one-off design	2.615	12
Customer satisfaction	2.615	13
Less variation and claim	2.577	14
Best value for money	2.538	15
Increase productivity	2.538	16
Minimise end-user complaint	2.538	17
Less of conflict / dispute	2.500	18
Guaranteed maximum price	2.423	19
Well thought-out standard design	2.385	20
Lower contract cost	2.192	21

Source: Adnan *et al.* (2012)

2.8 Advantages of design and build procurement approach

According to Petersen and Murphree (2004), flexibility, innovation, integration, and single-source delivery are keys to successful project delivery in ever changing environments. They therefore argued that design-build project delivery methods appear to offer all of these attributes.

In design and build procurement approach, the contractual relationship between the client and the contractor offer some advantages over other methods of construction procurement. This approach provides a single source of accountability for the project. According to Murdoch and Hughes (2008), this single point of responsibility is very attractive to clients, particularly those who may not be technical experts in the field of construction.

The single point of responsibility also means that the contractor does not rely on other firms (engineers, architects etc.) for the supply of information such as construction drawings in order to execute the design. Pain and Bennett (1988), argue that by removing those blocks to effective communication, experience has shown that programmes and budgets are more likely to be adhered to, and the speed of building is likely to be quicker in design and build procurement approach. In design and build projects, the contractor takes responsibility for most of the risks as can be shown in Figure 1 below:

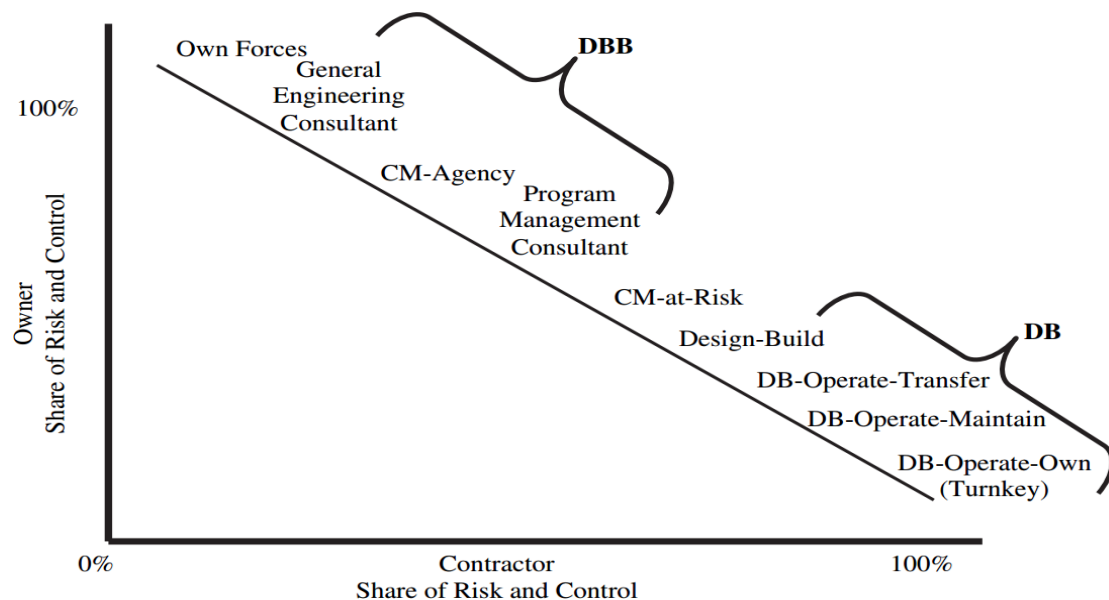


Figure 1: Project delivery method risk and control comparison.

CM: construction manager. DBB: design-bid-build. DB design and build.
Source: (Borowiec *et al*, 2016).

Effective communication amongst project team members is another advantage of the approach. This approach also fosters teamwork and lends itself to co-operation. The line of communication becomes short and relatively informal. In contrast to the traditional procurement approach, the members responsible for design-build see themselves as members of the same team. Titmus (1982), argues that traditional competitive tender processes (traditional procurement approach) often result in a project executed from an atmosphere of "them and us" hence it is losing favour (Ilori and Talukhaba, 2016).

Cost certainty for clients is another advantage of design and build procurement approach (Murdoch and Hughes, 2008). Design and build projects are based on a fixed price contract (sometimes subject to fluctuations). The contractor takes on the risk as far as pricing is concerned. The agreed price includes all the contractor's responsibilities such as design, construction and any necessary statutory approvals such as planning permission, unless expressly mentioned in the client's requirements. This means the client's financial commitment is very clear, and there is not much risk associated with this from the client. The risk of the cost exceeding the price lies entirely with the contractor (Murdoch and Hughes, 2008).

Hackett *et al.* (2007), point to the fact that given the higher degree of co-ordination at an early stage, through the single point of responsibility, variations during construction tend to be fewer and the risk of post-contract price escalation reduced. This is very attractive especially for public sector clients who are often faced with huge project cost overruns. Furthermore, costs and budgets are discussed during the design phase of the project. These discussions ensure that the project is kept within realistic budgets. Upon finalisation of the project scope of work, the project costs are clearly defined and controlled by the contractor.

Another advantage of the design and build procurement approach is that of time saving especially as it relates to early start on site. Most clients prefer projects to start early for economic and political reasons. This can be achieved in design and build procurement approach as this approach allows for construction to start before the design is completed, which increases the possibility of achieving good performance in terms of time. According to Hackett *et al.*, (2007), design and build procurement approach imposes a discipline, on clients (employer), to define the brief thoroughly at an early stage. The advantages of overlapping design with construction can lead to shorter project duration. According to Borowiec *et al.* (2016), time saving using the design and build procurement approach emanates partly from the lack of a second procurement process as well as the concurrent design and construction of different portions of the same project.

The design and build project can be completed in a shorter time due to the following:

- reduced procurement time
- problems are uncovered early
- scheduling can commence before the design is finalised. There are opportunities to overlap the design and construction processes and thus make an early start on the site.

- enhanced communication ensures that blockages are dealt with without delays.

The early start in design and build procurement approach is attractive especially to public sector clients need to start spending their budget within a short time of the money being allocated. The single point of responsibility means that the contractor is responsible for ensuring that the project is completed on time. Any delays beyond the control of the client will be at the risk of the contractor (Murdoch and Hughes, 2008). Figure 2 below compares a typical design and build project with a design-bid-build project indicating time saving associated with a design and build project:

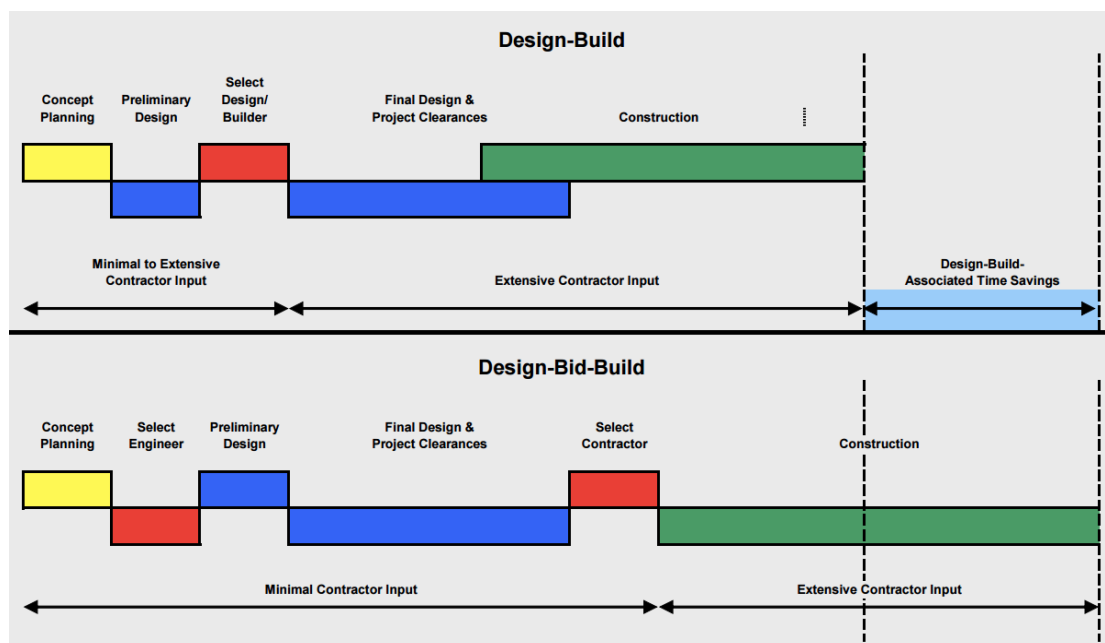


Figure 2: Comparison of a typical design and build project and a design-bid-build project.

Source: (Borowiec *et al*, 2016).

Another advantage of the design and build procurement approach is that contrary to perception, the approach does not require an experienced or technical expert client. Murdoch and Hughes (2008), argue that unlike other forms of procurement, it is not necessary for the design and build client to be an "expert" client. Often novice clients, who know nothing about the construction industry, particularly clients requiring small works, will often stumble into design and build procurement approach without realising it. In these instances, both the novice clients and contractors make modifications to requirements and proposals until they match, and prices are discussed until the client feels that the most economical and effective job will be done. Murdoch and Hughes (2008), conclude that, while design and build clients may be very sophisticated, it is equally likely that they may not be. Because of this, unlike

some other forms of procurement, the choice about whether or not to use design and build procurement approach does not depend upon the client's familiarity with construction (Murdoch and Hughes, 2008).

Buildability (also known as constructability) of the facility due to early engagement of the contractor is another advantage of the design and build procurement approach. The design and build procurement approach process increases the opportunities for harnessing the benefit of the contractor's experience during the design stages of the project. Value engineering is undertaken together with the contractor at an early stage. According to Ghadamsi (2016), value engineering is a systematic approach to deliver a project with the required functions at optimum whole life cost without being detrimental to quality, performance and reliability. It is therefore a team exercise that is principally used to identify and eliminate unnecessary costs of a product. The benefits of the integration of designers and contractors lead to better value engineering as well as a more economic and effective construction process. Ghadamsi (2016), concludes that design and build procurement approach and project management are most appropriate for clients placing a high priority on the build-ability of their project.

Flexible competition has also been cited as an advantage of the build and design approach. Murdoch and Hughes (2008), argue that the contractor's proposals will include design solutions to problems posed in the client's requirements. In this instance the contractors are competing not only on price but also on any criteria the client thinks important. Murdoch and Hughes (2008), argue that this presents opportunities for making the level of accommodation the selection criteria, where a client can put forward a budget and ask the bidders to demonstrate how much building they can supply for the money. The element of competition is therefore more flexible in this approach than in traditional procurement approaches (Murdoch and Hughes, 2008).

2.9 Challenges with design and build procurement approach

Common criticism of design and build procurement approach is that the approach is inflexible in dealing with variations. According to Hackett *et al.* (2007), design and build procurement approach is by its very nature an inflexible system, which does not allow the client the benefit of developing his requirements and ideas once the contractor has been appointed. It is always difficult to deal with variations in design and build procurement approaches. Furthermore, the approach is not conducive to the client's selection of specialist selected/nominated subcontractors. It is however noted that Hackett *et al.* fail to provide a solution to this “perceived” challenge of design and build procurement approach.

It needs to be mentioned that variations (changes to client requirements) are one of the most frequent causes of claims and often lead to litigious disputes. Murdoch and Hughes (2008), argue that a client who wishes to reserve the right to alter requirements during the construction process should not use design and build procurement approach. He further argued that the process demands early agreement between employer's requirements and contractor's proposals. A change in either of these documents makes the agreement awkward. The valuation of variations can be difficult without a comprehensive contract sum analysis, and the employer's insistence on time and cost targets is less convincing if the requirements are altered. Hackett *et al.* (2007), argue that any variations required by the client after signing a contract could prove expensive and difficult to evaluate. The limited scope of variations and changes is thus a weakness of the design and build procurement approach process (Murdoch and Hughes, 2008).

Design and build procurement approach is one of the few procurement processes that are not conducive to the employer's selection of specialist sub-contractors. In traditional procurement approaches the process of nomination or selection allows the client or employer to reserve the right to select particular specialists that the contractor must employ. This poses a challenge and cannot be done easily under a design and build contract. This therefore means that if technical challenges of a project are to be resolved by the use of specified (nominated) specialists, design and build procurement approach might be an unsuitable approach. Murdoch and Hughes (2008), argue that even though most design and build contractors will accommodate such specialists if they are named with the employer's requirements, careful drafting will be required to establish a direct relationship between the employer and the named sub-contractors (Murdoch and Hughes, 2008).

With design and build procurement approach, there is always a risk with regard to the quality of work. Hackett *et al.* (2007), point out that if the original brief to the contractor is not precise and the specification offered by the contractor equally indistinct, the contractor is often tempted to reduce standards. Furthermore, where several tenders are invited, comparison of these can be difficult as the end production in each instance will be distinctive and subjective judgments will apply. Finally, most design and build contracts include certain qualifications such as ground condition, the inclusion of provisional sums etc., which to a certain extent nullify the client's ideal of a known commitment.

2.10 Legislative framework applicable to public procurement in South Africa

The main legislation that regulates public procurement in South Africa is the Constitution of the Republic of South Africa, 1996. According to Section 217 of the Constitution, all organs of state must ensure that the principles of fairness, equitability, transparency, competitiveness and cost-effectiveness are adhered to when contracting goods and services. Other key applicable legislation governing public procurement include:

- Construction Industry Development Board (CIDB) Act 38 of 2000
- Public Finance Management Act 1 of 1999 (PFMA)
- Preferential Procurement Policy Framework Act 5 of 2000 (PPPFA)
- Broad-based Black Economic Empowerment Act 53 of 2003
- The Local Government Municipal System Act 32 of 2000
- Municipal Finance Management Act 56 of 2003.

The CIDB Act (Act 38 of 2000), establish the means by which the board can promote and implement policies, programmes and projects, including those aimed at procurement reform, standardisation and uniformity in procurement documentation as well as practises and procedures in construction procurement. In the year 2005, the CIDB undertook an initiative aimed at standardisation and to limit the choice of the forms of contract. In 2005, the construction industry, together with the appointed Inter-Ministerial Task Team for Construction Industry Development, evaluated a range of forms of contract and drew up a list of documents published by four different bodies. The aim was to limit the number of forms of contract in use. This list was compiled to ensure that clients could deliver projects using a wide range of contracting and pricing strategies, which are based on sound drafting practices (CIDB, 2005).

The recommended forms of contract were as follows:

- FIDIC (French acronym for International Federation of Consulting Engineers) 1999
- General Conditions of Contract for Construction Works (GCC, 2004)
- JBCC Series 2000
- NEC3 family of standard contracts.

Both FIDIC and NEC3 cater for design and build procurement approach (i.e. allow for design by contractor) while the JBCC and GCC 2004 only cater for design by employers (i.e. only allow design by contractor to an extent specified in the contract).

2.11 Contracting under design and build procurement approach

There are a number of standard forms of construction contracts which cater for design and build procurement approach but the most widely used in South Africa are FIDIC and the NEC.

2.11.1 Federation Internationale des Ingenieurs-Conseil (FIDIC)

The FIDIC suite of construction contracts is written and published by the International Federation of Consulting Engineers. The FIDIC acronym stands for the French version of the Federation's name (Federation Internationale des Ingenieurs-Conseil). FIDIC contract is a standard form or condition of contract that is part of standard families for procuring works or consultancy services (FIDIC). The FIDIC forms of contract can be applied to a wide range of differing engineering and construction projects.

FIDIC has been used for many years internationally and can be viewed as a traditional contract. According to Baker *et al.* (2018), FIDIC was founded in Belgium in 1913. Historically the use of FIDIC internationally was influenced to a large extent by the international financing institutions. Clients may benefit from using FIDIC conditions where potential tenderers are from different countries. Bidders are familiar with FIDIC conditions and this could translate into lower tender price as contract risks are understood by the bidders.

The Red Book (building and engineering works designed by the Employer) and the Yellow Book (building and engineering works designed by the Contractor) are the oldest FIDIC contracts with the Red Book dating back from 1957 (Baker *et al.*, 2018). To complement the FIDIC suites, many new contracts were published. These contracts include:

- The Orange Book for design, build and turnkey works published in 1995.
- The Green Book as the short form of contract and a Silver Book for turnkey contracts published in 1999.
- The amended version of the Red Book for use by Multilateral Development Banks published in 2005.
- The Gold Book for Design, Build and Operate contracts published in 2007.

It should be noted that the different forms of contract within the FIDIC suite are organised around the extent of design and other responsibilities assumed by the client (employer) and the Contractor. Evident is the fact that the FIDIC suite is now aligned with common procurement strategies rather than the nature of the construction works. Notably, where the construction work is predominately designed by the client (employer), then the Red Book is the appropriate form of

contract. The Yellow Book is appropriate where construction work is predominantly designed by the contractor, regardless of whether the works is civil, mechanical and electrical (Baker *et al.*, 2018). The FIDIC Suites suitable for design and build procurement approach are described below:

Yellow Book Conditions of Contract for Plant and Design-Build

The Yellow Book provide conditions of contract for construction works where the contractor carries out the design. It is applicable to the provision of electrical and/or mechanical plant, and for the design and execution of building or engineering works. Under the Yellow Book, contractor designs and provides the works in accordance with the Employer's requirements. Such work may include any combination of civil, mechanical, and electrical and/or construction works (Baker *et al.*, 2018).

The Engineer who is appointed by the Employer carries out the administration of the project and supervision of the works. The Engineer is responsible, amongst other things, for issuing instructions, certifying payments and determining completion. Interim payments of the lump sum Contract Price are made as work proceeds and are typically based on milestone payments specified in a schedule (Baker *et al.*, 2018).

Orange Book Conditions of Contract for Design-Build and Turnkey

The Orange Book is used where the contractor carries total liability for design. There is therefore a single point of responsibility for the employer. It however needs to be mentioned that due to this single point responsibility in the contract, the employer has less control over the design process and experience difficulties in imposing varied requirements. Under the Orange Book, the contractor is responsible for the design and provision of works. The works may include any combination of engineering (including civil, mechanical, electrical, etc.) and building works (Baker *et al.*, 2018).

The Orange Book is intended for use on turnkey contracts, under which the employer's requirements in most cases include provision of a complete facility, ready for operation at the flip of a key. According to Baker *et al.* (2018), the exact employer requirements need to be fully detailed to describe the design, construction, fixtures, fittings and equipment so that this could be provided for in the contractor's design.

Silver Book Conditions of Contract for EPC/Turnkey Projects

The Silver Book is suitable for use on process, power and private-infrastructure projects where a contractor is to take on full responsibility for the design and execution of a project. It should be noted that risks for completing the project

on time, within cost and quality are transferred to the contractor. In this regard it is important that the contractor be experienced and familiar with sophisticated risk management techniques.

In the Silver Book the contractor takes the risk for ground conditions as well as responsibility for the accuracy (subject to certain exception) for the accuracy of the employer's requirements. There is therefore a major difference to the usual design and build contracts. The employer still retains risks for war, terrorism and Force Majeure. Reference is not made of an Engineer in the Silver Book. This is due to the employer's reduced influence on the works and construction processes. The employer's role is more concentrated on validating the end performance and validating the potential ease of operation, maintenance and related aspects (Baker *et al.*, 2018).

Gold Book (DBO) Contract Conditions of Contract for Design, Build and Operate Projects

The Gold Book is a design build - operate (DBO) contract that is intended to be used in the type of project funded by project-financing. The DBO contract is more similar to the FIDIC Silver book. The DBO contract adopts a "green-field" DBO scenario with a 20-year operation period". A contract is therefore awarded to a single contracting entity in order to optimise the coordination of innovation, quality and performance. According to Baker *et al.*, 2018, the contract is not suitable for projects that are not based on the traditional design-build-operate sequence, or where the Operation Period differs significantly from the 20 years adopted. The DBO contract can only be used in projects where the design and build work and the operation and maintenance work are to be carried out by the same contractor.

2.11.2 New Engineering Contract (NEC)

The NEC was launched in 1991 and is a standard form of contract that is part of standard families for procuring goods, works or services. The NEC produces a diverse range of project management contracts to enable users to deliver projects within time, cost and quality. The suite can be used for the procurement of works, services and goods across all sectors including public and private, buildings and infrastructure, plant and equipment – as well as all stages of a project lifecycle, from planning, design and project management to construction, maintenance and facilities management (NEC3, 2005).

The principal NEC3 contracts, short contracts and subcontracts can be broadly grouped into works, services and supply. The complexity of the project as well as the level of risk determines the choice of the NEC3 form. The NEC3 Engineering and Construction Contract (ECC) is the main construction contract

within the NEC3 family, from which the options A-F are extracted. The NEC allows for design by employer, design by contractor or part design by either party. This is done by simply expressing in the works information what design the contractor is obliged to carry out.

The NEC3 design and build contract is used for the appointment of a contractor for engineering and construction work, including any level of design responsibility that is given by the employer. The NEC3 design and build contracts have been used in various projects including the London 2012 Olympics. In this regard both option A (priced contract with activity schedule) and C (target contract with activity schedule) have been used extensively in the project. According to Defra (2013), for projects such as the Olympic Stadium and the Velodrome, target contracts were chosen as there was recognition that the contractor's contribution to design and a collaborative approach to dealing with design change would be key requirements. During implementation of the projects, the NEC 3 placed significant administrative burden on the employer and contractors, it however assisted in facilitating the delivery of sustainable projects (Defra, 2013).

The NEC4 Design Build Operate contract (DBO) was launched in June 2017 and it allows Clients to procure a more integrated life cycle delivery solution. According to Hayes *et al.* (2017), the NEC4 (DBO) has been added to the NEC suite of contracts in response to the increasing demand for contracts to extend into the operational phase. The key advantage of the NEC4 DBO is that it combines the responsibilities for design, construction, operation and/or maintenance under a single contractor. The new Design Build Operate (DBO) contract under NEC4 provides for option A - priced contract with price list, option C - target contract with price list and option E - reimbursable contract.

As far as design responsibility is concerned clause 21.1 of the NEC4 ECC ('The Contractor's design') indicate clearly that the contractor designs the parts of the works which the scope (or works information in NEC3) says the contractor is to design. The NEC4 DBO contract is not only intended for use where the client requires a new facility to be designed, constructed and then operated by a contractor. According to Hayes *et al.*, (2017), the contract can even be used where a client wants to have an existing facility operated by the contractor while it is being upgraded or extended. In such situations, Hayes *et al.*, (2017) point out that the timing of the design and construction phase would normally be stated by the client, but may be determined by the contractor – which will undertake the work at a point to suit the performance requirements of the overall service.

It should be noted the NEC4 DBO has not been designed as a design-build-finance-operate contract. The contract does not include all the provisions that

would be required if the contractor was funding the construction and recouping the cost during the operation phase.

2.12 Design and build projects: South Africa's experience

Design and build procurement approach has been used to procure a range of projects in South Africa from various sectors and the project sizes have also varied from huge projects to very small ones. According to Mfongeh (2010), design and build procurement approach has been used more to procure private sector projects. Some of the major projects that have been procured using design and build procurement approach as listed below:

- The Nelson Mandela Bridge in Johannesburg valued at R120 million – public sector
- The Gautrain Rapid Rail Link valued at R25,1 billion - public private partnership
- The Prison at Louis Trichardt valued at R300 million – public sector (Engineering News 1999 and 2000)
- Saldanha Steel Plant valued at R800 million – private sector
- The Techno Centre for Vodacom in Bellville valued at R116 million – private sector
- Sanlam office spaces in Sandton valued at R40 million – private sector.

According to Ilori and Talukhaba (2017), design and build procurement approach is still considered to be a new concept in South African construction industry and will take some time before it can be well practiced in comparison with that of United Kingdom and the United States of America. Ilori and Talukhaba (2017), evaluated the practise of the design and build procurement approach in South Africa. Their study adopted a quantitative research approach in collecting data on the design and build procurement approach. Their study was carried out mainly in Gauteng Province (with the focus in Pretoria and Johannesburg). The remaining study took place in KwaZulu Natal and Mpumalanga Provinces. The research was based on stakeholder opinions and included both professionals in the built environment as well as academics (Ilori and Talukhaba, 2017).

According to the opinion of respondents who represented the stakeholders, Ilori and Talukhaba (2017) discovered that design and build procurement approach is not correctly practiced in South Africa. Furthermore, the general view was that design and build contracting continues to grow, mostly in the mining sector (Ilori and Talukhaba, 2017). Furthermore, the findings confirmed that there is a perception that design and build procurement approach is not being well practiced in South Africa. Based on the findings, Ilori and Talukhaba (2017) conclude that a good practice of design and build procurement approach will

assist to improve project performance in terms of costs and time and that this will result in better service delivery, which has been a challenge in South Africa.

Finally, Ilori and Talukhaba (2017) make recommendations which, if implemented, will assist government to effectively improve the practice of design and build projects in South Africa. These recommendations are that the government should:

- Focuses mainly on the technical qualifications of the design and build contractor rather than focusing heavily on price.
- That the design and build teams that have a demonstrated history of successfully collaborating on design and build projects be rewarded.
- Identify and involve key project stakeholders at the early stages of a project. There should therefore be education and training for all members of the design and build team with regard to the design and build procurement approach process as well as other delivery systems
- Put in place a committee of expert that will develop a code of good practice for design and build procurement approach (Ilori and Talukhaba, 2017).

2.12.1 Case study 1: The Nelson Mandela Bridge

The Nelson Mandela Bridge is one of the projects that was undertaken through a design and build procurement approach in South Africa. The bridge crosses 42 railway lines comprising Metrorail lines, the Metrorail staging yard and the Spoornet cleaning and catering yards. The total length of the bridge is 284 metres. The total cost of the bridge is estimated at R120 million (Sabinet, 2011). Brief statistics regarding the Nelson Mandela Bridge is given below:

- Bridge type: Asymmetrical, dual pylon, cable-stayed bridge
- Total length: 284m
- Main span length: 176 m
- Height of the highest pylon: 48 m above road level
- Length of the longest complete cable stay: 110 m
- Number of traffic lanes: Two, with provision for a third when re-painted
- Man-hours spent on design: 12000
- Man-hours spent on construction: 421000
- Contractor was appointed in May 2001 and the project ended in May 2003 (Sabinet, 2011)

The Blue IQ, the City of Johannesburg, SANRAL, the Department of Transport, the Johannesburg Development Agency and the Metropolitan Trading Company jointly funded the Nelson Mandela Bridge. Blue IQ took the lead in mobilising the funding as it acts as a catalyst for funding and promoting strategic

investment by working in partnership with business, government departments and other organisations in Gauteng (Sabinet, 2011).

SANRAL was tasked with the implementation of the project and appointed Goba Moahloli KEEVE Steyn as its consultants, tasking them with all the necessary preliminary studies and investigations as well as the tendering process. FIDIC (Federation internationale des Ingenieurs-Conseils) conditions of contract were used for the project. The aim of using FIDIC was to attract international companies by providing a familiar environment and to expose local companies to conditions that they might encounter in international markets (Sabinet, 2011).

As far as the employer's requirements were concerned, the brief was clear that the Nelson Mandela Bridge should be a structure of exceptionally architectural merit and distinction, which will serve to draw attention to the redevelopment of Newtown and the CBD thereby enhancing the general area.

It was the client (employer's) intention that the adoption of the design and build procurement approach will initiate and stimulate the creative abilities of the bridge design and engineering industry in the production of a high class and notable structure. It was the intention of the client that the preferred structure will reflect originality and creative thinking and combine aesthetics technology, functionality, constructability, serviceability, environmental sensitivity as well as the economics (Sabinet, 2011).

In terms of the brief, tenderers were required to propose the type of structure they wish to offer to the client and were at liberty to consider structures with long spans, multiple shorter spans or combinations of the two. The design of the bridge was supposed to take into account the logistics of construction on the site including the accommodation of rail traffic, electrification and existing services as well as the relatively poor geotechnical founding conditions. It was a requirement that the bridge should be a landmark structure of international note. The implementing agent being SANRAL was to ensure that a conducive environment was created to enable local and international companies to tender for the Nelson Mandela Bridge project as either competitors, joint ventures or consortia (Sabinet, 2011).

LBA Consortium, was appointed in May 2001 as a design and build contractor. LBA Consortium consisted of the Grinaker LTA·BCW JV and the Nelson Mandela Bridge Consultants Consortium (NMBCC), who were responsible for construction and design respectively. The NMBCC comprised BKS, ARQ and sub-consultants COWI, Dissing and Weitling and P D Naidoo and Associates. Construction of the project was completed in May 2003 (Sabinet, 2011).

Two most key challenges were identified during implementation of the project, the first key challenge was that of coordinating design and construction teams from South Africa and Europe to achieve a design and construct project within an extremely tight schedule. The second challenge related to managing the various parties involved and obtaining permission and approval of the architectural and technical details (Sabinet, 2011).

2.12.2 Case study 2: Gautrain Rapid Rail Link Project

Gauteng Provincial Government awarded the project to the Bombela Consortium consisting of Bombardier, Bouygues Travaux Publics, Murray and Roberts and Strategic Partners Group. The project was a public-private-partnership (PPP) which involved the building of the new railway including a 15-year operating and maintenance period. The intention was for the operations to be led by RATP – operators of the Paris Metro. Gautrain Management Agency is the responsible Client / Authority (Matthels, 2009).

The rapid rail link joins O.R. Tambo International Airport with Sandton and Rosebank in the southern section, with the northern leg continuing from Marlboro north to Hatfield in Pretoria. As a PPP project, the Gautrain's design and construction contract involved very short lead times between the production of the drawings and concrete being laid in the ground. Early in the design process, design criteria were established and agreed to by all parties, namely the client, various parties in Bombela Joint Venture (Matthels, 2009).

According to Matthels (2009), the Gautrain project is one of largest construction projects in the world. The Gautrain project is packed with many facets from stations, tunnels and massive earthworks to a diverse assortment of bridge structures including precast segmental viaducts. Gautrain incorporates a variety of engineering content:

- 80 km of modern-gauge railway
- 10 million m. of earthworks
- 15 km of tunnel
- 10 stations, of which three are elevated and three (3) are underground
- 10 km of viaduct
- 50 road or rail bridges (Matthels, 2009)

As far as project cost is concerned, Gautrain was a fixed price turnkey project where the price was fixed at the signing of the Concession Agreement on 28 September 2006. The total project cost is R21,9 billion with the Gauteng Provincial contribution amounting to R21,9 billion and private sector contribution amounting to R3,2 billion. In terms of the contract, only the two

increases in cost were to be allowed being extra work through a Variation Order (only 2.1% of Project Value) as well as escalation higher than the escalation prediction of the Reserve Bank (Matthels, 2009).

The Gautrain project was undertaken by means of Public-Private-Partnership (PPP) contract. The client (Gauteng Provincial Government) provided the output specification on this turnkey project. The contractor (concessionaire) made a bid to design, build, operate the project for the concession period. The concessionaire took all completion and integration risks on the project and offered a fixed price, fixed specification and fixed time frame (turnkey) contract (Akojee, 2015).

In terms of the contract, the concessionaire is fully involved in the operation and maintenance of the system for the full concession period. The intention with the project is that the concessionaire should hand over the system to the client at the end of the concession period in a prescribed condition agreed by all parties. The contract allowed for concessionaire innovation and world-best-practices during design and construction stages of the project (SADC-DFRC, 2016).

According to SADC-DFRC (2016), key lessons that can be learned from the project include the following:

- Design and build procurement approach ensured short lead times between production of drawings and construction
- Contract management drives Value for Money
- Empowered public sector essential
- Public sector drives change in a PPP
- External dispute resolution poor value for money
- Potential problems, e.g. value engineering/scope changes, variations, less opportunity to claim, etc.

2.13 Design and build projects: international experience

According to Petersen and Murphree (2004), various projects have been implemented using the design and build procurement approach. Furthermore, there are major public events such as the Winter Olympics in Salt Lake City that have highlighted advantages of design and build procurement approaches. International projects undertaken using this approach in the 2000s included projects such as the state-owned hospital in Kazakhstan with an estimated cost of \$90 and the high-speed rail project in Taiwan with an estimated cost of \$14 billion. The design and build procurement approach has been used for managing construction in the US after the crisis situation caused by terrorist attacks at the Pentagon. Currently, design and build procurement approach is used in the U.S extensively and legislation has been enacted to promote the approach (Petersen and Murphree, 2004).

2.13.1 Design and build procurement approach in the US

The popularity of design and build procurement approach has grown tremendously in the US. This construction delivery system began to be used in the United States in the 1970's. Since then, two important legislations in the US namely the U.S. Government Federal Acquisition Regulations as well as the United States Code were rewritten to include design and build procurement approach as an authorised delivery method for government projects (USACE, 1999). In 1993, the Design-Build Institute of America (DBIA) was in response to the emergence of the approach as a significant force in the design and construction within the US (DBIA, 2012).

The emergence of design and build procurement approach as a significant force in the US came as a result of this procurement approach being viewed by clients as an integrated and innovative process that created a partnership with a single project delivery source. There has been significant improvement in the push towards greater design and build procurement approach use in the US and DBIA has contributed towards this increase by among other things increasing overall awareness of the process (FMI, 2018).

Current Use of design and build procurement approach in the US

The use of design and build procurement approach in the US is expected to continue growing. FMI (2018), conducted a market study of the current and project use of the design and build procurement approach. The market study was based on the assessment of spending in various segments. The study revealed that between 2013-2017, design and build delivery method accounted for 39% share and is anticipated to represent up to 44% (\$323.6 billion) of construction spending in the assessed segments by 2021 (see Figure 3). In 2018, the expenditure using the design and build procurement approach was \$274.2. According to FMI (2018), design and build projects spending in Manufacturing, Highway/Street and Education represent the greatest percentage of design-build construction spending by segment over the 2018-2021 period.

Distribution of delivery method utilization
Source(s): FMI analysis of multiple sources

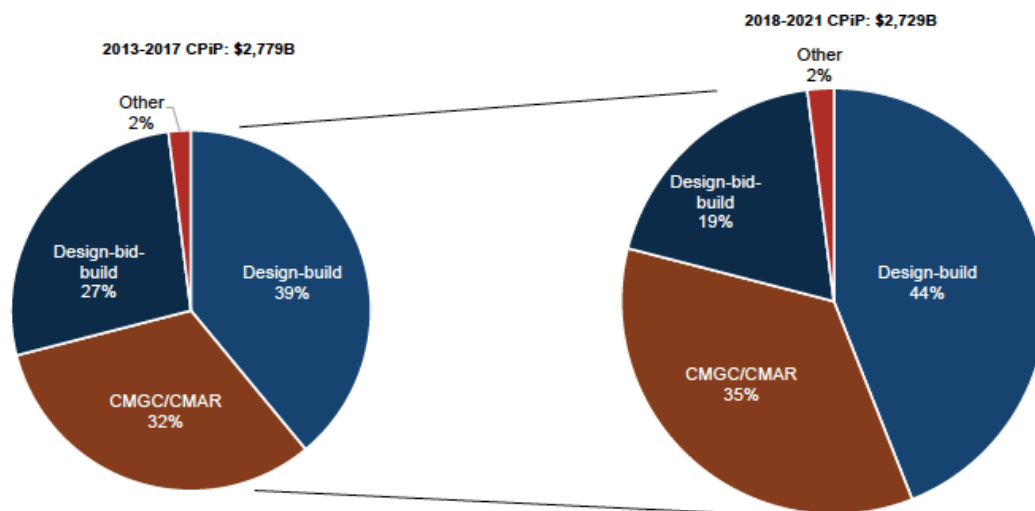


Figure 3: Distribution of construction delivery method utilisation in the U.S

According to FMI (2018), enabling design and build legislation has been put in place to facilitate increased use of the approach for public projects. The study revealed that private clients (employers) have indicated that they use design and build procurement approach on projects presenting unique challenges. Through the study, employers confirmed they received significant value from design and build procurement approach when employed on larger and more complex projects. They indicated that these large and complex projects allowed for greater opportunity to provide project innovations and subsequent cost savings. The study further revealed that design and build procurement approach use continues to expand into project sizes <\$25 million as employers continue to gain exposure to the benefits of design-build (FMI, 2018).

The study further revealed that employers' selection of a project delivery method involves multiple factors. Overall, employers identified delivery schedule as the greatest influence of project delivery method selection. It should be noted that employers' goals and objectives were identified to be highly influential in project delivery method selection. Finally, the study revealed that the education process for design and build procurement approach has continued to expand.

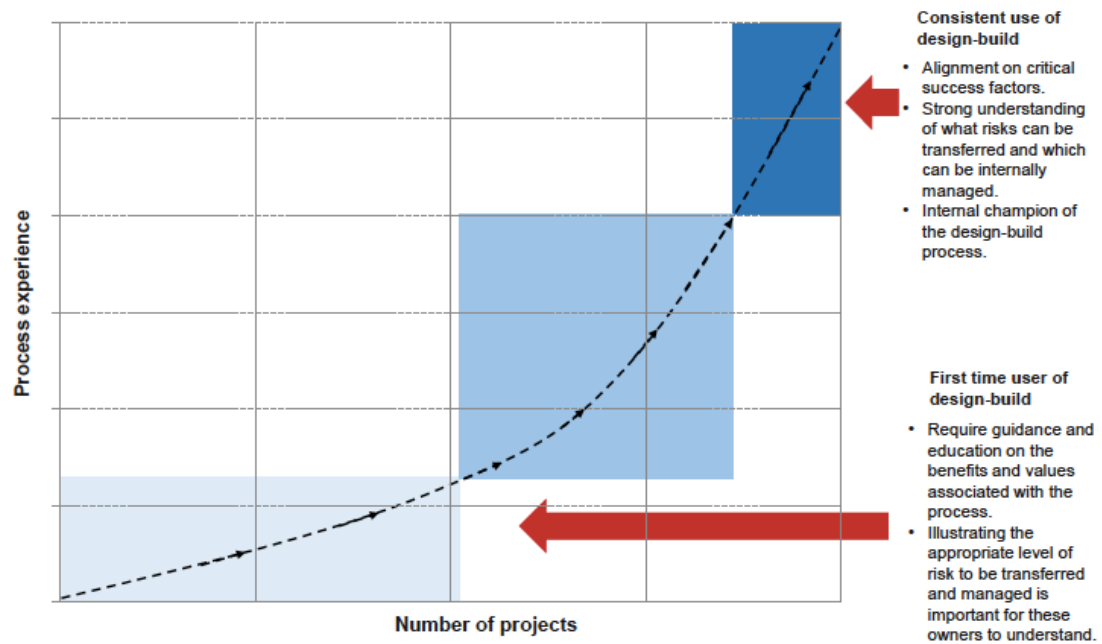


Figure 4: Design and build procurement approach experience / learning curve

(Source: FMI, 2018).

The lack of knowledge and understanding of the design and build procurement approach by employers was found to be a limiting factor for its greater use as revealed in Figure 4 above. It was established that once employers got full understanding of the process and benefits associated with design and build procurement approach, they were more likely to continue to employ it as a preferred delivery method. The study has asserted that a continued emphasis toward educating employers and project stakeholders on the process and benefits associated with design and build procurement approach will facilitate continued adoption and greater use of the approach (FMI, 2018).

2.13.2 Case study: The U.S. Army Health Facility Planning Agency

The U.S. Army Health Facility Planning Agency (HFPA) adopted a turnaround strategy using the design and build procurement approach to deliver high-tech army medical facilities. The Army Medical Command (MEDCOM) was dissatisfied with the U.S. Army Corps of Engineers (USACE). This led to the formation of the HFPA to take a lead in implementing the medical infrastructure projects. The HFPA was given the responsibility of being the employer (or client) representative and employed separate managers focusing on each phase of the project life cycle. The HFPA partnered with USACE in implementing the army medical facilities. USACE was therefore responsible direct project administration and contract management on these projects. According to Petersen and Murphree (2004), a number of the facilities were built during the first 20 years of HFPA and USACE partnership through the

Military Construction (MILCON) program (Petersen and Murphree, 2004).

The MILCON program was instrumental in implementing most of the health care infrastructure using the design-bid-build processes, which was steeped in bureaucracy. In most cases MILCON projects took as much as 7 to 10 years from programming through completion of construction. The MILCON process was not able to keep up with the time and quality demands for modifying facilities to meet business requirements, and as a result a lot of projects were not implemented within the desired quality and time and as such the MILCON healthcare modernization programme experience setbacks (Petersen and Murphree, 2004).

The HFGA implemented a turnaround strategy with improved processes regarding the delivery of medical facilities. This led to its role being expanded to become the action arm of the Medical Command and the Surgeon General in managing the entire capital investment program for army health facilities. It is important to note that the HFGA's new methods of delivering health care projects was the renewal program which was based on the design and build procurement approach. The HFGA, in the new role provided both employer representation and project management expertise through each phase of the project life cycle. The staff members used in the projects by HFGA were given the title of project integrator. The program was still done in partnership with USACE who only handled the contracting aspect of renewal projects (Petersen and Murphree, 2004).

According to Petersen and Murphree (2004), this approach led to shorter turnaround times and was critical for meeting the business needs of army health care. Furthermore, through the renewal program, facilities were quickly renovated and this assisted health care providers in modernising their operations and in repairing infrastructure (Petersen and Murphree, 2004).

The concept of project integration concept had a significant impact in balancing constraints on the renewal projects. Furthermore, soft skills (i.e. integration and management skills) for project integrators were important for execution of the duties of employer representative in a design and build environment.

2.13.3 Case study: Texas Department of Transportation projects

In an effort to improve the effectiveness and efficiency of the state's transportation system, Texas has over the years employed different project delivery methods (Borowiec *et al*, 2016). According to Borowiec *et al*. (2016), the design-bid-build approach was the primary method used for transportation projects in Texas for most of the 20th century where project owners contracted with separate entities to design and construct transportation projects.

The Texas Department of Transportation (TxDOT) and its regional partners have increasingly considered alternative methods of project delivery to keep up with the demand of delivering transportation projects needed to keep up with the state's economic and population growth. According to Borowiec *et al.* (2016), Texas has used the design and build procurement approach for large projects more often than most of the states in the U.S. These projects included capital maintenance, routine maintenance as well as operations projects. Most of the TxDOT projects clustered around the state's four largest cities, with many located in the Dallas - Fort Worth area.

Texas legislation on design and build procurement approach

Legislation has been enacted to provide prescription on how the state and local authorities procure design and build projects. The legislation has also been reviewed as and when there is a need. According to Borowiec *et al.* (2016), recent legislation has had an impact on how design and build procurement approach is implemented. A Bill (known as House Bill 20) was enacted and it increased the minimum threshold for delivering projects using the design and build procurement approach from \$50 million to \$150 million. House 20 Bill also prevented the state from using the design and build procurement approach if a project is already designed. The Bill has prohibited more than one project from being procured under a single design and build contract. The General Appropriations Act was also enacted which provided limits on the number of design and build contracts that can be entered into within certain threshold costs (Borowiec *et al.*, 2016).

An in-depth analysis of design and build projects in Texas was made by a research team. Most of these projects were scheduled for completion between 2016 and 2017. Although not all projects were completed by the time the research team produce their analysis report, it is interesting to note the following findings:

The design and build procurement approach was found to have had cost savings on the various projects implemented. The cost reduction was achieved through a variety of methods, including the shift of risk and control, shortened time frames for the various projects as well as fewer change orders. TxDOT has realised savings of \$326.3 million through implementation of Alternative Technical Concepts (ATC). The ATCs are basically cost or schedule saving ideas submitted by a private sector proposer. Notably, of the 12 projects reviewed, ATCs have been implemented in 11 projects. Furthermore, TxDOT noted that its best value design and build project proposals usually came in 15 to 20 percent below the engineer's estimate (Borowiec *et al.*, 2016).

Time saving was realised in the various projects implemented. The assessment

has confirmed that 10 of 12 projects implemented in Texas realised time saving based on the successful contractor's schedule when compared to the engineer's original estimate of expected project time. Furthermore, TxDOT noted that these projects typically finished 3 to 10 months early (Borowiec *et al*, 2016).

A practice was adopted where project quality was managed through the various maintenance agreements built in within the design and build contracts. Thus, quality in all the projects implemented was never an issue. According to Borowiec *et al*. (2016), in Texas, design and build projects typically came with a capital maintenance agreement, a comprehensive maintenance agreement, or a warranty that covers a period of time with renewals options. The 12 design and build projects in Texas had some maintenance option and most of them required the contractor to maintain the assets for five years with additional five-year periods at the discretion of the TxDOT's (Borowiec *et al*, 2016).

2.14 Best practise of design and build procurement approach

The Design-Build Institute of America (DBIA) identifies what it terms "best practices of design and build". These practices are written to be universally applicable over a range of design and build projects. According to DBIA (2014), the implementation of these best practices will lead to successful projects that will meet client's expectations while failure to implement same will result in poor projects performance and disappointed clients. The best practices cover the main areas outline below:

- Procuring design and build services
- Contracting for design and build services
- Executing the delivery of design and build projects.

2.14.1 Procuring design and build services

As far as procurement of design and build services is concerned, DBIA (2014) identifies three best practices for employers (clients). Firstly, the employers should conduct a proactive and objective assessment of the unique characteristics of its program or project and its organisation before deciding to use of the design and design approach. In this regard, the employers should understand the potential benefits, limitations, and attributes of the design and build procurement approach and make an informed decision as to whether the use of the approach will benefit their program or project. Furthermore, employers should ensure that there are key personnel to support the successful procurement and execution of a design and build project. Early determination of expectations should be made by the employers regarding the role to be played by the contractor in the start-up, commissioning and operations of the

project and this should be reflected in their procurement approach (DBIA, 2014).

Secondly employers should implement a procurement plan that promote collaboration and in furtherance of this practice, the employers should use a procurement process that:

- Focuses heavily on the qualifications of the design and build contractor and its key team members rather than on price
- Rewards design and build teams that have a demonstrated a history of successfully collaborating on design and build projects.
- Minimise the use of prescriptive requirements and maximise the use of performance-based requirements, which will allow the design and build team to meet and probably exceed the employer's needs through innovation and creativity (DBIA, 2014).

The employers should use competitive bidding processes that require the design and build contractors to submit price and technical proposals. In this regard the employers should establish clear evaluation and selection processes; ensure that the process is fair, open and transparent; and take into account both technical concepts and price in the selection process. DBIA (2014), advice that employers should undertake certain tasks upfront which will enable them to develop a realistic understanding of the project's scope and budget. This will assist in furnishing tenderers with information that they can rely upon in determining their price and other commercial decisions related to the project. In most instances these upfront tasks relate to geotechnical studies, environmental investigations and approvals by authorities (DBIA, 2014).

2.14.2 Contracting for design and build services

According to DBIA (2014), fundamental to any delivery process is the use of fair and clear contracts. It is therefore critical to understand the contract's language and its practical application by individuals who administer the design and build procurement and execution. DBIA (2014), argue that contracts in the construction industry tend to focus more on the relationship between the employer and the contractor. It is therefore presented that for the design and build contract to succeed, the same principles should be cascaded down to sub-consultants, subcontractors and major suppliers working within the design and build team (DBIA, 2014).

According to Windapo (2013), the most notable feature of design and build procurement approach is the lack of an independent certification role in the contract. Furthermore, there is no independent quantity surveyor responsible for preparing tender documents to be used as a basis upon which contractors

submit their tenders. In order to mitigate the risks in this regard, DBIA (2014) identifies three (3) best practices. The first practice requires employers to ensure that contracts are fair, balanced and clear, and promote the collaborative aspects inherent in the design and build procurement approach. The second practice is to ensure that that contracts between the employers and the design and build contractors address the unique aspects of the design and build procurement approach including expected standards of care for design services. Thirdly, contracts between the design and build contractor and its team members should address the unique aspects of the design-build process (DBIA, 2014).

2.14.3 Executing the delivery of design and build projects

DBIA, (2014), advocates that individual team members must understand the design and build process and acknowledge that success is directly dependent upon the ability of the entire team to work together collaboratively. This therefore means that individual team members not only need to be competent in their specific areas of responsibility. DBIA (2014), therefore identifies four (4) best practices in the delivery of Design-Build projects. Firstly, education and training of all design and build team members in the design and build process is important for successful programme or project delivery. It is important for team members to know the differences between design-build and other delivery systems.

The second aspect is the provision of required logistics and infrastructure that supports integrated project delivery. Where appropriate, the employers and design and build teams should share location or facilities where justified by project characteristics. Furthermore, design and build contractors should strive to have their design and construction teams working in the same place as often as possible (DBIA, 2014).

Thirdly, project teams should undertake processes that facilitate timely and effective communication, collaboration and provide resolution. Both employers and design and build contractors should develop and use a structured partnering process to be scaled appropriately to reflect the size and complexity of the projects. Furthermore, the employers and the design and build contractors should create an executive leadership group that will meet regularly in order to monitor the execution of projects as well as the facilitation of the parties understanding and achievement of mutual goals (DBIA, 2014).

Finally, according to Windapo (2013), the first action undertaken by the design and build contractor's internal team is to ensure there is a complete brief that the employer understands and agrees to. This is followed by designs and production of plans which the employer accepts. Such designs and plans take

into account subsequent production and commissioning implications of the design decisions. In this regard DBIA (2014), advocates that the project teams should use design management and commissioning processes that ensure that there is alignment among the team as to how these processes should be executed. In advancement of this practice, both the employers and the design and build contractors should acknowledge that there is a significant level of effort which is required to manage the development and review of the design. Both parties should therefore dedicate sufficient resources to encourage a collaborative environment for the design work and should mutually develop a realistic design development plan that efficiently engages the owner and key members of the design-builder's team in purposeful meetings (DBIA, 2014).

2.15 Summary

It has been argued that the choice of project delivery system and procurement approach significantly influence project results. These choices form the foundation for how the project will be developed, procured and executed and are among the first decisions employers (clients) should make on a project. There are many benefits that are inherent in the design and build procurement approach. The benefits relate to various indicators of projects performance such as time, costs, risk etc. From the various literature reviewed, time saving has emerged as a key benefit of the design and build procurement approach and was realised in the case study of projects implemented.

According to Borowiec *et al.* (2016), the reduction of project procurement time, reduced change order delays, and more efficient project delivery resulted in what employers noted as the true savings found in the design and build procurement approach. From the employer's view, the single point of responsibility, risk transfer to the design and build contractor as well as guaranteed maximum price are noted benefits.

There are however challenges associated with the design and build approach. The most common criticisms of the approach relate to the fact that it is inflexible in dealing with variations, it is not conducive to the employer's selection of specialist sub-contractors and that there is always a risk with regard to the quality of work. Furthermore, the design and build procurement approach has been criticised in that in certain instances, the contractor will place certain qualifications which in turn nullify the client's ideal of a known commitment. Finally, Borowiec *et al.* (2016) point out that there are concerns that design and build contracting approach has a negative impact on small business participation in the procurement process and that the method benefits only big companies. The recommendations to counter the challenges raised regarding the design and build procurement approach should therefore be further explored.

From the literature reviewed, it is evident that there is limited use of the design and build procurement approach in South Africa compared to both the U.S and UK. According to Molenaar *et al.* (2018), the average delivery speed for design and build projects have increased in the U.S over the past 20 years. Furthermore, the design and build procurement approach has provided greater reliability in cost and schedule performance for the projects implemented.

According to Molenaar *et al.* (2018), common themes have been identified through the examination of the best and worst performing design and build projects. In successful projects, the employer placed a high emphasis on creating a relational project culture as well as repeated use of the same design and build contractor. The latter is likely to face criticism in South Africa's public sector environment as the Public Finance Management Act (1999) advocate for openness, fairness and value for money in public procurement. The least successful projects highlighted lack of experience with the project delivery system or project management, poor communication between the employer and contractor as well as understaffing by either employer or design and build contractor's team (Molenaar *et al.*, 2018).

It has been established that there is a need for clients to have a clear understanding of project scope and to develop a clear client's brief. The thorough assessment of the contractor's proposal and development of a clear understanding of project costs as well as limiting changes in client requirements during construction are critical to the success of a design and build project. It is also important for employers (clients) to take note of project constraints and understand the roles and responsibilities of all parties involved in a design and build project (DBIA, 2014).

Petersen and Murphree (2004) argue that one of the most difficult aspects of project management in a design and build construction environment is trying to consistently and successfully balance project constraints (i.e. time, cost, quality, and scope) to produce project success. The employer representatives have an impact on project performance and balancing project constraints. The influence of employer representatives on the success or failure of a design and build project is therefore significant. The employer representatives must therefore excel in integration, management and people to positively contribute to the success of design and build projects (Petersen and Murphree, 2004).

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

According to Chellan (2004), research is the organised and systematic approach of finding solutions to questions. Conteh *et al.* (2005), argue that research is a systematic method of inquiry to providing information for an identified problem or proposed solution. Chellan (2004), argues that research is systematic in that it is broken up into clear steps that lead to conclusions. Research is therefore organised due to the fact there is a deliberate approach used to reach. Research is therefore successful if answers are obtained regardless of whether such answers are liked by the researcher or not. Chellan (2004), points out that there can be no research if there are no questions as development research is focused on asking relevant, useful and vital questions.

Conteh *et al.* (2005), point out that a research methodology provides a rationale for deciding on the use of certain research tools as well as decision on particular combination of methods to the particular phenomenon in question.

3.2 Research paradigm

Two types of research paradigms are identified by Creswell (2003). These are quantitative and qualitative research. In his other work, Creswell (2009), describes the quantitative paradigm as a systematic research approach in which the researcher explains reality with the aid of using computational, mathematical and statistical techniques. Creswell and Poth (2017), argue that the key assumptions of quantitative research are that reality is objective, singular and independent from the researcher.

Quantitative research is defined by Bryman (2012), as a research strategy that emphasises quantification in the collection and analysis of data. The method emphasises the measuring of something or measuring of variables (Rahman, 2017). According to Rasinger (2013), the investigation in quantitative research concerns itself in obtaining answers to the questions starting with how many, how much, to what extent.

Queirós *et al.* (2017), argue that due to its objectivity, quantitative research is more appropriate when there is the possibility of collecting quantifiable measures of variables and inferences from samples of a population. The adopted structured procedures and formal instruments for data collection allows for data to be collected objectively and systematically. The analysis of numerical data is therefore performed through statistical procedures such as SPSS, R or Stata (Queirós *et al.*, 2017).

Phiri (2015), argues that qualitative research on the other hand is concerned with aspects of reality that cannot be quantified, and therefore focuses on dynamic social relations and their understanding as well as their explanation thereof. Qualitative research works with meanings, beliefs, values and attitudes, corresponding to relationships, processes and phenomena that cannot be reduced to the operationalisation of variables (Queirós *et al.*, 2017).

The mixed research method has emerged which involves the use of both the qualitative and quantitative research types. The mixed method is premised on the argument that both qualitative and quantitative researches have limitations that can be addressed by combining both qualitative and quantitative research approaches (Johnson and Onwuegbuzie, 2004). According to and Choy (2014), the mixed research approach has its own shortcomings, pertaining to the consolidation of two contrasting approaches.

3.2.1 Quantitative research design

The study adopted a quantitative research approach. Research design is a structured investigation to answer research questions. Research design specifies the various decisions connected with carrying out data collection, processing and analysis and presents a logical basis for these decisions. Social scientists have defined research design in various terms. Research design is described by Cooper and Schindler (2003), as a blueprint for executing a research project in order to answer specific research questions.

According to Creswell and Clark (2007), research design is basically a plan of the proposed research work and holds all of the elements in a research project together. To further cement this statement Akhtar (2016), argues that research design is the arrangement of conditions for the collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy and procedure.

3.2.2 Advantages of quantitative research

Quantitative research provides various advantages. Firstly, the quantitative findings are likely to be generalised to a whole population or a sub-population in a bigger sample that is randomly selected. Secondly, quantitative research methods do not require relatively a longer time for data collection. Finally, data analysis is less time consuming as it uses the statistical software such as SPSS (Rahman, 2017).

For the purpose of the research project, surveys were used to collect data. Queirós *et al.* (2017), point out the following advantages of surveys:

- Low development time
- Cost-effective
- Easy data collection and analysis using statistical methods
- Can reach large audiences
- High representativeness
- Not affected by the subjectivity of the researcher.

3.2.3 Disadvantages of quantitative research

Rahman (2017), points out that the major disadvantage of quantitative research is that it fails to ascertain deeper underlying meanings and explanations. Furthermore, Bricki (2007), explains that the limitation of quantitative research is that it is impossible to account for how the social reality is shaped and maintained in that it cannot account for how people interpret their actions and those of others.

Another weakness of quantitative research approach is the tendency of taking a snapshot of a phenomenon. This is because quantitative research measures variables at a specific point in time.

Queirós *et al.* (2017), points out the following disadvantages of surveys:

- Reliability of data is very dependent on the quality of answers and on the survey structure
- Rigidity of the structure
- Surveys do not capture emotions, behaviour and changes of emotions of respondents (Queirós *et al.*, 2017).

3.3 Survey methodology

Cargan (2007), describes a survey in research as a means of collecting data about the characteristics, actions or opinions of a large population of people referred to as a population. In this regard, Cargan (2007), views questionnaire surveys as very efficient both in time and effort.

The questionnaire survey was used to collect data on design and build procurement approaches from public sector organisations. The target population comprised public sector officials involved in planning and implementing infrastructure projects. Brace (2008), describes the role of the questionnaire as the provision of a standardised interview across all subjects so that all respondents are asked the questions that are appropriate to them.

Brace (2008), further points out that the questionnaire is the medium of conversation between two people though they are remote from each other and never communicate directly.

The nature of the research problem and the objectives of the study make the case for the use of the questionnaire survey in order to generalise and measure severity of the challenges explored in the literature reviewed as far as design and build procurement approach is concerned as well as quantifying opinions of public sector officials with regard to various aspects of design and build procurement approach. Survey questions were framed around the key aspects concerning design and build procurement approach that were explained and explored in the literature review phase of the research.

The questionnaire was used for this research project due to its advantages relating to low cost of data collection, low cost and ease of processing and its ability to reach respondents over a relatively large geographical area. The questionnaire was combined with participant information sheet attached to the e-mails sent. The participant information sheet indicated the objectives of the study and was addressed to the participants.

3.4 Research population

The research population comprised all identifiable public sector officials involved in infrastructure projects in terms of development and management of infrastructure. McClendon (2004), defines a research population as the total number of participants who share a common characteristic and can be included in a study. The population for the research was identified as public sector officials involved in implementing infrastructure projects and was broadened to include the following categories:

- Officials employed by municipalities or municipal owned entities
- Officials employed by national government departments, agencies and parastatals
- Officials employed by provincial government departments and provincial government agencies
- Officials in public universities.

3.5 Sample and sampling technique

A sample was drawn from the population in order to obtain information to answer the research questions and achieve the objectives of this research project. This process is termed sampling and is the most practical approach to conducting research on an extensive population (Creswell, 2013).

Sampling techniques can be divided into two types:

- Probability or random sampling which is a sampling technique in which each unit in a population has a specifiable chance of being selected
- Non- probability (non- random) sampling which is a sampling technique in which each unit in a population does not have a specifiable probability of being selected. Non-probability sampling does not select their units from the population in a mathematically random way (Taherdoost, 2016).

The non-probability sampling was followed in undertaking the research. Four types of non-probability Sampling Techniques are identified and indicated below:

- Convenience Sample
- Quota Sampling
- Purposive or Judgmental Sample
- Snowball Sampling (Taherdoost, 2016).

Due to the limited knowledge of design and build procurement approach, the aim was to target infrastructure experts employed in the public sector and therefore two techniques being the purposive and snowball sampling were chosen in order to reach these participants.

According to Maxwell (1996), purposive sampling is a technique in which particular settings persons or events are selected deliberately in order to provide important information that cannot be obtained from other choices. Taherdoost argues that purposive sampling is where the researcher includes participants in the sample because they believe that they warrant inclusion (Taherdoost, 2016). It uses the judgment of an expert in selecting cases. Purposive sampling is therefore used most often when a difficult-to-reach population needs to be measured.

According to Regoli (2019), there are various purposive sampling types that can be used by researchers to collect data. These are:

- Heterogeneous variation
- Homogenous
- Typical case sampling
- Deviant or extreme
- Critical case sampling
- Expert; and
- Total population

The goal is to intentionally select participants to gather information. The focus in this regard is on potential participants with specific characteristics in a targeted population group of interest (Regoli, 2019). Advantages of purpose sampling include: time and cost savings for data collection, targeting niche demographics to obtain specific data points, it allows researchers to look at the averages in the data, information collected has a low margin of error and the production of results that are available in real time among other advantages (Regoli, 2019).

Dolores and Tongco (2007), identify seven (7) key steps in purposive sampling which are:

- Decision on the research problem
- Determination of the type of information needed and verification that the information by only certain members of the community
- Definition of the qualities the participants should or should not have
- Sourcing the participants based on the defined qualities
- Analysing potential participants and taking cognisance of the importance of reliability and competency in the analysis of the potential participants
- Use appropriate data gathering techniques
- Analysing data and interpret the results inclusive of documenting the bias Dolores and Tongco (2007),

The major criticism of this technique is that the process is extremely prone to researcher bias, it can be an ineffective method when applied to large population groups and the fact that there is no way to evaluate the reliability of the expert (Regoli, 2019).

In this research, the method of choosing participants was purposeful in that it was aimed at achieving a more variant and diverse trend to the study from both senior and junior public sector officials. It involved participants in the public sector from all spheres of government; namely, national, provincial and local government. In this manner one can understand design and build procurement approach at the different levels of government from the information provided by both senior and junior officials involved in implementing infrastructure projects.

According to Creswell (2009), snowball sampling can be defined as a strategy used to identify cases of interest from sampling people who know people that generally have similar characteristics who, in turn know people, also with similar characteristics. Snowball sampling is also known as network or chain referral sampling.

According to Naderifar *et al.* (2017), snowball sampling is a convenience sampling method. The snowball sampling method is often applied when it is difficult to access participants with the target characteristics. In this method, the existing research participants recruit future participants among their networks.

Sampling continues until data saturation. The snowball method saves time and provides the researcher with the opportunity to communicate better with the samples, as they are networks of the first sample and the first sample is linked to the researcher. It should be noted that snowball sampling is a gradual process and time influences the selection of samples. Sampling usually continues until there is data saturation (Naderifar *et al.*, 2017). Two main criticism of snowball sampling method can be noted. Firstly, there is sampling bias and high margin of error due to the fact that participants will refer those whom they know and have similar traits. Secondly, there is a fair chance that there might still be a lack of cooperation and refusal to participate in the research even after referrals.

To ensure adequate responses, the questionnaires were distributed to targeted public sector officials and were further requested to provide names of their colleagues who could be potential participants.

In total the sample size of this study comprised 50 participants from various public sector organisations. The aim was to ensure that all spheres of government were represented. The number of questionnaires were distributed and spread according to the hierarchy of government with National Government and its agencies receiving the greatest number of questionnaires. The allocation of the questionnaires is given in Table 4 below.

Table 4: Allocation of questionnaires to the various levels of government

Sphere / Level of Government	Questionnaires Allocated	Number of Questionnaires Received Back
National Government Departments and National Government Agencies	20	16
Provincial Government Departments and Provincial Agencies	14	11
Municipalities and Municipal Owned Entities	10	9
Public Universities	6	6
Total	50	42

Figure 5 below indicates the public sector officials who responded to the survey and the type of organisation they are working for. Notably, most of the respondents (38%) were from national departments and national agencies.

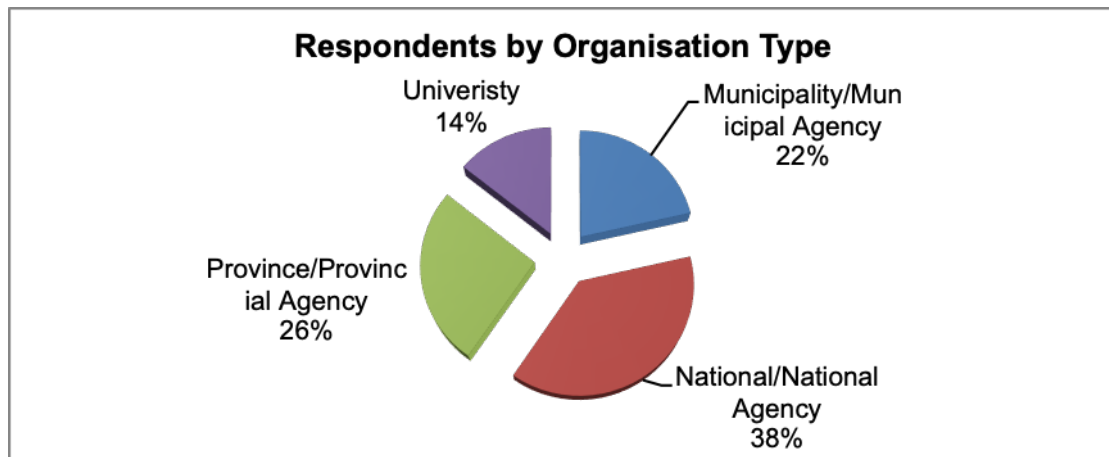


Figure 5: Respondents by organisation type

Figure 6 below indicate that the respondents are a varied mixture of directors, project managers and other senior posts within public sector organisations. Notably 38% of the respondents were senior managers and directors involved with infrastructure projects in their organisations. Their level of experience and seniority within their organisations give further validity to the survey results. Their views provided significant insight into the research questions regarding the design and build procurement approach in the public sector.

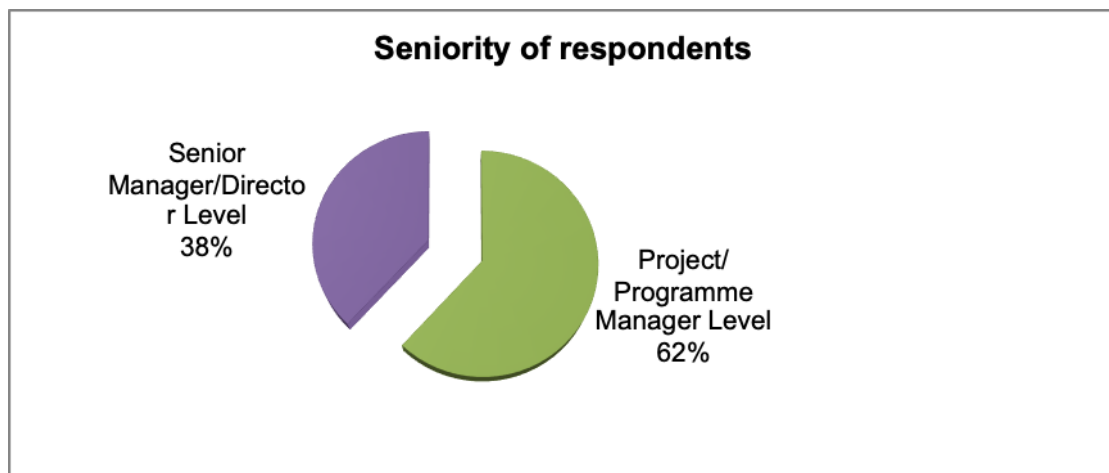


Figure 6: Seniority of respondents

3.6 Data collection method and instrument

Following the identification of the population and the selection of the sample, the researcher proceeded to obtain relevant information, which assisted in providing answers to the research question. This process is called data collection. Olsen (2012), defines data collection as a systematic process of obtaining relevant and accurate information important for the research outcome.

The data collection procedure involved issuing of a formal request letter to all potential participants. The letter highlighted information about the purpose of the survey, the researcher's and supervisor's contact details, what participation entailed, the data collection instrument, the researcher's responsibilities and participant's rights. Overall 50 emails were sent out and 42 responses received representing approximately 84% response rate.

Questionnaire format and overview

The questionnaire format was in a form of soft copy emailed to all potential participants. Pilot testing was not undertaken. A questionnaire consisting of 23 questions was sent out to the target population. The questions can be grouped into five (5) categories listed below:

- Criteria for selecting a project delivery system
- Knowledge and use of design and build delivery system in the public sector
- Capacity to implement design and build procurement approach in the public sector
- The future of design and build procurement approach
- Areas of enhancement and further support required

The first set of questions targeted specific information about the respondents' criterion for selecting a project delivery system. According to Ghadamsi (2016), poor project performance is sometimes caused by the use of inappropriate procurement method. He further argues that employing an appropriate procurement method often influences project success. Ghadamsi (2016), argues that due to the availability of various procurement methods presenting individual unique features, clients' decisions to choose an appropriate is now complex and challenging. This has led to a need to conduct a selection process in a disciplined and systematic manner. The aim of including this aspect in the questionnaire was to find out if the criteria clients use for choosing a delivery method is in line with the criteria for selecting a design and build procurement approach.

The aim of the second part of the questionnaire was to get some background information about the respondents' familiarity and their involvement with design and build procurement approach as well as the extent to which this approach is implemented by public sector organisations. Furthermore, the aim was to gain insights into the challenges that respondents have encountered when implementing projects using the design and build procurement approach.

The third set of questions looked at gaining insights into the existing capacity to implement design and build projects in public sector organisations. This section investigated the perception of respondents to some of the key aspects related to capacity to implement design and build projects by probing amongst other aspects the forms of contracts used for projects, familiarity with forms of contracts suitable for design and build procurement approach, information and training provision as well as capacity self-assessment in the organisations.

The fourth set of questions focused on gauging the optimism on the future of design and build procurement approach in the public sector. The section investigated the perception of respondents to some of the key aspects relating to whether they believe that design and build procurement approach could improve projects performance, their opinion on increasing the use of design and build procurement approach for projects as well as the key research question relating to the use of design and build procurement approach as an alternative to accelerate projects delivery in the public sector

The fifth set of questions looked at gaining insights into design and build procurement approach identified areas of enhancement (i.e. procurement, contracting and execution) and further support that could be provided to public sector officials. The section sought to investigate amongst other things, the perception of respondents to possible introduction of design and build procurement approach legislation, CIDB guidance on design and build approach as well as the possible establishment of a design and build institute for South Africa.

3.7 Data analysis

The data collection was followed by data analysis. According to Braun and Clark (2008), data analysis is the process of applying reason to understand and interpret collected data.

Data analysis through statistical techniques assists in investigating variables as well as their effect, relationship and their patterns of involvement (Lutabingwa and Auriacombe, 2007). According to Bhatia (2018), the two most commonly used quantitative data analysis methods are descriptive statistics and inferential statistics. Descriptive statistics is also known as descriptive analysis and is the first level of analysis. It helps researchers summarize the data and find patterns. The commonly used descriptive analysis include mean, median, mode, percentage, frequency and range. Descriptive statistics are most helpful when the research is limited to the sample and does not need to be generalized to a larger population. On the other hand, inferential statistics is a more complex analysis which show the relationships between multiple variables to generalise

results and make predictions. These might include correlation, regression and analysis of variance (Bhatia, 2018).

Data cleaning

Data cleaning is a process of detecting and correcting errors is called data cleaning. Four common ways in which data is cleaned include the following:

- data verification
- extensive pre-testing of the computer-assisted survey procedures
- wild-code checking of illegitimate codes
- consistency checking (Lutabingwa and Auriacombe, 2007)

For the purpose of this research, once the data from the questionnaires was entered into the computer, it was checked for errors that may have resulted from transmitting the data to the computer. The emphasis was also on consistency checking particularly where responses to certain questions are related in reasonably certain ways to responses to particular other questions

Data Reliability

According to Heale and Twycross (2015), researchers needs to consider both the results of the study as well as the rigour of the research. Rigour in this instance refers to the extent to which the researcher has worked to enhance the quality of the research. Rigour is therefore achieved through measurement of both validity and reliability. Reliability in research relates to the consistency of a measure (Heale and Twycross ,2015).

Yu (2005), highlights a number of ways to determine the reliability of a test. These are as follows:

- Split half method
- Internal consistency method
- Alternative forms method
- Test-rest method (Muriro, 2015)

Yu (2005), points out that the internal consistency method is one of the most important ways to measure reliability.

For the purpose of the research, consistency was enhanced by substantial descriptions of research design, implementation and operational details of data collection. Furthermore, consistency was improved by limiting the interference of the researcher behaviour and action in the research process

Data analysis

Once the data was processed, the data analysis process commenced. The analysis began by examining and describing in summary the data that has been collected. This was accomplished through univariate analysis which is basically the category of method used to examine one variable at a time. The collected data was conveyed by means of bar/column graphs and pie charts. The following general rules were observed in preparing the bar graphs:

- Clear title identifying what information is presented
- Clear label for columns and rows
- Appropriate categories, each with some entries,
- Clearly show any trend or differences in the data; and
- Accurate in a visual sense (Lutabingwa & Auriacombe, 2007).

Bar graphs increase readability and understanding of the data. Column graphs are good for comparing values. Pie charts were also used to show the relative proportions of a conceptual whole. According to Lutabingwa and Auriacombe (2007), pie charts are applied to nominal levels of measurements so that there is no presumption of order. Pie chart's main advantage is that they are simple with a drawback that it can be difficult to see the difference in slice sizes when their values are similar. It was therefore important to label the slices with actual values for the purpose of the research report.

3.8 Ethical consideration

According to Farrimond (2012), ethical issues are important in the primary research in particular, but also in the use of secondary data sets because there are ethical issues relating to fair and unbiased selection of sources and analysis that need to be considered. Various issues are involved in ethical considerations. These relate to consent by participants, information about the purpose of the research, the researcher as well as the results (Bryman and Bell, 2003). Maintaining the confidentiality of the results and anonymity of the participants are equally important (Rahman, 2017).

Hammersley and Traianou (2012), highlight five commonly recognised principles relating to ethical consideration. These are:

- minimising harm,
- respecting autonomy,
- protecting privacy,
- offering reciprocity,

- treating people equitably.

Rahman (2017), points out that the effects of not following the above-mentioned principles are negative and has further maintained that overlooking some principles may be useful. Various authors have argued that ethical issues are mostly concerned with qualitative research rather than quantitative research. Hughes *et al.* (2001), argue that ethical issues mainly affect qualitative data collection methods due to the fact that there is an intimate relationship between research and researched. Darlington and Scott (2003), further argue that ethical issues are highly concerned with qualitative research rather than quantitative research due to the fact that in-depth interview and observation can be widely intrusive to the people interviewed.

For the purpose of the research project, two key ethical issues were considered which are consent and confidentiality. This therefore meant that all participants had to freely consent to participate in the survey without being pressured or coerced. Consent to participate in the study was obtained from all participants who were equally informed of their rights in the course of their participation. Furthermore, anonymity was guaranteed for all participants as their identity has been protected. The researcher further protected the identity of all participants by not disclosing their identities or collecting information that might reveal their identity.

The researcher applied for and obtained permission from the University of the Witwatersrand Research Ethics Committee. The research ethics clearance certificate is attached to this research report as an appendix.

3.9 Summary

There are many approaches that are available for researchers to adopt in undertaking research. It has been argued that the research methodology should be based on the research problem. The existing approaches being the qualitative, quantitative and mixed approaches have been discussed and justification for adopting the quantitative research methods outlined. The next chapter presents findings from the survey undertaken

CHAPTER 4: FINDING AND ANALYSIS

4.1 Introduction

This chapter presents the findings and analysis of the quantitative research. The sample profile is highlighted and detail explanation of the responses to the questions is given and inferences presented.

The objective of the research was to undertake an assessment of the extent of the use of design and build procurement approach in the public sector, to assess the factors limiting the use of the approach, to investigate if design and build procurement approach can be enhanced to address the perceived challenges of the approach and finally to determine the extent of using the approach as an alternative to accelerate delivery of projects. The output of the assessment was used to inform and provide focus for the formulation of key recommendations contained in this research report.

4.2 Sample profile

Table 5 below indicates the public sector organisations that responded to the survey questionnaire. A total of 50 questionnaires were sent out and a total of 42 questionnaires received back. This represents a response rate of 84%.

Table 5: List of organisations responded

Organisation	Number of respondents
National Department of Public Works	1
National Department of Basic Education	1
Transnet	1
Passenger Rail Agency of South Africa (PRASA)	5
Development Bank of Southern Africa (DBSA)	2
Eskom	4
Housing Development Agency (HDA)	2
Coega	1
Kwazulu-Natal Department of Public Works	5
Mpumalanga Economic Growth Agency (MEGA)	1
Gauteng Department of Health	2
Gauteng Department of Infrastructure Development (DID)	2
Johannesburg Development Agency (JDA)	3
Johannesburg Roads Agency	2
City of Ekurhuleni Metropolitan Municipality	2
City of Tshwane Metropolitan Municipality	1
Steve Tshwete Local Municipality	1
Durban University of Technology (DUT)	5
Mangosuthu University of Technology (MUT)	1
Total	42

Figure 7 below indicates that most of the respondents were involved in building, civil and maintenance projects (10), followed by those who were involved with civil engineering projects only (8). A total of 7 respondents were involved with building projects only with the rest of the respondents involved in a combination of building, civil, maintenance and other types of projects such as electricity projects.

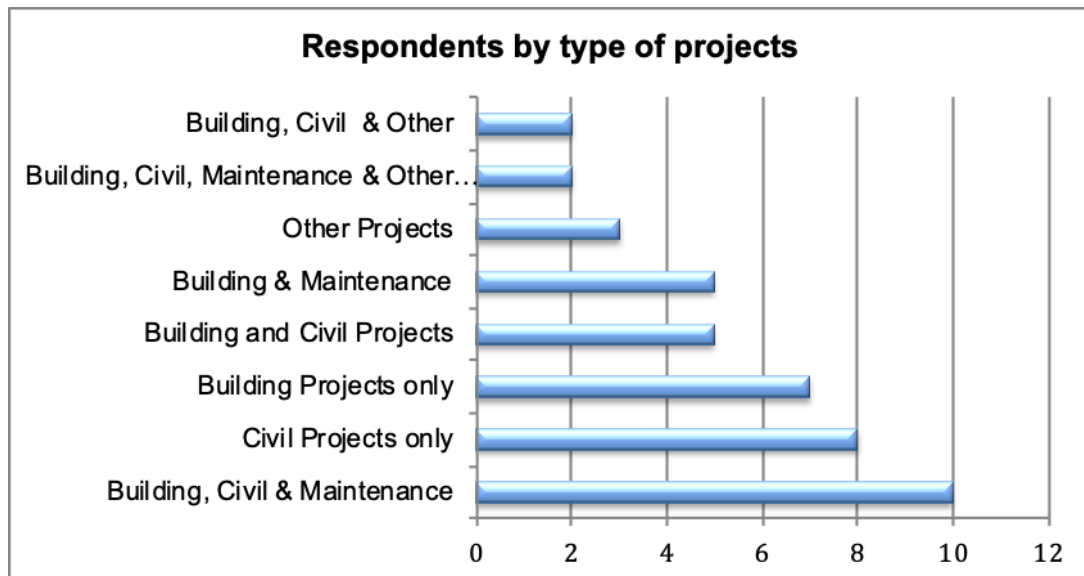


Figure 7: Respondents by type of projects

4.3. Findings

4.3.1 Criteria for selecting a project delivery system

The circumstances in which the design and build procurement approach is recommended for use by clients include the following:

- The client is unfamiliar with the construction process
- Technically complex projects
- Low likelihood of variations to the project
- Single point of responsibility required by the client
- The employer desires a quick start to work on site.
- The client desires to prioritize either time, quality, price or value for money,
- The client desires an opportunity for effective direct communication with contractors.
- The client desires integration of the design and construction process (Ghadamsi, 2016).

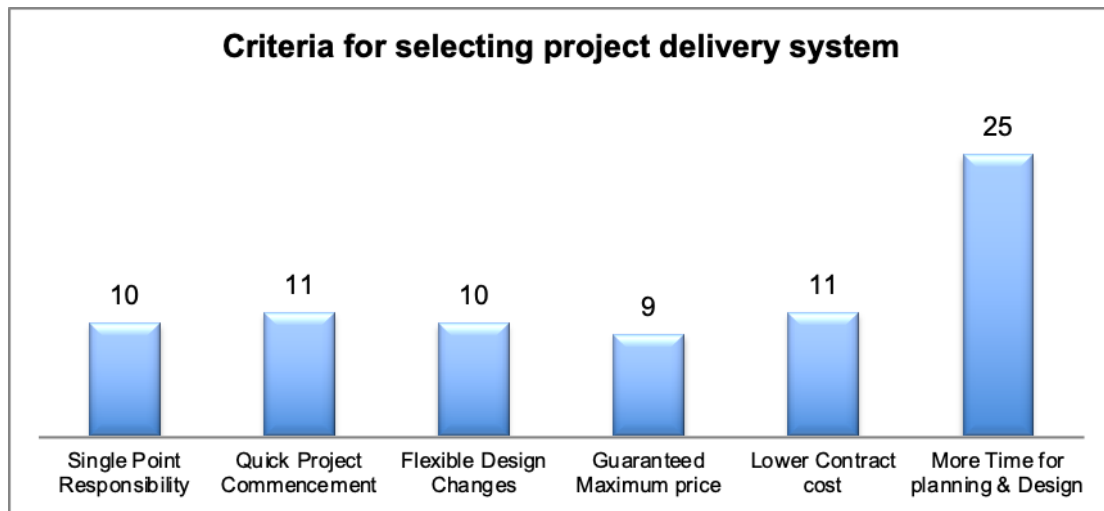


Figure 8: criteria for selecting project delivery system

Table 8 above indicates that the most important criterion for selecting a project delivery system according to the survey respondents was the need for more time for planning and design (25 respondents). This was followed by the need for quick project commencement (11 respondents) and the need for lower contract costs (11 respondents). From the literature review, it has been established that quick project commencement is one of the advantages of a design and build procurement approach. More time for planning and design as well as lower contract cost is associated with traditional forms of procurement systems. The above results therefore indicate public sector clients' preference for key elements of the traditional procurement systems.

4.3.2 Knowledge and use of design and build procurement approach in the public sector

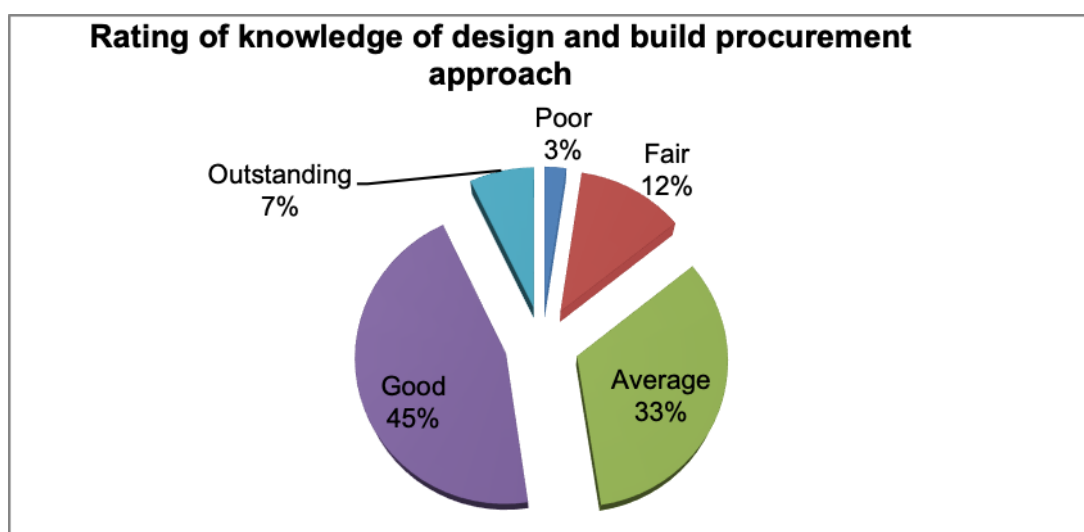


Figure 9: Rating of knowledge of Design and Build by respondents

According to Illori and Talukhaba (2016), the late introduction of the design and build procurement system into the South African construction industry compared to other countries especially in Europe has led to the current limited use of the approach. It is evident from the survey conducted that there is limited knowledge of design and build procurement approach. Figure 9 above indicates that only 7% of the respondents rated their knowledge of the approach as outstanding. Notably, most of the respondents (45%) rated their knowledge of the approach as good followed by 33% of the respondents who rated their knowledge of the approach as average. This limited knowledge therefore contributes to the limited use of the approach by public sector officials.

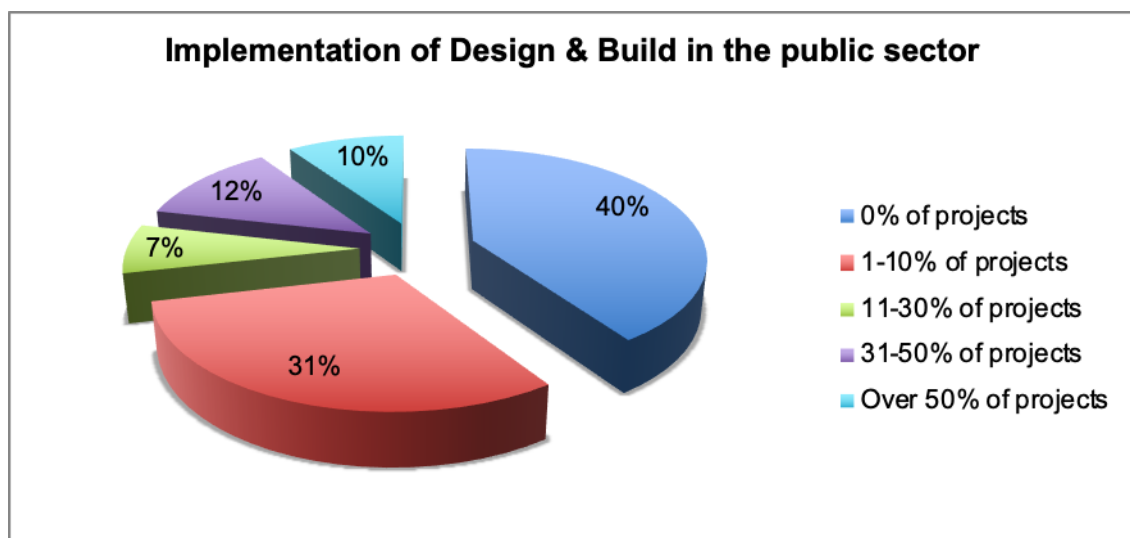


Figure 10: Implementation of design and build procurement approach

Figure 10 above, confirms the limited use of the design and build procurement approach within the public sector. Notably 40% of the respondents indicated that they do not deliver their projects using the design and build procurement approach. At total of 31% of the respondents implement between 1-10% of their projects, using the approach. Only 10% of the respondents had over 50% of their projects implemented on the design and build procurement approach. This is significant to the research given that the focus of the research is to determine the extent of the use of the approach and to explore challenges encountered by participants when delivering projects using the approach.

Figure 11 below shows the respondents' view on the factors limiting the use of design and build procurement approach in the public sector. The responses confirm the outcome from the literature review that lack of knowledge is a key factor limiting the use of design and build procurement approach in South Africa. Lack of knowledge was cited by 41% of the respondents as a key factor limiting the use of the approach in the public sector followed by 21% who cited bureaucracy (i.e. the rigid system of government administration) as a key factor and 19% who indicated that the contract is difficult to manage.

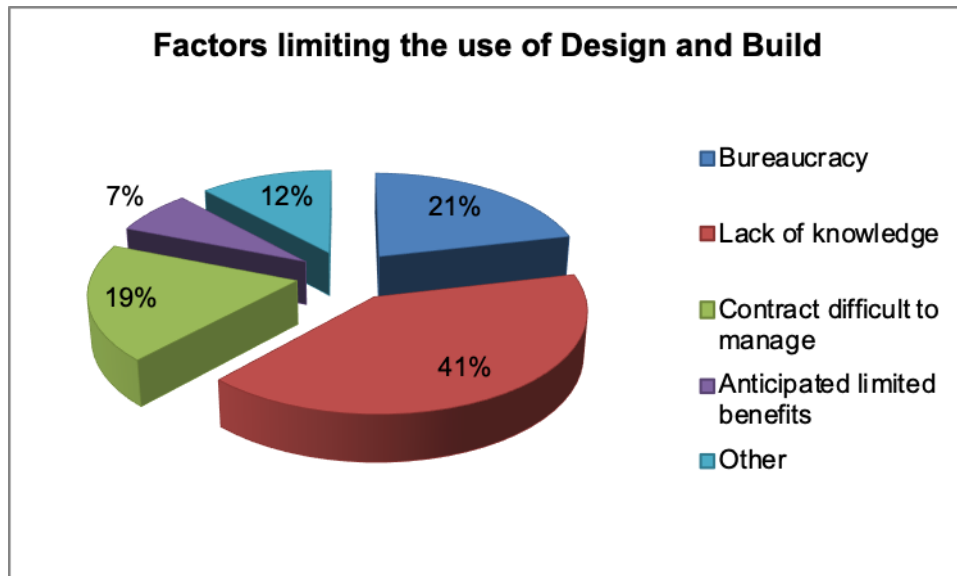


Figure 11: Factors limiting the use of design and build procurement approach in the public sector

Various challenges with the design and build procurement approach were discussed in the literature review. The five dominating challenges highlighted in the literature review relate to:

- Loss of control by clients
- Inflexible regarding variations
- Difficulty in appointing client specialists
- Potential for standards reduction
- Monitoring difficulties since the single responsibility of designing and building of the infrastructure is given to the contractor

Figure 12 indicates the respondents' view regarding actual and perceived challenges of implementing the design and approach method. Notably the biggest challenge (27% of respondents) was that design and build procurement approach result in loss of project control by the client. Project control is vital for public sector clients due to accountability prescribed by legislations such as the Public Finance Management Act (PFMA, 1999) and Municipal Finance Management Act (MFMA, 2003).

The second biggest challenged cited by the respondents (25% of respondents) with regard to design and build procurement approach was that of monitoring difficulties. This is due to the fact that the contractor is responsible for both design and construction and can therefore execute the project to completion with minimal role from the client. The third highest challenge (20% of respondents) according to the respondents was that design and build procurement approach lead to lower than expected quality of work (i.e. lower

standards and risk of standards reduction) as the contractor is responsible for design, building and certification of the works and that there is no independent person certifying the works

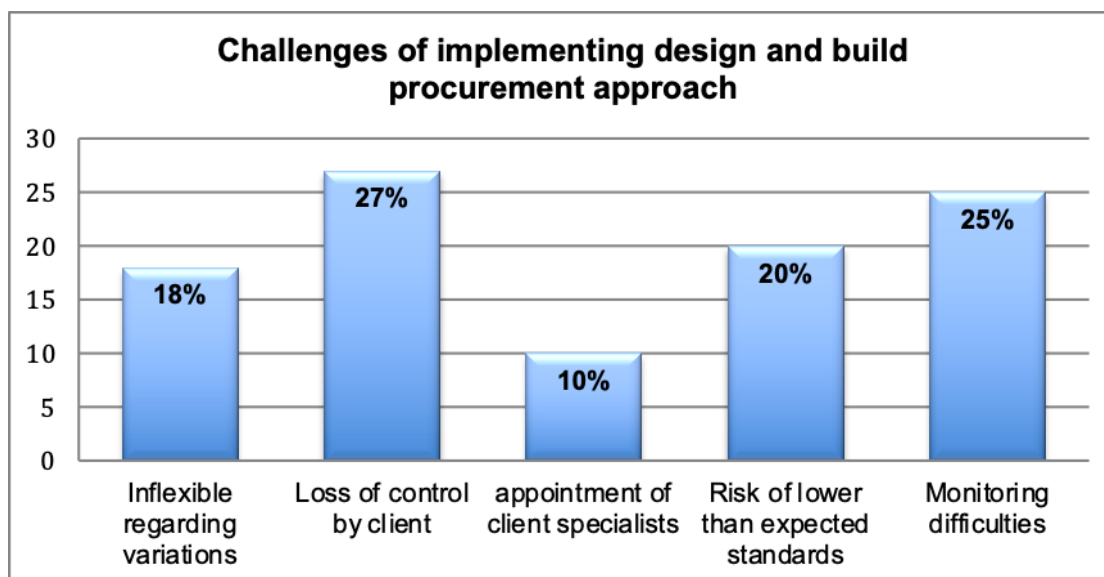


Figure 12: Challenges of implementing design and build procurement approach

Figure 13 below highlights the performance of design and build projects from the respondents. Of the 42 respondents, 23 respondents were implementing design and build procurement approach in their infrastructure projects. Good performance on design and build procurement approach was experienced by 13 respondents while 10 respondents experienced average performance of design and build projects. It needs to be mentioned that no respondents experienced either excellent or poor performance of the design and build projects. This presents an area for future research in order to establish the underlying reasons for the highlighted performance of the design and build projects.

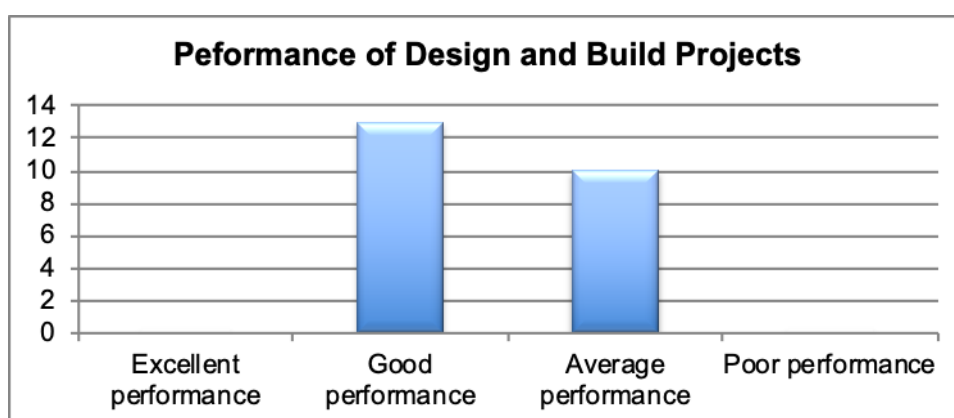


Figure 13: Performance of design and build projects

As discussed in the literature review, most clients in the US confirmed they received significant value from design and build procurement approach when

employed on larger and more complex projects. These clients indicated that the large and complex projects allowed for greater opportunity to provide project innovations and subsequent cost savings (FMI, 2018)

Figure 14 below highlights the challenges encountered by the respondents when implementing design and build projects. Notably 35% of the respondents indicated both late completion and contract management challenges from the projects implemented. Cost overrun was cited by 22% of the respondents with only 8% of respondents indicating that implementation of their projects was without challenges.

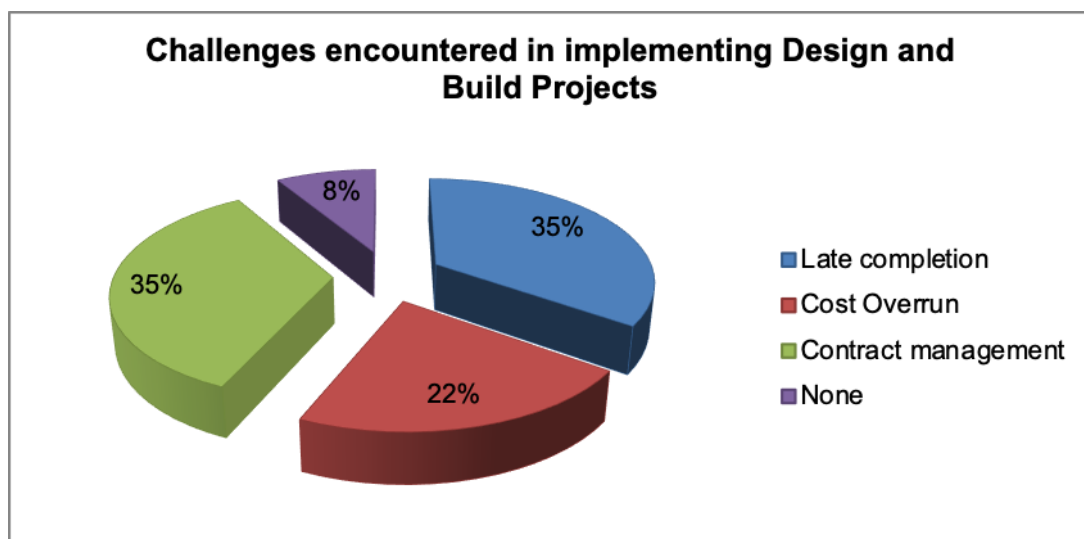


Figure 14: Challenges encountered in implementing design and build projects

4.3.3 Capacity to implement design and build procurement approach in the public sector

As discussed in the literature review, the two main suitable forms of contracts for implementing design and build approach is the New Engineering Contract (NEC) as well as FIDIC. The JBCC is a design by employer and thus not suitable for design and build approach. Figure 15 below indicates that 57% of the respondents indicated that they were using the JBCC form of contract to implement their projects compared to 24% who were using NEC and 14% who used FIDIC.

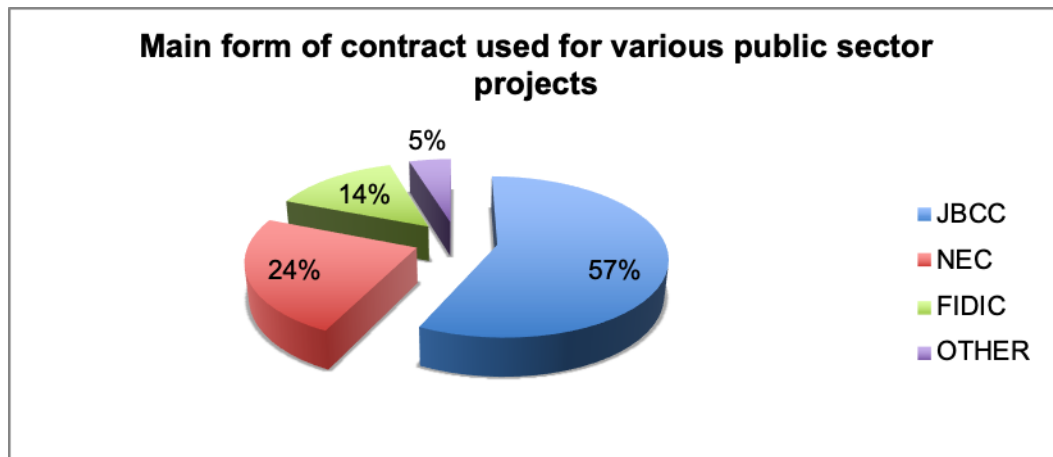


Figure 15: Forms of contracts used for public sector projects

Familiarity with the forms of contracts suitable for implementation design and build is another key determinant of the public sector official's capacity to implement the approach. From Figure 16 below, it is evident that most of the respondents (38%) were only familiar with the JBCC and other forms of contract highlighted in the literature review which are not suitable for design and build projects. There is therefore a need for capacity building initiatives regarding forms of contracts in order to successfully implement design and build projects.

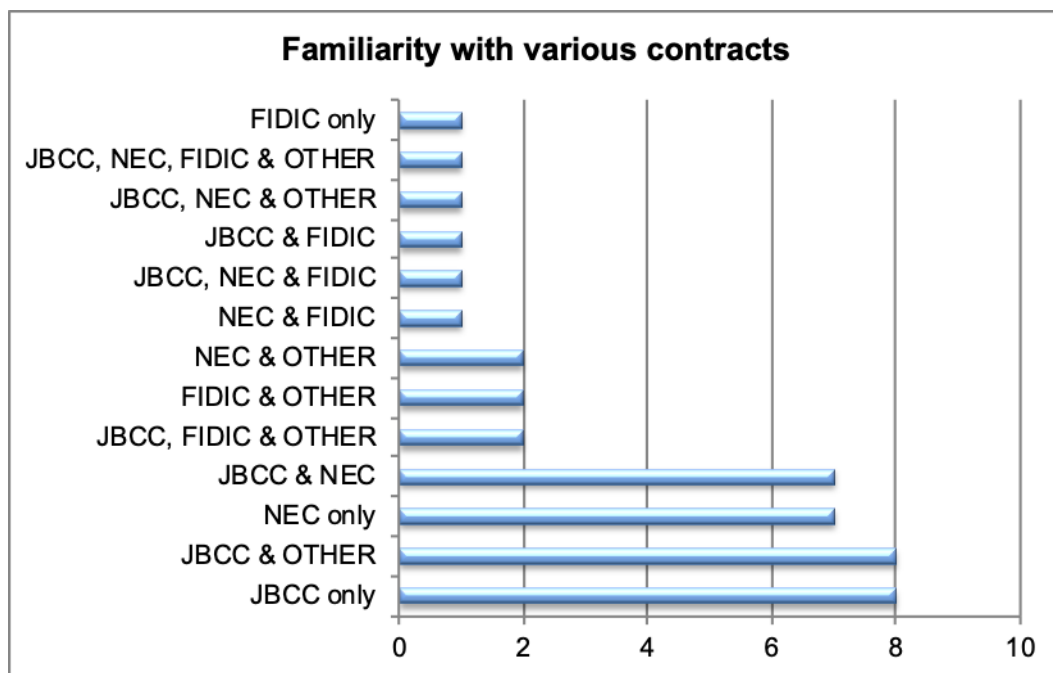


Figure 16: Familiarity with various forms of contracts

From the literature review, it was highlighted that education and awareness plays a critical role with regards to deciding on the use of the design and build procurement approach. According to FMI (2018), it was established in the US that once clients got full understanding of the process and benefits associated with design and build procurement approach, they were more likely to continue to employ it as a preferred delivery method. The study further concluded that a

continued emphasis toward educating clients and project stakeholders on the process and benefits associated with design and build procurement approach will facilitate continued adoption and greater use of the approach (FMI, 2018).

From the survey conducted, respondents were requested to indicate their view on the level of information that they have been exposed to regarding the design and build procurement approach. Figure 17 below indicates that 67% of the respondents indicated that there is insufficient information provided with 21% indicating that there is sufficient information.

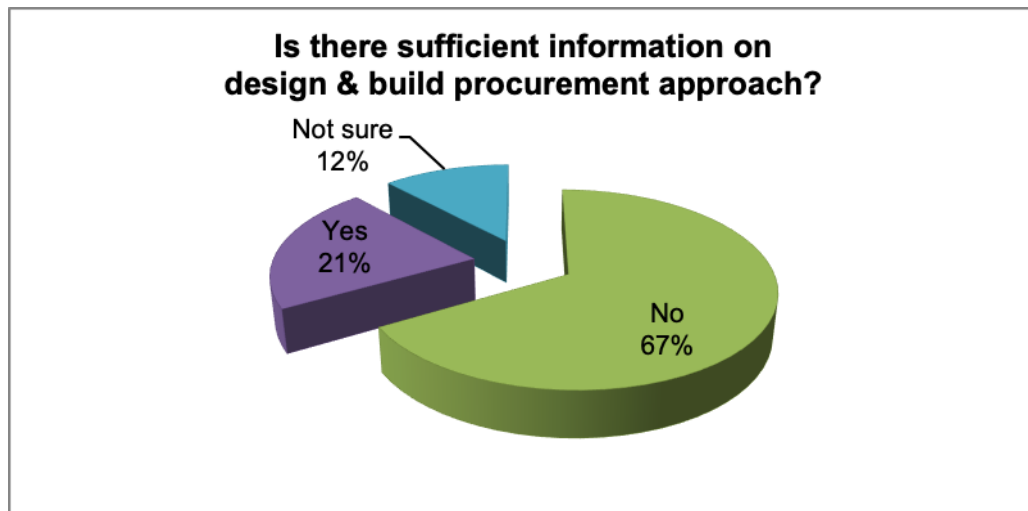


Figure 17: Information provided to public sector officials on design and build procurement approach

As part of assessing the capacity of public sector officials to implement design and build projects, the respondents were requested to indicate if any training was provided by their organisations regarding the design and build procurement approach. Figure 18 below indicates that only 19% of the respondents confirmed that training has been previously provided by their organisations with the most (67%) indicating that no training has ever been provided by their organisations regarding the design and build procurement approach

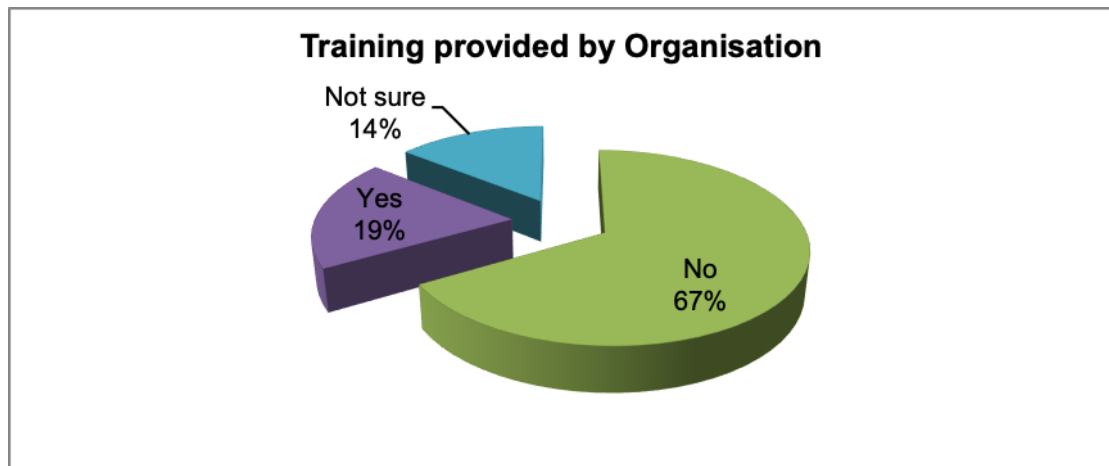


Figure 18: Training provided by public sector organisations on design and build

The respondents were further requested to indicate if they require training on the design and build procurement approach. Figure 19 below reveals that an overwhelming number of respondents (95%) indicated that they require training on the approach. Only 3% of the respondents indicated that they do not require any training on the approach with 2% of the respondents not sure whether they require training or not.

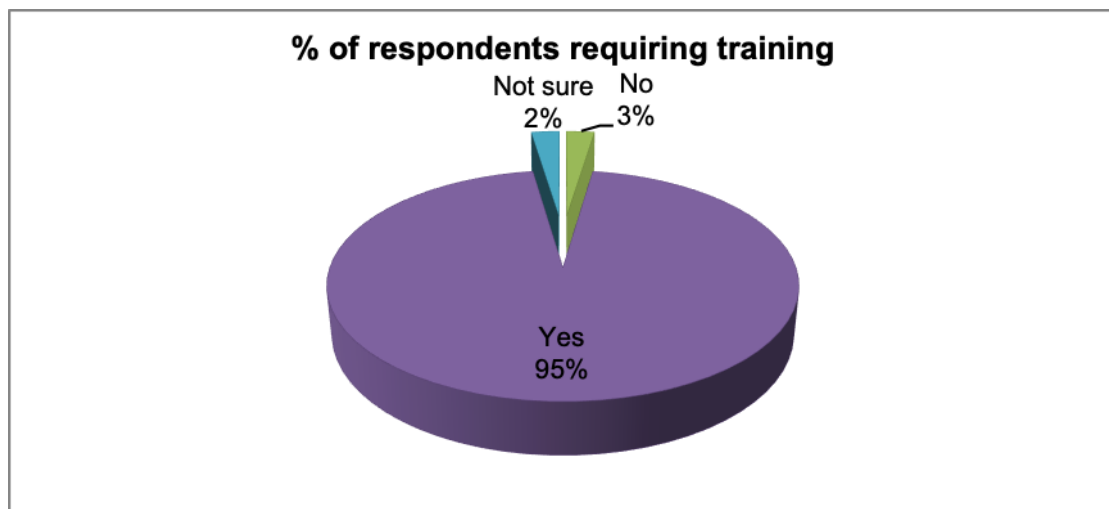


Figure 19: % of respondents requiring training

The respondents were further requested to indicate whether their organisations have the required capacity to implement design and build projects. Figure 20 below shows that only 42% of the respondents indicated that their organisations have the capacity to implement design and build projects. Notably, 34% of the respondents indicated that there is insufficient capacity in their organisations to implement design and build projects with 24% of respondents not sure whether there is sufficient capacity or not. In order to successfully implement design and build projects, the capacity challenge should be addressed by public sector organisations.

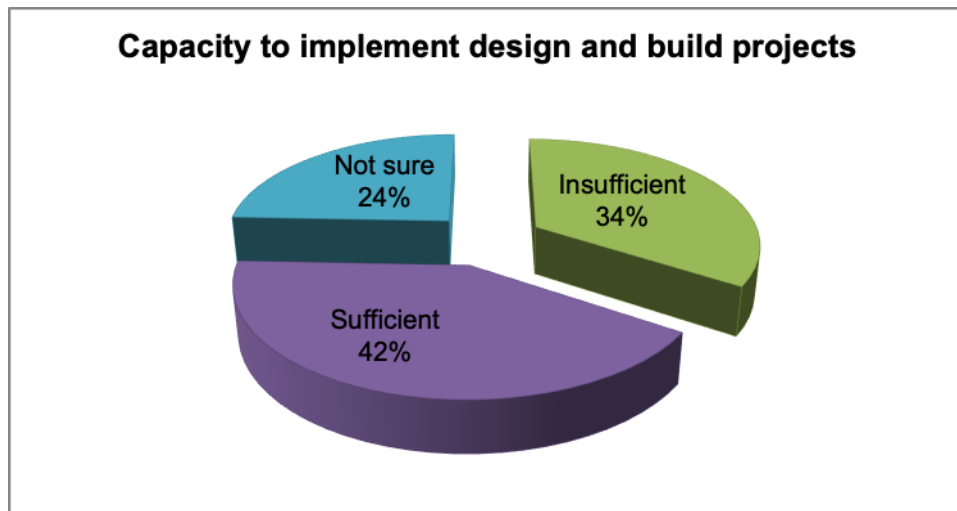


Figure 20: Capacity to implement design and build projects

The respondents were also requested to indicate whether they consider the design and build procurement approach to be a complicated method. Most of the respondents (86%) as can be seen in Figure 21 below, indicated that the method is not complicated with only 9% indicating that the method is complicated and a further 5% who were not sure if the method is complicated or not.

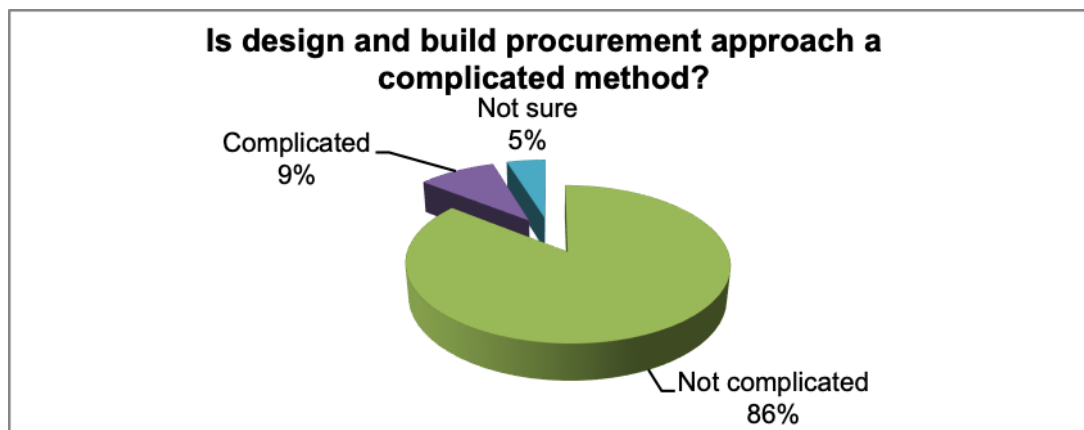


Figure 21: Respondents' response to perceived complication of design and build procurement approach

4.3.4 Future of design and build procurement approach in the public sector

In order to gauge optimism regarding the future of design and build procurement approach in the public sector, certain perception questions were posed to the respondents. The respondents were requested to indicate whether they believe that design and build procurement approach can improve projects performance. A positive response was received as the most (79%) of respondents indicated that indeed design and build procurement approach can improve projects performance. Only 12% of the respondents indicated that design and build procurement approach cannot improve projects performance

with 9% of the respondents not sure whether the approach can lead to improvement in projects performance (see Figure 22).

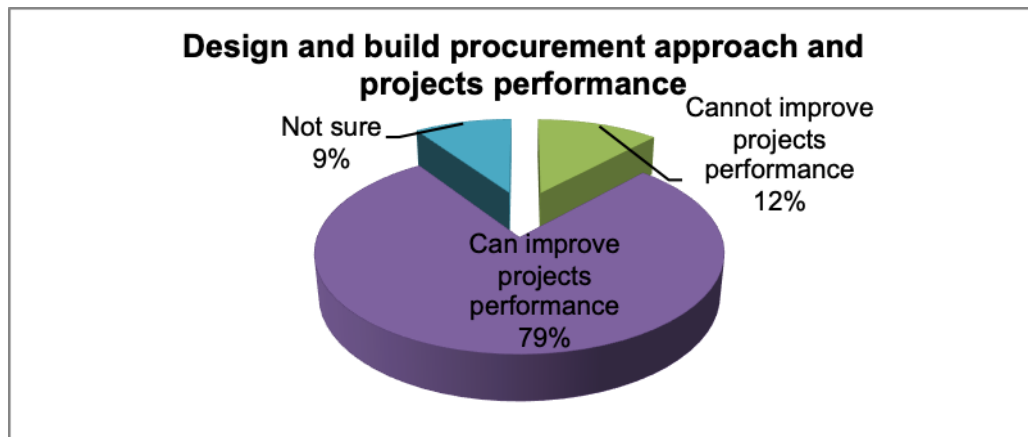


Figure 22: Design and build procurement approach and projects performance

Respondents were further requested to share their opinion on whether the use of design and build procurement approach should increase for their public sector projects. A positive response was received as 74% of the respondents indicated that they would like to see more projects implemented on the design and build procurement approach. This was followed by 14% of the respondents who were not sure whether the approach should be increased or not. A minority (12%) of the respondents indicated that they do not want to see more projects implemented on the design and build procurement approach (see Figure 23). The positive response from the respondents outlined above presents a high level of optimism and fertile ground for planning and implementing design and build projects in the public sector. More work should therefore be undertaken in order to address the real and perceived challenges associated with design and build procurement approaches.

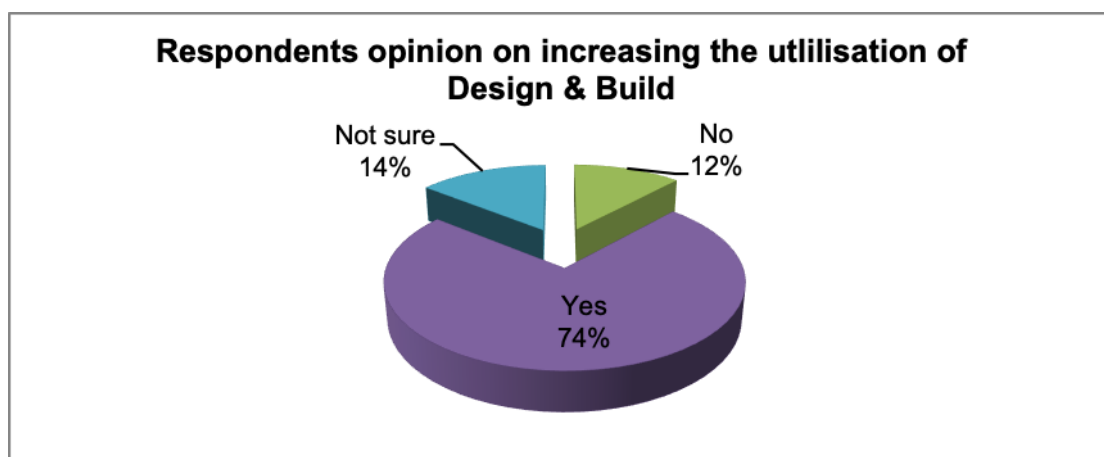


Figure 23: Opinion on increasing the use of design and build procurement approach

Respondents were requested to share their thought on whether design and build procurement approach can be an alternative that can be used to accelerate delivery of infrastructure projects in South Africa's public sector. Figure 24 below indicates that 83% of the respondents agreed that design and build procurement approach could be an alternative that can accelerate the delivery of infrastructure projects in the public sector. Only 10% of the respondents indicated that design and build procurement approach could not be an alternative mechanism to be used in fast tracking projects. A further 7% of the respondents were not sure if design and build procurement approach could serve as an alternative delivery mechanism for public sector projects.

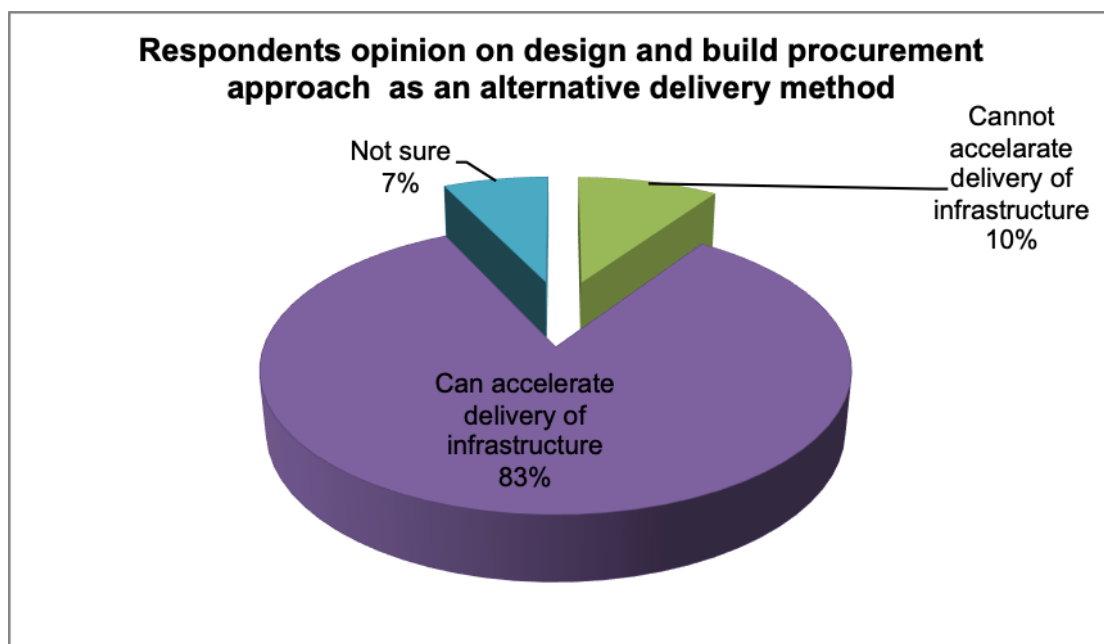


Figure 24: Opinion on design and build procurement approach as an alternative

4.3.5 Design and build procurement approach areas of enhancement

Respondents were requested to indicate areas where they thought design and build procurement approach should be enhanced in order to successfully deliver infrastructure projects. The design and build best practices were explained in the literature review. The best practices cover the main areas outline below:

- Procuring design and build services
- Contracting for design and build services
- Executing the design and build projects (DBIA, 2014)

Figure 25 indicates that 34% of the respondents equally indicated both contract aspects and procurement of a design and build contractor as areas that needs enhancement. Notably, 27% of the respondents indicated that the approach

should be enhanced in the area of executing the delivery of design and build projects. A small number of respondents indicated that design and build procurement approach should be enhanced in all the three approaches stated above.

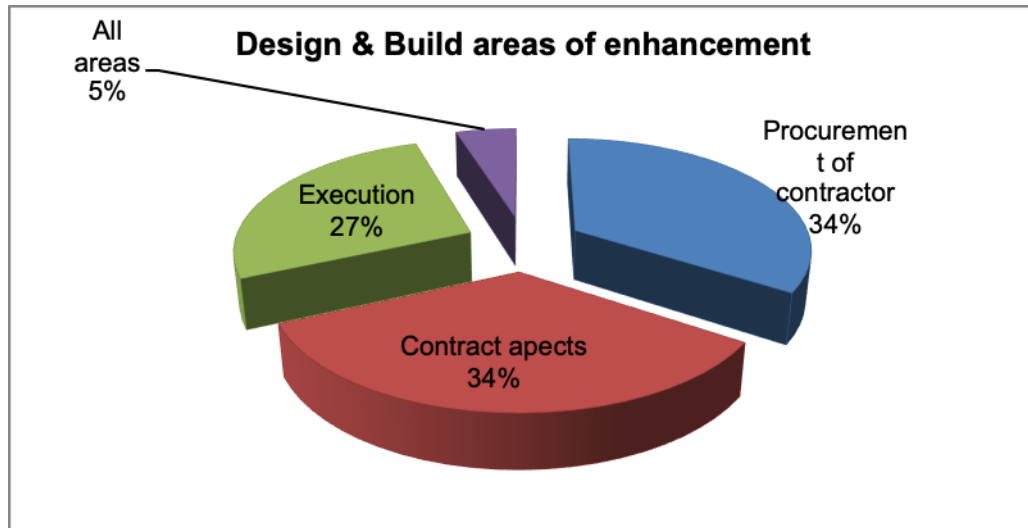


Figure 25: Design and build procurement approach areas of enhancement

Respondents were also requested to indicate whether legislation should be introduced and implemented in order to promote the design and build procurement approach. As discussed in the literature review, legislation was introduced in the US in order to promote and regulate the usage of design and build procurement approach (USACE, 1999).

Figure 26 reveals that 66% of respondents indicated that legislation should be introduced in order to promote the design and build procurement approach while 24% of the respondents indicated that legislation should not be introduced in this regard. Furthermore, 10% of respondents were not sure whether legislation should be introduced to promote the approach.

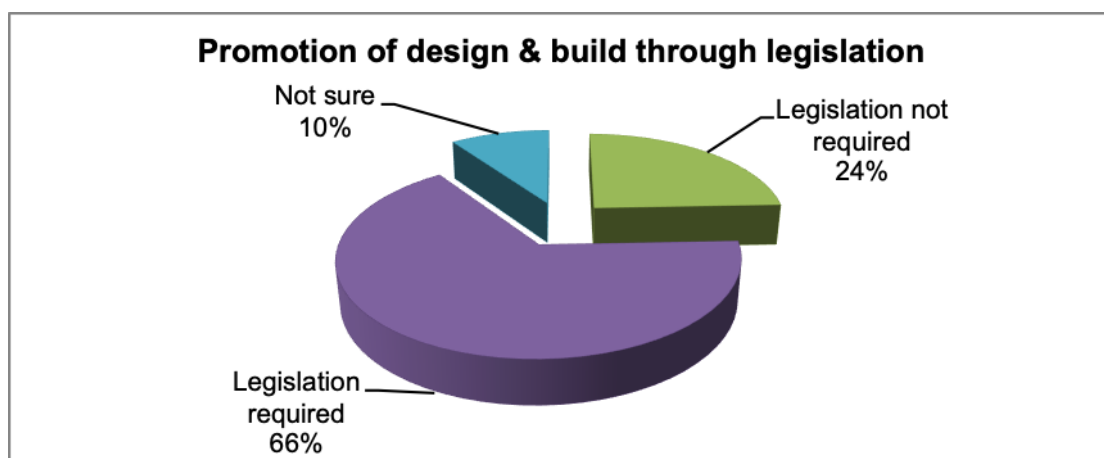


Figure 26: Promotion of design and build procurement approach through legislation

Respondents were also requested to indicate their view on whether the Construction Industry Development Board should provide more guidance in terms of framework and policy documents for implementing design and build projects. As indicated in Figure 27, a total of 86% of the respondents indicated that CIDB guidance is required. A further 9% of the respondents were not sure whether CIDB guidance is required. A small number of respondents (5%) indicated that there is no need for the CIDB to provide guidance in terms of a framework and other policy documents.

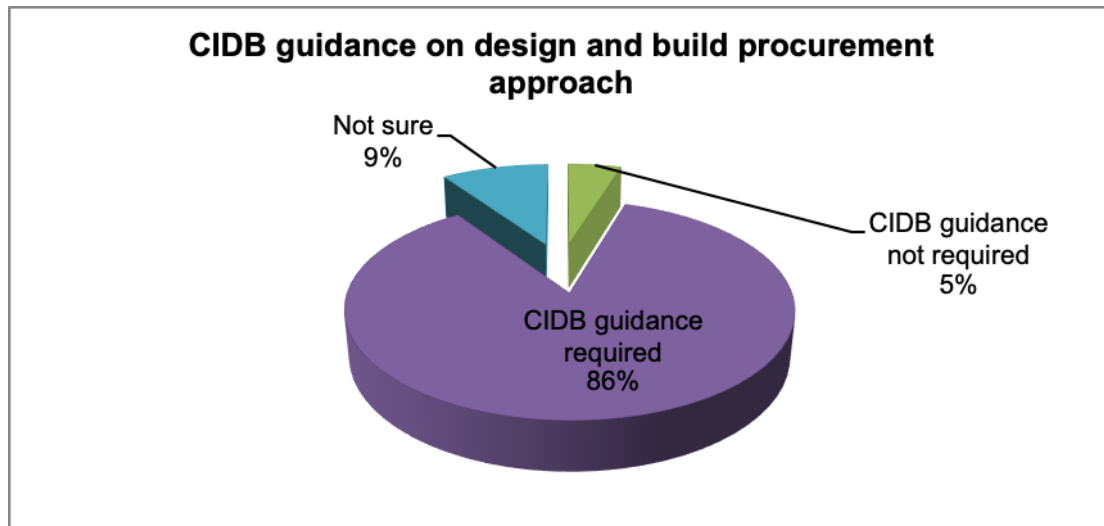


Figure 27: CIDB guidance on design and build procurement approach

Respondents were further requested to share their opinion regarding the possible establishment of a Design and Build Institute for South Africa. Such an institute would actively promote the design and build approach and contribute to education as well as the awareness of the approach similar to the approach taken in the US. According to the DBIA (2002), the Design-Build Institute of America (DBIA) was formed in response to the emergence of the approach as a significant force in the design and construction within the US. Figure 28 shows that 76% of the respondents indicated that the establishment of a design and build institute for the country is required. Notably, 12% of the respondents indicated that the establishment of such an institute is not required with a further 12% who were not sure whether such an institute should be established.

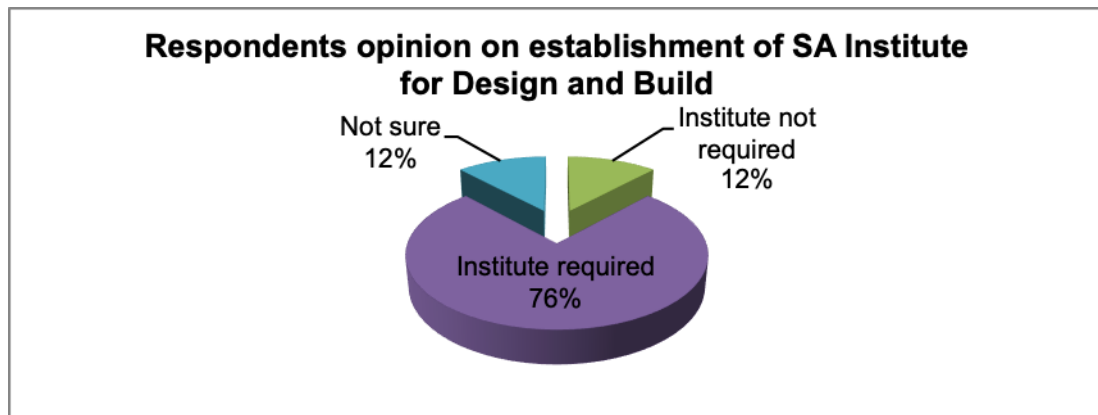


Figure 28: Opinion on establishment of SA Institute for Design and Build

4.4 Research questions revisited

Four research questions were formulated to provide a guide in conducting the research. The research questions and the manner in which they were answered is provided below:

Research question 1

To what extent is the design and build procurement approach currently used in South Africa's public sector?

The study revealed that there is still limited use of the design and build procurement approach in the public sector with almost 40% of public sector officials not using the design and build procurement approach to implement infrastructure projects. The study further revealed that the public sector officials implemented a few projects using the approach with 31% implementing between 1-10% of their projects using the approach. The research did not however focus on the nature of the projects in terms of scope of work, duration and value of these projects. This is an area of further research as determining the magnitude of these projects will enhance the literature available on design and build procurement approach.

Research question 2

What are the major factors limiting the use of the design and build procurement approach in South Africa's public sector?

The study revealed three major factors limiting the use of the design and build procurement approach in the public sector. These were lack of knowledge (41% of the respondents), bureaucracy (21% of the respondents) and difficult contract management (19% of respondents).

Research question 3

Can design and build procurement approach be enhanced to address perceived challenges of the approach?

The study revealed that the approach can be enhanced to address challenges in three areas being procuring of design and build services (34% of the respondents), contracting for design and build services (34% of the respondents) and executing the delivery of design and build projects (27% of the respondents).

Research question 4 and 5

Can design and build procurement approach as an alternative delivery mechanism contributes to accelerating delivery of infrastructure construction projects in the public sector and ensure successful delivery of projects?

Can design and build procurement approach as an alternative delivery mechanism ensure successful delivery of projects?

The study revealed that 83% of the respondents indicated that design and build procurement approach could be an alternative that can accelerate the delivery of infrastructure projects in the public sector. Furthermore, most (79%) of respondents indicated that implementing projects using the design and build procurement approach could improve projects performance. Finally, 74% of respondents indicated that they would like to see more projects implemented using the design and build procurement approach.

4.5 Summary

More time for planning and designed emerged as the most important criterion for selecting a project delivery system. As discussed in the literature review, this criterion is not amongst the top key criteria for selecting a design and build procurement approach. Further exploration should be made to investigate the possibility and conditions thereof of allowing more time for planning and design within this approach. Quick project commencement emerged as the second ranked criteria for selecting a project delivery system. Design and build procurement approach, has as one of its advantages the provision of quick project commencement. The selection of this criteria therefore strengthens the case for implementing the design and build procurement approach to accelerate projects delivery.

It has been confirmed through the research that there is limited knowledge as well as limited implementation of the design and build procurement approach in public sector organisations in South Africa. The lack of knowledge emerged as a key factor limiting the implementation of the approach. The positive coming

out of the research survey is that there was no poor performance recorded from the design and build projects implemented within the public sector. Notably, there was no record of excellent performance from the projects implemented. The performance of the projects was either average or good. This is a potential area of future research.

With regard to the capacity to implement design and build procurement approach in the public sector, the survey revealed that there is insufficient capacity to implement design and build projects. Furthermore, there is a lack of sufficient information provided to public sector officials regarding the design and build procurement approach. There is acknowledgement from public sector officials that there is a need for more training in order to fully grasp the essence of the design and build procurement approach.

There is optimism regarding the future of design and build procurement approach in public sector organisations. Most respondents confirmed that they would like to see more projects implemented using the design and build procurement approach. The respondents further confirmed that the design and build procurement approach can improve projects performance and can be used as an alternative to accelerate projects delivery in the public sector.

Lastly, the research survey confirmed a need to promote the design and build procurement approach in the areas of procuring design and build services as well as in contracting for design and build services. Furthermore, the research survey pointed to a need for introduction of legislation to promote and regulate the use of the approach, CIDB guidance in terms of producing framework and policy documents as well as a possible establishment of a design and build institute for South Africa. Such an institute could, if established, actively promote the design and build procurement approach through education and awareness of the approach.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents recommendations based on issues identified in the literature review as well as findings from the survey conducted. The limitations of this research project are also presented in this chapter together with recommendations for future research. An overall conclusion of the research project is further presented in this chapter.

5.2 Conclusion of the research project

It has been argued that the choice of project delivery system and procurement approach significantly influences project results. Ilori and Talukhaba (2016), define design and build procurement approach as an approach that is present when a substantial amount of building is accomplished under a single contract, covering both the design and building of the project. There are many benefits that are inherent in the design and build procurement approach. The benefits relate to various indicators of project performance such as time, costs, risk, etc. From the literature reviewed, single point responsibility came up as a key advantage of design and build procurement approach.

This research project investigated the following:

- The extent of current use of the design and build procurement approach in South Africa's public sector
- The major factors limiting the use of the design and build procurement approach in south Africa's public sector
- feasibility of enhancing design and build procurement approach in order to address challenges of the approach
- The use of design and build procurement approach as an alternative that can contribute to accelerating delivery of infrastructure construction projects in the public sector and ensure successful delivery of projects.

The study adopted a quantitative research approach. The nature of the research problem and the objectives of the study justify the use of the questionnaire survey in order to generalise and measure severity of the challenges explored in the literature reviewed as far as design and build procurement approach is concerned as well as quantifying opinions of public sector officials with regard to various aspects of design and build procurement approach. The questionnaire survey was used to collect data on design and build procurement approaches from public sector organisations. The target population comprised public sector officials involved in planning and implementing infrastructure projects. A questionnaire consisting of 23 questions

was sent out to the target population. A total of 50 questionnaires were sent out and a total of 42 questionnaires received back.

It has been confirmed through the research that there is limited knowledge as well as limited implementation of the design and build procurement approach in public sector organisations in South Africa. The biggest challenge with regards to design and build procurement approach from public sector officials is that the design and build procurement approach results in loss of project control by the client. On the capacity to implement design and build procurement approach in the public sector, the survey revealed that there is insufficient capacity to implement design and build projects. The research survey confirmed a need to enhance the design and build procurement approach in the areas of procuring design and build services as well as in contracting for design and build services.

Recommendations have been made to enhance the approach and to mitigate the challenges identified regarding the approach. Further mechanisms should be put in place to ensure that the client is involved throughout the project. It is recommended that project steering committees be established to provide oversight role on design and build projects. Design progress reviews are necessary to assist clients in monitoring design and build projects. For strengthening the quality assurance, it is recommended that clients insist that design and build contractors establish two key functions being the design quality management function and the construction quality management function. It is further recommended that all design and build contracts contain a change clause, according to which the contract price may be adjusted if the parties agree to an amendment to the client's requirements for changes.

It is further recommended that details regarding specialist work to be undertaken in projects by client contractors be made known to potential design and build bidders so that this can be factored in by the bidders when they prepare and submit proposals to clients. It is important that clients develop their project requirements prior to commencing the design and build procurement process. Pre-design studies are important in order to develop the project criteria. It is therefore recommended that both FIDIC and NEC contracts be used for design and build contracts in the public sector rather than drafting bespoke contracts for projects.

As part of capacity building, it is important that sufficient information be disseminated to all relevant public sector officials involved in infrastructure projects. It is recommended that the design and build procurement approach be promoted through the Construction Industry Development Board guidance, introduction of legislation and establishment of a design and build institute to promote the approach and recommend best practises.

Design and build procurement approach can be an alternative that can contribute to accelerating delivery of infrastructure construction projects in the public sector and ensure successful delivery of projects. The approach offers many advantages for accelerating delivery of infrastructure. The approach can be enhanced thereby mitigating the challenges identified. Finally, optimism for the approach in the public sector has been confirmed. From the survey undertaken, 83% of public sector officials indicated that design and build procurement approach can be an alternative that can accelerate delivery of infrastructure. Furthermore, a positive response was also received as 74% of the respondents indicated that they would like to see more projects implemented using the design and build procurement approach.

5.3 Limitation of the study

According to Phiri (2015), limitations are accepted as a common feature for any research and are presented for the benefit of outlining recommendations for future research. This research has the following limitations:

The research was confined to survey questionnaires sent through emails. No interviews were held with the public sector officials in order to obtain detail explanation for the responses provided. The original sample size was also limited to 50, this was due to time constraints in conducting research. In view of this limitation, care should be exercised in generalising these research findings.

5.4 Recommendations for future research

During the course of this research, areas of further research were identified for the benefit of enhancing the design and build procurement approach. Based on the results of this study, the first recommendation for future research would be to investigate design and build projects implemented in the public sector in order to identify best practices and areas of improvement as well as to obtain a deeper understanding of challenges faced in the projects implemented. Public sector officials can then learn of each other's experience.

Future research should also investigate the feasibility of establishing an institute for design and build in South Africa having assessed the performance of both the American and Canadian Institutes for design and build. The scope of the research project did not allow for such an exploration.

5.5 Recommendations

Based on the findings and conclusion of this research project, the following recommendations are made:

5.5.1 Mitigating identified challenges of the design and build procurement approach

Loss of control by the client

The client's loss of project control has been cited as a major challenge of the approach. The survey respondents confirmed this challenge. This is due to the fact that the relationship between the client and design-build team is substantially different than in traditional procurement approaches. A single contract with the design and build contractor impacts how the client communicates with the design professional and contractor. Early commitment to design and price transfers risk to the design-builder, giving them authority to make detailed decisions that maintain scope, budget and schedule and limiting the extent of the client's review (CPARB, 2017).

It is important that clients understand and accept the limits on their direct control of project details. The design and build contractor should always keep the clients involved at the appropriate level throughout the process. The design and build contractor should identify issues that require the client's input, present cost-effective solutions and strive to serve the client's interest. Further mechanisms should be put in place to ensure that the client is involved throughout the project.

It is recommended that project steering committees be established to provide oversight role on design and build projects. Steering committee meetings will therefore focus on the design and build team's milestones with regard to progress, document submission and review. The steering committee should comprise of senior public sector officials involved in infrastructure projects. The Progress meetings with the client's project managers should be held over and above steering committee meetings in order to discuss project details.

It is also important that communications protocols be defined in the design and build teaming agreements. Clients should define their specific requirements for communicating with the design and build team when requesting proposals from bidders. The integrated design process is key to the success of any project and works best when all of the key players are engaged in a dialogue about the project. It is therefore recommended that clients and design and build contractors strive to bring the entire leadership team from both parties together to discuss management, design, technical, cost and schedule issues in order

to take advantage of the collective knowledge and wisdom of the entire leadership team (CPARB, 2017).

Finally, to ensure that clients do not lose control of projects, it is important that both the client and the design and build contractor discuss and agree on the following before the project is handed over to the contractor:

- Design development and design review process
- Design development and design review schedules
- Critical Path Method (CPM) Schedule
- Quality Plan
- Safety Plan
- Any other plans required or specified by clients (TDOT, 2017)

Monitoring difficulties

Design progress reviews are necessary to assist clients in monitoring design and build projects. It is important that planning of design reviews be considered before appointment of the design and build contractor. It is recommended that the client's requirements for the scope and frequency of design progress reviews be defined in the request for proposal document issued to potential design and build contractors. This will enable the bidders to understand client's goals as far as monitoring of the project is concerned.

The design and build contractor should be responsible for keeping the client informed about the progress of the design completion documents and identifying variations that require the client's approval. According to CPARB (2017), effective design and build contractors make the client part of the integrated team, engaging them in a dialogue about the challenges and solutions as the documents are developed and construction is undertaken.

According to CPARB (2017), client progress reviews should focus on verifying that the design completion documents meet the requirements of the basis of design. Furthermore, the level of client review depends upon the amount of detail provided in basis of design (CPARB, 2017).

It is important that the design and build contractor submit progress reports to clients. A mechanism should be established where clients can withhold any progress payment for non-submission of these reports by the design and build contractor.

The progress report should contain the following as a minimum:

- A progress narrative (including the overall project completion percentage)
- Quality certifications
- A safety report
- A monthly Project Status CPM Schedule Update
- A Change Order status report
- A monthly subcontract report (TDOT, 2017).

Post-construction review is also essential for effective monitoring of design and build projects. A post-construction review meeting is important where all stakeholders will identify all significant project problems and make recommendations on how these problems can be avoided on future projects. A post-construction review report should therefore be prepared and presented to the project steering committee. The report shall provide recommendations on any construction process improvements and how the identified delays can be eliminated in future (TDOT, 2017).

Risks of lower than expected standards

The risk of lower than expected standard of work is often cited as a challenge of design and build procurement approach. It is recommended that clients take the responsibility of providing the required inspection and quality assurance. It is important that a quality programme be put in place. The purpose of the quality programme is to:

- Ensure that the design and build contractor provides the Department a completed Project that meets Contract requirements,
- Prevent the occurrence of design and construction non-conformances through active and effective monitoring of processes, and
- Assure that the design and build contractor manages the work such that the client has the ability to substantiate that the requirements of the contract are being met and substantiate that appropriate payments for the work are made (TDOT, 2017).

A quality plan that documents and implements the quality program should be developed by the design and build contractor. It is important that the quality plan detail how the design and build contractor will establish and operate the quality program management structure independent from design and construction, as well as documenting procedures pertaining to all aspects of the work. According to TDOT (2017), the quality plan should be established and maintained by the design and build contractor such that it provides an auditable

system that assures that the design and build team complies with contract requirements.

It is recommended that the quality plan contain the following:

- Contract responsibilities;
- Organisation of the Quality Team;
- Independence of the Project Quality Manager from the design and build production team;
- Processes, procedures and protocols the Quality Team will use to assure quality of the Project in the areas of work.

According to TDOT (2017), clients should have the right to perform quality inspections and audits of the design and build contractor's management, design, construction, and maintenance activities. Furthermore, clients should be able to inspect and audit the design and build contractor's quality management activities, the quality of materials as well as and the quality of workmanship. It is important that the project quality manager is separate and independent from the design and build contractor's project manager. It is therefore recommended that the project quality manager report directly to the responsible official in the client's employ.

For strengthening the quality assurance, it is recommended that clients insist that design and build contractors establish two key functions being the design quality management function and the construction quality management function. The design and build contractor should make provision for a design quality manager who will independently review design documents received from the design team. The design quality manager should evaluate design development processes and procedures and design documents in accordance with the submitted quality plan and should certify to the design and build contractor as well as the client that the design complies with all contract requirements.

The design and build contractor should also make provision for a construction quality manager who will oversee, manage, certify and perform construction quality management activities as specified in contract documents as well as in the design and build contractor's quality plan.

Inflexible regarding variations

From the survey undertaken, it is noted that 18% of the respondents indicated that the challenge they have with design and build approach is that it is inflexible with regard to client variations on projects. According to TDOT (2017),

variations are inherent in the nature of construction and may be necessary during the course of project construction. It has been established that the TDOT always reserve a right for requesting variations in their design and build contracts. These changes may modify, without limitation:

- Specifications and design;
- Grade and alignment;
- Cross-sections and thicknesses of courses of materials;
- Method or manner of performance of work;
- Project limits (TDOT, 2017).

It is recommended that all design and build contracts contain a changes clause, according to which the contract price may be adjusted if the parties agree to an amendment to the client's requirements for changes. It is important that a distinction be made regarding genuine variation emanating from client requirements, which is to be paid for by the client, and a change in the design solution proposed by the contractor, which is at the expense and time of the contractor, even when the change resulted from the client's request.

Appointment of client specialist contractors

The survey undertaken as part of the research project revealed that 10% of the respondents indicated that the challenge with design and build procurement approach is that it is difficult for client's specialists (nominated contractors) to participate in a design and build project. The Preferential Procurement Regulations (2017) requires subcontracting of a minimum of 30% of the value of work as pre-qualification for most public sector contracts. Furthermore, clients often desire to bring in specialist contractors (i.e. such as audio visual, laboratory equipment, special furniture and fittings etc.) for construction projects.

It is recommended that details regarding specialist work to be undertaken in projects by client contractors be made known to potential design and build bidders so that this can be factored in by the bidders when they prepare and submit proposals to clients.

5.5.2 Identified areas of design and build procurement approach enhancement

Procuring design and build services

From the survey conducted 68% of the respondents indicated that design and build procurement approach needs to be enhanced in the area of procuring the design and build contractor (34%) as well as in contracting aspects (35%) of

design and build procurement approach. According to CPARB (2017), procuring a design and build contractor involves the process for preparing for and managing the process of selecting a design and build team. This include amongst other things aligning scope, schedule and budget, preparing pre-solicitation documents, setting evaluation criteria for the selection, assembling the selection panel and requesting proposals (CPARB, 2017).

It is important that clients develop their project requirements prior to commencing the design and build procurement process in order to develop their procurement requirements which requires the following to be included in the requests for proposals:

- Performance and technical requirements as well specifications inclusive of functional and operational elements;
- Building performance goals and validation requirements;
- Gross areas of any building;
- Preliminary engineering and architectural drawings as well as the target budget of the project. (CPARB, 2017)

Pre-design studies are important in order to develop the project criteria. Predesign assists in defining the project scope in terms of client's requirements, schedule and budget. It is recommended that pre-design includes conceptual drawings that demonstrate the feasibility of the project so that they can also serve as a basis for a cost estimate which confirms the alignment of project scope and budget. According to (CPARB, 2017), the main purpose of the pre-design is to provide a solid foundation from which to commence design, it is important that the pre-design not impose constraints that cannot be altered during the design process as additional information becomes available (CPARB, 2017).

It is further recommended that where clients lack capacity, consultant teams be brought in to provide support by developing the project criteria. The appointed consultants can therefore assist by identifying the client's intent, translating the intent into documents that become part of the request for proposals (i.e. RFP) and ensuring implementation. Furthermore, the consultants can provide support on behalf of the client in meetings, on-going review of design and evaluation of completed project performance (CPARB, 2017).

Contracting for design and build services

A critical milestone is the finalising of the design and build agreement once the contractor has been appointed. According to CPARB (2017), this represents a critical point at which the project parameters are adequately fixed to allow the risk transfer from the client to the design and build contractor to take place. It only after conclusion of this agreement that the design and build team's responsibility for managing the scope, quality, budget and schedule increases as the client's responsibility and involvement in detailed project execution decreases CPARB (2017).

It is important that the design and build contractor's contract include sufficient design and construction contingencies to manage their risks which include agreeing to a price prior to completion of construction documents, errors and omissions in the design documents, unforeseen work requirements and price escalations. The amount of the contingency will depend on the project scope and complexity CPARB (2017).

DBIA (2014), considers three best practices in design and build contracting. Firstly, contracts used on design and build projects should be fair, balanced and clear, and should promote the collaborative aspects inherent in the design and build process. It is then important for contracting parties to proactively and cooperatively identify significant project-specific risks and clearly identify in the contract how such risks will be handled. Furthermore, contracts should reasonably allocate risks to the party that is best capable of addressing and mitigating the risk (DBIA, 2014).

Secondly, contract between the client and the design and build contractor should address the unique aspects of the design and build process, including expected standards of care for design services. It is therefore recommended that both FIDIC and NEC contracts be used for design and build contracts in the public sector rather than drafting bespoke contracts for projects. It is important that special clauses be incorporated in the contract, which will clearly specify the role of the client during execution of the project particularly relative to the following:

- The process for the design and build contractor reporting and communicating with the client
- The client's role in acting upon design and other required submissions by the design and build contractor
- The client's role in quality assurance and quality control

Thirdly, contracts between the design and build contractor and its team members should address the unique aspects of the design-build process. It is therefore important that clients insist on receiving subcontracting agreements between the design and build contractor and its team members. In this regard, it is critical that during the proposal phase, the design-builder should use written subcontracting or teaming agreements with each team member to develop and capture an understanding of their relationship and key commercial aspects of their relationship (DBIA, 2014).

5.5.3 Capacity to implement the design and build procurement approach

The survey results have confirmed that there is lack of information provided on design and build procurement approach within the public sector. As part of capacity building, it is important that sufficient information be disseminated to all relevant public sector officials involved in infrastructure projects. It is recommended that various summits, workshops and seminars be held in order for information to be exchanged on design and build procurement approach amongst public sector officials, educational institutions, private sector and industry experts.

The study further highlighted to a need for training on design and build procurement approach. An overwhelming 95% of the respondents indicated a need for further training. There is a further need for training on forms of contracts suitable for design and build procurement approach. It is recommended that a short course on design and build procurement approach be developed and be accredited by the relevant construction sector education and training authority. The training course can then be presented to relevant officials in all three spheres of government including parastatals and agencies.

5.5.4 Promoting the design and build procurement approach

It is recommended that the design and build procurement approach be promoted through the following mechanisms:

- Construction Industry Development Board guidance
- Introduction of provincial ordinances to promote the approach
- Establishment of an institute to promote the approach and recommend best practices.

The Construction Industry Development Board (CIDB) has a mandate to drive enhanced infrastructure delivery management, capacity improvement and contractor development in the construction industry through strategic interventions and partnerships. The CIDB has a critical role to play in promoting

and providing guidance on design and build procurement approach. The CIDB should establish standards for design and build procurement approach that promotes transparency, fairness and which encourages firms to pursue design and build opportunities thereby increasing competition.

Various States in the US have introduced legislation for regulating the use of design and build projects (DBIA, 2017). Various States considered legislation to allow design and build project delivery in order to achieve time and cost savings as well as to expand the potential for use of innovative construction technology in various projects especially on transportation projects (DBIA, 2017). The South African provincial governments could consider introducing ordinances that will promote the use of design and build procurement approach in their provinces. This could entail setting criteria and threshold values for projects to be implemented using a design and build procurement approach. It is critical that pilot programmes be undertaken and reviewed before full-scale implementation.

From the survey conducted, a total of 76% of the respondents agreed that a Design and Build Institute for South Africa is required. Such an institute could promote the use of design and build procurement approach as an alternative project delivery mechanism. Secondly, such an institute could educate the industry and support best practices for design and build procurement approach. Finally, the institute can also provide a platform for information sharing on design and build procurement approach and can in the long run work with the South African government to accredit design and build contractors. It is recommended that the Construction Industry Development Board initiate discussions amongst role players on the feasibility of establishing a design and build institute for South Africa.

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APPENDIX A: PARTICIPANT INFORMATION SHEET

Good day

My name is Nyiko Gudlhuza and I am currently studying towards a Master of Science in Engineering (Project and Construction Management) at the University of Witwatersrand. As part of the requirements to fulfill the degree, I am required to undertake a research project. My research is interested in finding out the following:

- To what extent is the design and build procurement method utilised in South Africa's public sector?
- what are the major factors limiting the use of the design and build approach in south Africa's public sector?
- can design and build approach be enhanced to address perceived challenges of the approach?
- to what extent can design and build approach as an alternative contribute to accelerating delivery of infrastructure construction projects in the public sector and ensure successful delivery of projects?

As a public sector official responsible for planning and implementing infrastructure projects, I would like to invite to participate in my research. I would like you to complete a short questionnaire which you can complete at the comfort of your office or at home. The questions contained in the questionnaire relates to your experiences regarding the implementation of infrastructure projects in the public sector. The completed questionnaire can be emailed back to myself or alternatively I could make arrangement to collect it.

Your participation is voluntary, you are not obliged to answering any question that bring discomfort. You may feel free to withdraw at any time. There are no benefits or payment offered for your participation in this study. What you say will be used for academic purposes only. Your participation is highly regarded and there are no foreseeable risks related to it. Your participation in this research is totally anonymous. I will not make a record of your name (you can choose another name/pseudonym if you like). The completed questionnaire will be stored in a password protected computer only accessible to me and no one else. When reporting the findings, I would like to quote from the completed questionnaire, but I will refer to you using a 'made-up name'.

The information gathered will be presented in a research report which will be available electronically to the Wits staff, students and other researchers on the Wits Library website. The research is solely for academic purposes, however you may feel free to request a summarized copy once completed.

Should you have any comments or clarification questions, kindly contact me at Nyiko.gudlhuza@students.wits.ac.za (cell phone number: 0768119982) or my supervisor, Professor Raymond Nkado at raynkado@mweb.co.za

Thank you for your interest.

Nyiko Gudlhuza

APPENDIX B: QUESTIONNAIRE

No.	QUESTION	TICK THE APPROPRIATE
1	What type of infrastructure projects is your organisation currently implementing?	☐ Building works ☐ Civil works ☐ Maintenance works ☐ Other type of works
2	What are the two important criteria for selecting a project delivery system according to you? PLEASE TICK A MAXIMUM OF TWO.	☐ Single point responsibility ☐ Quick project commencement ☐ Flexible design changes ☐ Guaranteed maximum price ☐ Lower contract costs ☐ More time for planning and design
3	Are you familiar with the Design and Build approach (sometimes also known as Turnkey Projects where the design and construction responsibility lies with one service provider / contractor)	☐ Yes ☐ No ☐ Not sure
4	Can you rate your knowledge of the Design and Build approach?	☐ Poor ☐ Fair ☐ Average ☐ Good ☐ Outstanding
5	Looking at the projects that your organisation has implemented over the past five years, how many projects would you say have been implemented using the Design and Build approach?	☐ 0% of projects ☐ 1-10% of projects ☐ 11-30% of projects ☐ 31-50% of projects ☐ Over 50% of projects
6	In your view what are the factors limiting the use of Design and Build approach in your organisation or in the public sector?	☐ Bureaucracy ☐ Lack of knowledge ☐ Contract difficult to manage ☐ Anticipated limited benefits ☐ Other
7	In your view what are the main challenges of implementing a design and build? PLEASE TICK A MAXIMUM OF TWO.	☐ Inflexible regarding variations ☐ Loss of control by client ☐ appointment of client specialists ☐ Risk of standards reduction ☐ Monitoring difficulties
8	From the projects that you have implemented using the Design and Build approach, what has been the outcome in terms of project/s performance?	☐ Excellent performance ☐ Good performance ☐ Average performance ☐ Poor performance ☐ Not applicable
9	From the projects that you have implemented using the Design and Build approach, what have been the challenges that you have encountered?	☐ Late completion ☐ Cost Overrun ☐ Contract management

		☐ Other ☐ None ☐ Not applicable
10.	Which is the main form of contract you using for your projects?	☐ FIDIC ☐ JBCC ☐ NEC ☐ Other
11.	Which form of contract are you familiar and comfortable with? YOU CAN TICK MORE THAN 1.	☐ FIDIC ☐ JBCC ☐ NEC ☐ Other ☐ None
12.	Do you think there is enough information provided to public sector officials regarding the Design and Build procurement method / approach	☐ Yes ☐ No ☐ Not sure
13.	Has the organisation provided any training regarding the use of Design and Build approach?	☐ Yes ☐ No ☐ Not sure
13.	Do you think more training is required to ensure project managers and procurement practitioners in your organisation are comfortable with the Design and Build approach?	☐ Yes ☐ No ☐ Not sure
14.	Do you think your organisation has sufficient capacity in terms of resources and professionals required to implement projects utilising the Design and Build approach?	☐ Yes ☐ No ☐ Not sure
15.	Do you think the Design and Build approach is a complicated approach?	☐ Yes ☐ No ☐ Not sure
16.	Do you agree that Design and Build can offer more benefits and improve projects performance in construction projects in the public sector?	☐ Yes ☐ No ☐ Not sure
17.	In which areas do you think Design and Build (D and B) can be enhanced?	☐ Procuring D and B services ☐ Contract aspects of D and B ☐ Execution of the D and B contract
18.	Would you like to see more projects being implemented utilising the Design and Build approach?	☐ Yes ☐ No ☐ Not sure
19.	Do you think Design and Build can be an alternative which can be utilised to accelerate delivery of infrastructure projects in South Africa's public sector?	☐ Yes ☐ No ☐ Not sure
20.	Do you think legislation should be enacted to promote Design and Build approach in South Africa?	☐ Yes ☐ No ☐ Not sure

21.	Do you think that the CIDB should provide more guidance in terms of Framework and Policy Documents for implementing Design and Build projects?	☐ Yes ☐ No ☐ Not sure
22.	Do you think there is a need for establishment of a Design and Build Institute in South Africa that will actively promote the Design and Build approach and contribute to education as well as the awareness of the approach?	☐ Yes ☐ No ☐ Not sure

APPENDIX C: RESEARCH ETHICAL CLEARANCE CERTIFICATE



SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING ETHICS COMMITTEE **CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)**

CLEARANCE CERTIFICATE

PROTOCOL NUMBER: CEECC-9306437V-2019

PROJECT TITLE DESIGN AND BUILD APPROACH AS AN ALTERNATIVE FOR IMPROVING PUBLIC SECTOR CONSTRUCTION PROJECTS PERFORMANCE IN SOUTH AFRICA

INVESTIGATOR Mr Name: Nyiko Gudihuza **STUDENT NUMBER:** 9306437V

SCHOOL/DEPARTMENT OF INVESTIGATOR CIVIL AND ENVIRONMENTAL ENGINEERING

DATE CONSIDERED 27 February 2019

DECISION OF THE COMMITTEE Approved unconditionally

EXPIRY DATE Date of submission of the project report

ISSUE DATE OF CERTIFICATE 27 February 2019 **CHAIRPERSON** Prof John Ndiritu

cc: Supervisor : Prof Raymod Nkado

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.

I fully understand the conditions under which I am authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.



Signature

Date 27 / 02 / 2019