

**Investigating critical factors of cost estimates
in the construction industry**

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ABSTRACT

This study aimed at investigating critical factors that project estimators must consider, before coming up with a cost estimate for a construction project. Factors that can be noted as challenges towards producing a sound estimate are continuous scope change, increase in the cost of labour and materials, and levies and cost of complying or not complying with regulations that may change before the completion of a construction project.

The study was designed to focus on previous literature in the form of textbooks and journals that deals with construction, general and cost estimates journals for investigating critical factors of cost estimates in the construction industry. The study was designed quantitatively. Therefore, professionals in the construction industry were consulted using questionnaires, to determine to which extent critical factors in the industry impacted on project cost estimates.

The major findings noted by the respondents by which cost estimates are concerned are access to the site, labour workforce, and location of the project, cost overruns, type of work method and scope changes.

The study divulged that the appointment of a project estimator, who has knowledge and understanding of the construction industry, is highly crucial. He or she should be able to visualise the magnitude, resources, time allocated on a project and should also be able to foresee financial risks associated with the running of the project and allow for necessary financial risk mitigation measures.

Keywords: Cost estimation, cost overruns, project estimator, estimating methods, critical factors, construction projects and construction industry.

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CHAPTER 1: NATURE AND SCOPE OF THE STUDY

1.1 Introduction

Cost estimation of construction projects is a very complex process requiring the consideration of numerous dynamic factors that can impact the final construction cost. This skill is not easily acquired. Proper study, training and experience are needed to become proficient in construction project cost estimation. The project estimators must consider numerous factors relating to costs before providing an estimate. One of the challenging issues of cost estimates is that, during the project cycle (from pre-implementation until final close-out), changes could and do occur that can impact the final project cost. For example, the cost of labour, material, machinery and regulations may change before construction start (Mahamid, 2015:117). However, even with these challenges of cost estimation, estimates can be made considering the prevailing conditions and costs of a related project. The critical factors in the cost estimates of construction projects relate to the unexpected rise or fall in prices of products and services. The duration of a project is one of the determining critical factors to be considered. For example, the longer the project takes to complete, the more likely it is that the original cost estimates will be exceeded, particularly when there are delays. In this example, to avoid excessive budget deficits, a project needs to be completed within the scope and on time (Azhar, 2011:241).

1.2 Background

As a critical sector of the economy and development, construction plays a key role in South Africa. Identifying factors that influence cost estimates in the construction industry will make it possible to manage projects within the predetermined project scope, time, cost and quality. The cost estimate is influenced by various factors. In construction projects, cost estimates consider various factors that affect the success of a project. The cost estimating process includes an estimated cost breakdown for project activity. These cost estimates can include labour, materials, equipment and any other direct and indirect costs and for project activities (Belniak *et al.*, 2013:90). Based on the activity, resource

and duration estimates, the cost estimates express the cost, normally in monetary amounts, of completing the work of the project. There are both physical and perceived factors that may occur during the contract or after completion thereof. The main factors in cost estimates that contribute to the value of a project include labour, land price and cost of equipment and machinery; of these, the value and price of land are considered the most important. All construction projects require land as a site where the work and the structure are set up. Cost estimate in the construction industry entails numerous considerations that revolve around pricing, schedule and design (Shabniya, 2017:380). The size and structure of a construction project also influence its cost or price. Project estimation considers a wide range of factors before laying down a cost estimate for a construction project.

The construction industry is faced with many changes that are both influenced by market forces and nature (Zavadskas *et al.*, 2014:33). For example, a strong economy, where the cost of products tends to rise, may result in a higher cost of the project. A change in weather may cause delays, and this leads to cost overruns when the price of materials rises. This rise in the cost of materials and labour leads to cost overruns for a construction project. Most of the projects in South Africa have had a negative aspect of cost rise, mainly caused by poor estimation (Love *et al.*, 2014:275).

1.3 Problem statement

The construction industry is an area that involves extensive planning, cost estimation, designing and meeting deadlines. Despite the size of the construction project, the cost estimation issue has remained a challenge to designers and project estimators (Engle & Rowan, 2014:10). The real questions that revolve around cost estimation include: what will the project duration be, how much will it cost and how will the deadline be met? Various issues play a role in the aspect of cost estimates and hinder accurate projects in terms of cost and deadlines. Mega projects in South Africa have faced similar challenges, particularly in road, stadiums and railway construction. The project estimators find it hard to pinpoint the value or costs of a project before it is started which complicates the design and schedule issue (Shane *et al.*, 2014:221). Cost estimates for a construction project

revolve around many things that must be observed before the final figure is drafted. Aspects of a change in weather, the site of the projects, the distance, the accessibility of construction materials and change in labour costs, among other units of production, make it hard to make an accurate cost estimate (Shabniya, 2017:383).

Cost estimates can include labour, materials, equipment and any other direct costs for project activities. Based on the activity resource and duration estimates, the cost estimates express the cost, normally in monetary amounts, of completing the work of the project (Hwang *et al.*, 2015:188). There are both physical and perceived factors that may appear while the project is underway or when it is completed. The challenge of cost estimates is thus a common phenomenon that affects the modern construction industry, both in South Africa and globally. Changes in the cost of labour are identified as major hindrances in cost estimation within the construction industry. The aspect of change against time is the greatest issue that makes it hard to predict the change or flow of costs during the construction period. South African projects like the 2010 World Cup issue of cost overruns in the stadium construction is just a clear example of how hard it is to pinpoint the cost of a project (Flick, 2015). Delays caused by weather and logistics are also issues that complicate cost estimates and lead to cost overruns. The value of a project is estimated with the real cost of materials against the time it takes to complete the project.

Delays tend to cause overruns as the cost of materials and labour is likely to rise. Such issues are common in the construction industry, not only in South Africa. Studies have shown that 95% of the country's projects end up in cost overruns, either caused by delays or ineffective logistic management or planning. The setting up of a cost model for a big project demands vast planning and projections that must reflect relative prices of units of production and labour. Cost overruns occur when negative aspects like delays increase in the price of labour and construction materials and these contribute to price increases (Zavadskas *et al.*, 2014:34). The cost of a construction project often goes higher during completion, and this is due to the many factors that cause price inflation. The cost of

materials or labour may rise during the construction period and this, in turn, leads to a higher cost or cost overrun.

1.4 Objective of the study

1.4.1 Main objective

To investigate critical factors that cause cost overruns in construction projects.

1.4.2 Secondary objectives

1.4.2.1 Literature objective

- To determine from literature which factors are inhibiting project cost management.
- To investigate the critical factors that influence cost estimates in general.
- To investigate the critical factors that influence cost estimates in the construction industry.
- To investigate the critical factors that could cause problems in cost estimation in the construction industry.
- To determine how the cost of labour and efficiency of the work methods chosen for a construction project influence the cost estimates in the construction industry.

1.4.2.2 Empirical objective

The empirical objective of the study was:

- To use empirical research to determine what the issues pertaining to the construction industry are.
- To identify the population for the study.
- To sample the population study group.
- To develop questionnaires based on the issues highlighted the main and secondary objectives of the study.
- To collect and analyse data.

1.4.2.3 Conclusion and recommendations

- To draw conclusions and offer recommendations on how to manage these critical factors that are affecting cost estimates

1.5 Research methodology

1.5.1 *Literature study*

With the literature study, the researcher attempted to analyse theories on cost estimates and theories on critical factors that could lead to project failures. The following sources were consulted in support of the research:

- Books.
- Journal (general) articles on the topic of cost estimates.
- Journal (construction) articles on the topic of cost estimates.
- Journal articles on the topic of critical factors of cost estimates in the construction industry.

1.5.2 *Empirical study*

- 1.5.2.1 Research design

The research design used for this study was a quantitative survey method. This was mainly chosen because it was vital to gather a lot of data within a limited timeframe.

- 1.5.2.2 Population

The study population for this study was the construction industry in South Africa. The data was gathered from role-players involved in the construction industry including government institutions, professional consulting firms and construction companies dealing with construction projects.

- 1.5.2.3 Sample

The study identified a set of three (03) key role-players in the construction industry. These identified role-players are actively involved in the day-to-day business of construction projects and consist of government officials, professional industry officials and the construction company's officials. Out of each of the three groups identified, 20 officials were selected. This added up to a total of 60 officials who formed part of the sample. Random sampling techniques were used for the study.

- 1.5.2.4 Collection of data

Questionnaires were developed based on the literature, and it comprised three sections, namely section A, which was demographic information; section B, which was the cost in the construction industry and lastly section C, which was the cost estimation in the construction industry. Questionnaires were distributed among the three identified role-players and were delivered and picked up later. Prior arrangements to deliver and collect the questionnaires were made to ensure that the respondents were met at their convenience, though this does not automatically ensure positive responses from respondents.

- 1.5.2.5 Analysis of data

Data obtained from the questionnaires were coded, organised and analysed using Version 25 of the Statistical Package for Social Sciences (IBM SPSS, 2017). Descriptive statistics such as mean, standard deviation, frequency distribution, maximum, minimum and percentages were used to describe the important features of the variables quantitatively. The findings are presented in this research paper as tables, frequencies and percentages.

1.6 Limitations of the study

The study was limited to only 60 respondents, 20 from each identified role-player. Furthermore, the study did not focus on the entire construction industry. Therefore, the

findings could not be generalised as the true reflection of the critical factors that influence cost estimates for construction projects in the construction industry.

1.7 Ethical principles

The research was conducted in an ethical manner where the interest of the participants was considered throughout. First, the consent of the participants was obtained to ensure that they understood the reason for and their role in the study. All participants provided information voluntarily. If the instance did arise where the participant believed the information could not be divulged, it was accepted, and all precautions were taken to protect the identity of the participant (Neuman & Robson, 2014). During the study, the participants could withdraw from taking part in the study if they wished to do so. The study also gathered data by ethical means by only asking questions that reflected the nature and purpose of the study. Before carrying out the study, respondents in the sample were briefed by the researcher on the importance of the study and the overall expectations. An affirmation of confidentiality was given by indicating that the information gathered was confidential and would only be used for this study (Mackey & Gass, 2015).

Completion of the questionnaires by the respondents was voluntary. The names or other means of personally identifying the respondent were avoided throughout the study, and the source of information was provided. Confidentiality of the study was also maintained, and the researcher would not expose the data gathered to unauthorised persons. The participants were also provided with a secure and comfortable environment to respond to the questions asked by the researcher. Materials needed, like pens and paper, were provided to the participants so that they could complete the questionnaires. The participants were given ample time to respond to the questions, thus maintaining the integrity of the study (Taylor *et al.*, 2015).

1.8 Summary

In this chapter, the following was discussed: introduction, background, problem statement, objectives of the study, research methodology, limitation of the study and conclusion. A concise discussion of the literature is provided in the next chapter.

CHAPTER 2: LITERATURE STUDY

2.1 Introduction

In this chapter, a review of existing literature, including previous studies of cost estimates of construction projects in the construction industry is provided. In the first section, definitions of terms and concepts are provided. In the second section, the mechanism to identify cost and different types of costing models are discussed. This is followed by a third section, which covers major aspects and factors to be considered when compiling cost estimates and lastly, in the fourth section, critical factors to be considered when compiling cost estimates are discussed.

2.2 Project cost estimation

Project cost estimation refers to the formula or tool used to come up with approximate figures in terms of the costs of a construction project. The major purpose of estimation is to determine rough figures of the amount of funds or materials needed to complete a construction project. Most project cost estimations are done about other projects and are thus not always accurate. According to Zhang *et al.* (2015:777), project cost estimation is the formula or procedure used to arrive at the approximate figures that any project may demand.

The major role of a project cost estimator is to give an average and approximate figure in terms of the costs that the construction project may demand. The project estimator arrives at the figures after comparing market prices of both materials and labour. To make the correct estimation, the project estimator compares various projects and their overall costs to that of the current market prices of the materials and labour needed. Most project estimators are people who have experience and understand all aspects of both large and small construction projects (Mumtaz & Zanetti, 2014:341).

2.3 Costing

Costing is a system of computing costs of production, like labour and materials, by allocating expenditures to various stages of a production process or different operations of a firm or company. Construction companies develop their costing based on the prevailing and likely cost of units of production, like labour and machines. Costing also involves the assigning of variables or fixed costs to property, service or any form of the product (Ramabodu & Verster, 2010). The assigning of the variable costs which are likely to vary is known as direct costing and mainly happens with firms dealing with tangible products. On the other hand, indirect costing entails the assigning of fixed costs which are those that remain the same, irrespective of the level of activity (Ball, 2014). Construction companies often make their estimates or cost forecast using direct costing, where the costs of materials or labour are likely to vary. Such a costing approach helps to create space for adjustment and cushions the service provider from adverse cost overruns or losses; for example, the change in labour supply and demand as well as labour unrest.

It is difficult to make accurate estimates on construction projects like roads, buildings or ports. The challenging issue in such construction projects is that they take a long time to complete, sometimes years or almost a decade. During this lengthy construction period of such projects, costs of materials like labour and construction products needed are likely to change (Yiw & Chan, 2013:214). In most cases, it is always wise to make a higher figure estimate above the normal cost rates, particularly for the mega projects. Costs overruns mainly occur where the estimated costs are lower than the current costs when the project is being carried out. For instance, a cost overrun on labour is brought by a rise in the cost of labour during and before the construction project is completed (Peter *et al.*, 2005:1).

Costing in construction projects is a vital element that determines the returns made by the service provider (Olawale & Sun, 2015:509). Cost overruns mainly occur when there is a significant deviation between the estimated cost and actual cost incurred during the

project cycle. Costing is used for both internal and external reporting. Internal reporting uses costing to learn about the cost operations to help monitor project cost, cost variations, project progress and project risk management. The information developed from internal reporting helps management make decisions on the pricing of a product or service (Winch, 2010). This study shows that change in weather leads to delays or additional costs above the projected estimates. Thus, the value of a project is influenced by among others weather and its changes. To avoid cost overruns, the cost estimates should always be above the prevailing market value to cushion for a likely rise during the project construction. South African construction companies also face similar issues when it comes to cost estimates. As the country tries to reach a high level of development, more mega projects are being laid down.

2.4 Cost overruns

Costs overruns mainly occur when the estimated costs are lower than the current costs when the project is being carried out. For instance, a cost overrun on labour is brought by a rise in the cost of labour during and before the construction project is completed. According to Fulford and Standing (2014:315), cost overruns are the process that occurs when the cost of the project falls far behind the real costs when the project is still underway or when it is completed.

The issue of cost overruns mainly results from the rapid rise in the cost of materials when the project is underway (Matin, 2016:1062). To prevent such price shocks, it is wise to factor in an imaginary rise margin for the predicted rise in the price of the overall production of the project. Failure to factor in the possibility of an increase in the cost estimates may lead to price shocks or overruns in the overall costing of the project (Cooke & Williams, 2013).

2.5 Typical cost associated with construction industry

2.5.1 *Material cost*

Material cost refers to the total amount of money needed to purchase materials for construction works. These costs are inclusive of all money required for the procurement of building materials. As the size of the project increases, so is the cost of materials expected to rise. Project estimators can estimate the amount of material needed and provide a projected cost estimate on how much the materials would cost for the entire project. The use of these projections plays a vital role in assessing what the project may demand and thus contributes to valuable projections. Material costs are prone to change during construction. These may be due to delays or scope change, which may lead to a rise in the cost of materials. The key to successful analysis and listing of the cost of materials is the study and understanding of the project scope (Ramabodu & Verster, 2010).

2.5.2 *Cost of labour*

Cost of labour is defined as the aggregate of all human, physical and mental effort used in the creation of goods and service (Sun & Zou, 2015). Some researchers define the cost of labour as the services performed by workers for wages, as distinguished from those rendered by entrepreneurs for profit. And lastly, in the economic field, labour is defined as a measure of the physical work done by a human being, most especially in contrast to that done by machines or by working animals (Yiw & Chan, 2013:215).

Labour costs are difficult to estimate as they are prone to change with time. It should also be factored according to its source of production, which is human labour or machinery, cost of training and extra supervision. The cost of a construction project is mainly determined by the impact of the increasing labour force. The aspect of labour as a key element in the construction industry which shapes up costs and thus its estimation is vital in the construction industry (Potts & Ankrah, 2014).

2.5.3 Cost of electricity

Electricity is defined as the energy that is fuelled by the transfer of electrons from positive and negative points within a conductor. Furthermore, as the fundamental form of energy observable in positive and negative forms that occur naturally (such as lightning) or is produced (as in a generator) and that is expressed regarding the movement and interactions of electrons. The source of electrical energy can be in on grid, off the grid (for example generators and solar energy), or hybrid; these must be taken into consideration when coming up with the cost of electricity for a construction project (Olawale & Sun, 2015:509).

Cost of electricity for construction projects is referred to as the cost that is incurred by the project in the process of producing the given task of the project to bring the project into completion. Such a cost needed to be taken into consideration and factored into the project cost by the project estimator when busy with the cost estimation of the entire project (Porwal & Hewage, 2014:204).

2.5.4 Cost of water

Water is essential in the construction industry. Although water is a vital requirement for building purposes, not all types of water can be used in the construction industry. For example, salt water is not ideal for cement mixing. Therefore, for some projects without access to suitable residential water supply, despite the availability of a large amount of water, cost of water may be high due to outsourcing of suitable water from elsewhere which shall in turn determine the cost of water depending on the overall magnitude of the project (Bassan *et al.*, 2010).

The best method to reach a favourable water cost estimate is to list down the activities that will utilise water during the construction process. The total costs should also be compared to the overall cost of the project to determine the value of how much the cost of water is. Having cost of water projections is vital to make a relatively accurate estimate (Xiong *et al.*, 2015:59).

2.5.5 Machinery cost

The use of machines tends to cut down the cost of labour. More modern projects have a higher value and quality compared to the older ones, due to the efficiency of the machines and technology. Mega South African projects have mainly utilised machinery as the key source of labour. Just like any other cost in the construction industry, machinery cost is the total expenditure of purchasing or hiring the machinery needed for the project. Machinery cost is mainly common with mega projects like roads, ports and large buildings. These projects demand a labour-intensive approach that requires the use of heavy machinery. The contractor may purchase or hire machines depending on the magnitude and expected the duration of a project (Porwal & Hewage, 2014:205).

The decision to buy or hire is also guided by the projected cost cash flow of the project and thus used in the final cost analysis to decide whether to buy or hire. Large projects have high machinery cost that amounts to a large portion of the final cost of the project. The use of machinery may be inevitable, due to the type and magnitude of the project and such a cost must be considered when preparing the cost estimation of a construction project (Wickham, 2016).

2.6 Additional costs to be considered when compiling cost estimates

The cost of construction projects varies depending on other additional cost factors required to complete the project. These additional aspects are considered when compiling cost estimates. Next, additional cost factors are discussed (Robert, 2013:215).

2.6.1 Location of the project

The location of the project refers to the place where the construction site of the project is situated. The location of a project is an additional key cost factor in the construction field, it is assessed and enables the cost estimator to come up with the cost of all related overheads which the project might require. In most cases, the location of a project is considered as the distance of the project to the source of all related resources that the project might need to get underway as well as the ease of access to the site. If a project

is in a distant location, the cost of the project overhead is usually high and thus influences the final cost estimation of the project. The location of a project is also looked at, in terms of how safe the site is (Xiong *et al.*, 2015:60).

2.6.2 Means of transport and accessibility to site

The means of transport to the site of a project refers to the mode of transport or the means of conveying the material and labour to the construction site. Distance and the accessibility to a construction site are additional cost factors that need to be factored in by the project estimator when preparing the cost estimation of the project. In most cases, the road is the most commonly used mode as it provides real-time and close accessibility to the site. Different modes of transport have varying costs, and it is the role of the project estimator to select the most cost-effective mode. The ease of access to the site also influences the mode of transport to be used. Construction projects on land mainly utilise the road as key mode of transport to reach the site. However, projects in the sea like oil rigs use both water and air transport to deliver materials and labour (Abdelgaw & Fayek, 2010:1028).

2.6.3 Distance between the construction site and sourcing of building materials

The distance between the site and the source of building materials are additional cost factors that determine the cost estimates of a project. Large distances imply huge transport costs, thus adding to the final cost of the project. To reduce the total cost of a project, the distance between the site and the sourcing of building materials must be the shortest distance possible. It is also wise to consider the ease of accessibility. The project cost estimator must take into consideration the costs related to the type of transport that will be used; the access routes be rail, roads and air and the distance that must be travelled and must be provided for in the cost estimates of the project (Koch, 2014:24).

2.6.4 Duration of the project

The duration of a project refers to the time it will take to complete a project. Depending on the magnitude and scope of the project, the time may be in months, years, or even

decades. Large projects take longer than small ones and thus have a different schedule plan (Pewdum *et al.*, 2009:544). The time factor is vital in the construction industry as it determines the accuracy and reliability of the cost estimates. Delays are common in the construction industry which may increase the duration of the project, resulting in cost overruns. Delays caused by a shortage of materials, labour or change in weather can influence the project duration and therefore also the costs (Koch, 2014:25).

2.6.5 Contingency amount provision

Contingencies are downside risk estimates that make allowance for the unknown risks associated with a project. Typically, contingencies refer to costs and are amounts that are held in reserve to deal with unforeseen circumstances (Musa *et al.*, 2011:41).

A contingency may also refer to the part of a contingency plan, which is a plan that can be enacted to mitigate project risks, such as an addition in the scope of work to be carried out. The project estimator comes up with a contingency cost allowance, in terms of a percentage.

The major purpose of putting the funds on reserve is to cushion against risks such as a change in scope of work and other unforeseen factors (Fulford & Standing, 2014:319). A case in point is where the scope of works increases and the cost estimates of the project fall far below the current costs. The contingency amounts come in to fill in the gap or the deficit in the funding and thus ensure smooth flow of the entire construction period.

The contingency amount is allowed by calculating the project estimates and the final figures where a certain percentage is set aside for cushion during construction. In most cases, the contingency amount is 10% of the final or total cost of the project. Large projects demand huge planning and fund allocation to ensure proper use of the materials (Abdul Rahman *et al.*, 2013:288).

2.6.6 Project cost escalation

Projects cost escalation allowance in construction projects relates to an amount set aside by the project estimator, to cater for project price fluctuations on labour, plant and

materials. The adjustment is done in consultation with the project owner and the project estimator to ensure that prices are market related. Prices are adjusted using a formula which provides for the needs of contractors who require an easy, agreed on escalation recovery formula method and reasonable reimbursement for price fluctuations. A workable formula method of contract price adjustment simplifies accounting procedures and generally provides for acceptable reimbursement (Devi & Jegan, 2017:271).

The project cost escalation formula cannot precisely reflect actual cost fluctuations on a contract or any element of work. It is designed to simplify adjustment procedures while providing a level of compensation accepted as fair to the employer, contractor and subcontractor.

2.7 Different types of costing models

The process of project cost estimation is central to setting up the foundation for making key decisions, taking the initiative, budgeting activities and controlling expenditure. Cost estimation models are mathematical algorithms or parametric equations used to estimate the costs of a product or services (Challal & Tkiouat, 2012:15). The results of the models are typically necessary to obtain approval to proceed and are factored into business plans, budgets and other financial planning and tracking mechanisms (Tarone *et al.*, 2013). The three types of costing models, namely the bottom-up costing model, the analogous costing model and the resources cost estimating model are discussed in the following paragraphs.

2.7.1 Bottom-up costing model

The bottom-up costing model is defined as the project management technique in which people who are going to be involved in the project actively participate in the cost estimating process. It can be described as the detailed cost estimates of a project computed by estimating the cost of every single activity in a work breakdown structure, summing the estimates and adding appropriate overheads. Lastly, the bottom-up

estimating model is a way to approximate an overall value by approximating values for smaller components and using the sum of these values in the overall cost (Bauer, 2014:10).

The approach is like the resource cost rates estimation – the difference being that material costs are also considered, and the aggregation begins from work materials going upwards to the work packages. All types of project costs, such as direct and indirect costs, are considered in this type of estimation. This model is often used for mega projects like roads or ports. Fluctuation in the cost of labour affects the cost of projects (Pinto *et al.*, 2016:616). The utilisation of machinery and technology often requires skilled workers, where the availability of the required skills could have an impact on project costs. The benefits expected from improving a cost estimate should outweigh the cost of devoting additional resources to provide a more realistic final cost estimate. The model helps to make estimates based on the size of the project and the number of materials needed.

2.7.2 Analogous estimating costing model

The analogous estimating model is based on the cost and duration of similar projects. It is a model based on the comparison of similar projects. The accuracy of this model is dependent on the access to enough quality historical data from similar projects. It is therefore regarded as the technique for estimating a variety of projects, parameters and measures. These measures include project cost, budget, scope and duration (Challal & Tkiouat, 2012:15).

Analogous estimation is dependent upon the similarity of the two projects being considered. Making the right cost estimates requires the project estimator to factor in the possibility of future changes in the project cost of labour, materials and machinery. This can be difficult cost estimates as the cost of materials and labour is dynamic. Cost overruns can result from a significant rise in the cost of materials when the project is in progress. To prevent possible price shocks, it is recommended that a margin that will accommodate possible future increase in the price of material, machinery and labour be included in the cost estimates (Zimina *et al.*, 2014:383).

2.7.3 Resource cost estimating costing model

The resource cost estimating model is described as identifying the possible quantity, cost and price of the resources required for the project. Resource cost estimation is the art of assigning value. It is also a science that makes use of a wide range of techniques to estimate the costs of activities and assets (Porwal & Hewage, 2014:209).

Depending on the need for the cost estimates, estimates can be ball-park, semi-detail or detailed. The development of accurate cost estimates can be influenced by the uniqueness of the project, resource availability and the estimator experience, skills and knowledge (Zavadskas *et al.*, 2014:37).

Resource costing also entails coming up with estimates for the materials to be used in the construction project. The costs should be drafted considering the existing market costs. For example, the cost of the building materials needs to be factored in as a key cost determiner in construction projects (Olawale & Sun, 2015:512). Cost-per-unit approach is essential in determining the costs for construction projects.

2.8 Critical factors to be considered when compiling cost estimates

Critical factors that affect the value of a project and that should be accommodated in cost estimation include work methods, weather, by-laws compliance, scope change and escalation of cost. The key critical factors impacting on project costs are discussed below.

2.8.1 Choice of work method

The choice of work method is defined as the method that is used to undertake any given task based on the scope of works, magnitude and duration of the task (Potts & Ankrah, 2014).

With the growth in technology and innovations, construction has become simple as there are different work methods that can be used in a construction project. Normally, a project will either take a labour-intensive approach or use technology, thus minimising labour

demands. Mega projects mainly utilise technology such as machines and minimise the use of labour (Peter *et al.*, 2005:7).

Productivity in construction is often broadly defined as output per labour hour. Since labour constitutes a large part of the construction cost and the number of labour hours in performing a task, construction is more susceptible to the influence of management than are materials or capital. This productivity measure is often referred to as labour productivity (in the case of labour-intensive building material, prefabrication cost and new application of the form of work can reduce the dependency on unskilled labour). However, it is important to note that labour productivity is a measure of the overall effectiveness of an operating system in utilising labour, equipment and capital to convert labour efforts into useful outputs and is not a measure of the capabilities of labour alone. For example, by investing in a piece of new equipment to perform certain tasks in construction, the output may be increased using the same number of labour hours, thus resulting in higher labour productivity (Arifa *et al.*, 2015:60).

The choice of the construction method or labour source remains a great factor in cost estimates for construction projects. To make the right or correct estimates, a project estimator must evaluate the total current costs of the method chosen. The choice of the construction method or labour source remains a great factor in cost estimates for construction projects. Therefore, to ensure the most reliable estimates, a project estimator must consider the current costs of the method chosen. Labour-intensive methods are more prone to sudden changes than machines-dependent methods. Fluctuation in the cost of labour could affect the final cost of a project and must be considered when costing (Jafari & Rodchua, 2014:222).

2.8.2 Weather

Weather is defined as the state of air and atmosphere and the temperature and other outside conditions at a time and place. Weather is described in terms of variable conditions such as temperature, humidity, wind velocity, precipitations and barometric

pressure (Kent & Becerik-Geber, 2016:815). Weather is the day-to-day temperature and precipitation, whereas climate is the term for the averaging of atmospheric conditions over longer periods, the conditions in the air-above the earth such as wind, rain, or temperature, especially at a particular time (Crissinger, 2005:20).

Weather is always unpredictable, and its impacts can affect the way the construction projects are done. Extraordinary weather conditions include a large amount of rain or snow, ice and frost and high temperatures. For example, the processing of concrete at temperatures beneath 40 degrees Celsius requires specialised methods. It makes it difficult to do certain tasks like mixing of cement, protection of formwork, controlling the dipping of concrete, and more in the project under a frosty weather condition, which need to be taken into consideration by the project estimator when busy with the cost estimates (Lopez & Love, 2014:585).

2.8.3 *By-laws compliance*

By-laws compliance cost is defined as the cost incurred because of local, provincial, national or international regulations that apply to construction projects. These include all the costs that a project incurred to ensure compliance with these regulations (Murray, 2013).

The costs of licenses and other registration documents of the project also determine the costs estimates. Most construction projects have a lengthy registration and clearance procedure which may add to costs in the final stage. The value of a project is determined by its legal and physical value, and this makes the legal documentation a critical factor in the formation of cost estimates within the construction industry (City of Cape Town, 2007).

By-laws compliance implies the act of responding and adhering legal demands from a legally instituted body or authority that seeks to regulate a certain sector. By-laws compliance in the construction industry refers to how best the project owner adheres to the municipal by-laws put in place to bring order and safety in the construction industry. The laws are usually put in place to ensure that both small and large projects meet the

required standards. Compliance to these laws also points to the value of meeting the internal costs like purchasing the right standard materials for construction. Failure to comply with the laws results in penalties or a total stop of the entire construction process (Gale *et al.*, 2013:117).

2.8.4 Scope change

Scope change is an official decision made by the project manager on request of the client to change a feature that shall expand or reduce the functionality of the final project product. In general, changing the ‘features’ may lead to a change in specification, duration, material, quality and unplanned structures that need to meet certain regulative requirements, upgrading finished works to support the changes and increased labour cost including the requirement of specialists. It is always advisable to ensure that the representative of the client signs off the agreed change of scope on behalf of the client before scope change is implemented (Hao *et al.*, 2008).

2.8.5 Preliminaries and general provision

According to the Association of South African quantity surveyors, published in August 2008, preliminaries and a general provision for construction projects refer to the cost estimation allowance that the project estimator makes for the overall cost overheads and management of the entire project, from inception to completion. Cost estimation for preliminaries and general depend widely on the type and magnitude of the proposed project to be undertaken. Therefore general specifications give the project estimator a general view of what the project needs and demands. Likewise, general specifications are vital, help in showing the view of the project and assist in better project cost estimations.

2.9 Summary

In this chapter, a concise overview of literature related to previous studies on the critical factors of cost estimates for construction projects was discussed in detail, including, typical, additional and critical factors that should be considered when compiling cost

estimates and lastly the type of costing model to be used when compiling cost estimates. The research method, data processing and analyses follow in the next chapter.

CHAPTER 3: RESEARCH METHODOLOGY AND FINDINGS

3.1 Introduction

This chapter provides a discussion of the research methodology, including the methods used in the target and sampled population. The development of the research instrument, data processing and data analyses are also discussed.

3.2 Research design

A research design alludes to the methodology or method used to gather, measure and analyse data. It also implies the relationship among variables or the structure of the problem being addressed. The research instrument used in this study is the descriptive quantitative survey, as it has many advantages and indicates the relationship that exists between variables. In the following section, both the target and sample populations used in the study are described.

3.3 Design of questionnaire

The research questionnaire is designed in line with the literature review; it shall address all the critical issues that have been identified as key factors that are contributing to cost estimates of construction projects.

3.4 Population

The population in this study was from the building environment, dealing with construction projects in government departments, professional consulting firms and construction companies in South Africa.

3.5 Sample

This study used a random selection method to enhance the reliability of the sample used as a fair reflection of all officials of the selected groups who participated in the research. All targeted respondents were included in the study. The sample for this study was

selected on the basis that each role-player had a total of 20 participants which brought the total number of participants to 60.

3.6 Collection of data

In the study, a quantitative method (in the form of a questionnaire as a data collection tool) was used to gather data. The method assisted to maximise the frame of the study and thus improved the accuracy. Under the quantitative method, the main tool for data collection is a questionnaire. In this study, questionnaires were selected because it allowed the researcher to gather more data due to its flexibility (Gast & Ledford, 2014). The study focused on assessing the various critical factors that influenced cost estimates of construction projects within the construction industry.

Questionnaires were prepared without highly technical terms to make it easy for the participants to understand the questions asked. The researcher assisted the respondents to explain the questionnaire and how to respond to questions asked, while not influencing the respondents' responses. The questionnaires were prepared and revised to ensure that they had no errors and to make it easy for the respondents to respond to the questions. The use of questionnaires gave first-hand information of the study groups and thus improved the accuracy and reliability of the data.

3.7 Data collection procedure

Sometimes the researcher was present and where some of the respondents (approximately 3 of the respondents with less than five (5) years' experience in the construction industry, about the type of costing model that they prefer when coming up with cost estimates for construction projects) didn't understand some of the questions, the researcher would explain the model, and this made it easier for respondents to answer the questionnaires.

3.8 Analysis of data

All 60 members of the sampled group returned their questionnaires. The returned questionnaires were verified, coded where necessary and then processed. In analysing

the data, descriptive statics including, mean, standard deviation, ranking and percentages were used. A concise discussion of the analyses of the results is provided in the next section.

3.9 Results

Out of the 60 questionnaires that were sent out, the researcher managed to obtain responses from the entire sample. In the analyses, the demographics profile of the respondents is discussed. This is followed by the factors as perceived by respondents that are most likely to impact on the cost of the project and the cost estimation model most favoured in the industry.

3.9.1 Survey response

3.9.2 Demographic Information (Section A)

In section A of the questionnaire, the respondents were asked to provide their demographics to capture all background information properly. This information also enhanced the reliability of the analysed information, thus drawing credible inference and findings. The background gives more information about the respondents.

3.9.2.1 Gender

The gender distribution of the respondents is provided below.

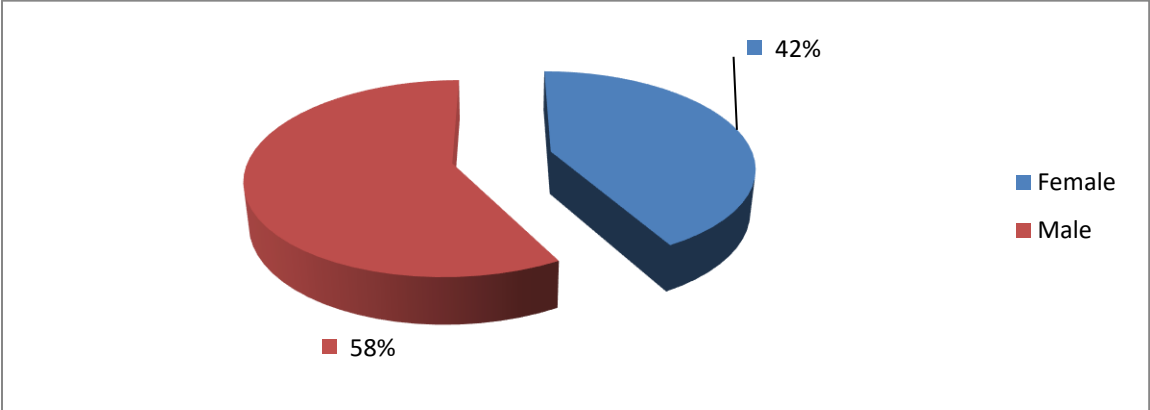


Figure 3. 1 Gender analysis

The findings show that forty-two percent (42%) of respondents were female and fifty-eight percent (58%) were male.

3.9.2.2 Level of experience in the construction industry

The level of experience of the respondents in the construction industry within the four age groups is outlined below.

Table 3. 1: Level of experience in the construction industry

	Frequency	Percent
Less than 5 years	5	8.33
5 to 10 years	10	16.6
11 to 15 years	20	33.3
Above 15 years	25	41.6
Total	60	100

- Analyses of the results

The data as presented in Table 3.1, provides the number of the respondents according to the years of experience in the construction industry. This is presented as both frequency and percentage.

According to Table 3.1, the majority (41.6%) of the respondents had worked in the construction industry for more than 15 years. 33.3% have 11 to 15 years' experience, 16.6% have 5 to 10 years' experience and 8.33% have less than five years of experience. Based on the responses, 74% of the respondents have been working in the industry for more than 10 years.

3.9.2.3 Level of education

The formal qualifications of respondents are outlined below.

Table 3. 2: Level of education

	Frequency	Percent
Matric	0	0
Certificate	0	0
Diploma	17	28.3
Degree	28	46.6
Masters	10	16.6
PhD	5	8.3
Total	60	100

- Analyses of the results

The data as presented in Table 3.2 provides the number of the respondents according to their highest formal qualification and is presented as both frequency and percentage.

The study showed that a majority (46.6%) of the respondents had a degree, 28.3% had attained a diploma education, while 16.6% had a master's education level and lastly 8.3% had a PhD. It could, therefore, be assumed that all respondents are knowledgeable about the construction industry.

3.9.2.4 Analyses of age group

The age groups of the respondents are outlined below.

Table 3. 3: Age group

	Frequency	Percent
18-30 years	15	25%
31-40 years	25	41.6%
41-50 years	20	33.3%
Above 50 years	0	0
Total	60	100

- Analyses of the results

The result of the survey is graphically represented in Figure 3.3 that compares the age group of the respondents.

The study showed that 41.6% of the respondents were aged 31 to 40 years, 33.3% were aged 41 to 50 years and 25% were aged 18 to 30 years. None of the respondents was below 18 years.

3.9.3 Cost in the construction industry (Section B)

3.9.3.1 The effect of changes in the successful completion of a project

In the context of this study, a completed project is recognised, when it is completed within project scope, time, quality and cost.

- The objective of the question (Question 1 of Questionnaires)

The objective of the question is to determine the extent to which cost fluctuation affects the successful completion of a project. The responses are provided in Table 3.4 below.

- Results: The results are presented in Table 3.4

Table 3. 4: Effect of cost fluctuation in the cost of construction projects

	Frequency	Percent
Low extent	7	11.6
Moderate extent	17	28.3
Great extent	36	60.0
Total	60	100

- Analyses of the results

The study showed that changes in the costing of the construction project influence the success and completion of projects to a great extent at 60.0%, 28.3% to a moderate

extent and 11.6% to a low extent. Therefore, based on the responses, 88.3% of the sample group perceived that cost fluctuations do have a significant influence on the successful completion of a project.

3.9.3.2 Aspects that affect the success of construction projects

- The objective of the question (Question 2 of Questionnaires)

The objective of this question was to determine the extent to which the following factors, namely: increase in the cost of materials, increase in cost of labour, increase in the duration of the project, accessibility to water and power affect the successful completion of a project. The responses are provided in Table 3.5 below.

- Results: The results are presented in Table 3.5.

Table 3. 5: Aspects influencing the success of construction projects

	Not at all	Low extent	Moderate	Major extent	Extreme
Increase in cost of materials					X (25%)
Increase in cost of labour				X (20%)	
Increase in the duration of the project				X (20%)	
Accessibility to water					X (25%)
Accessibility to power			X (10%)		

- Analyses of the results.

Based on the above responses, most of the respondents perceived that an increase in the cost of materials and accessibility to water have an extreme influence, followed by an increase in the cost of labour and an increase in the duration of the project which had a

major influence. Lastly, the accessibility to power was indicated as a moderate factor that could affect the successful completion of a project.

3.9.3.3 Availability of plant resources (movable)

- The objective of the question (Question 3 of Questionnaires)

The objective of this question was to determine the extent to which the availability of movable resources affects the successful completion of a project. The responses are provided in Table 3.6 below.

- Results: The results are presented in Table 3.6.

Table 3. 6: Availability of plant resources (movable)

	Frequency	Percent
Not at all	0	0
Low extent	8	13.3
Moderate extent	19	31.6
Extreme extent	33	55.0
Total	60	100

Analyses of the results

Based on the above responses, most of the respondents (86.6%) perceived that the availability of movable resources as a factor that could affect the successful completion of a project.

3.9.3.4 Availability of plant resources (immovable)

- The objective of the question (Question 4 of Questionnaires).

The objective of this question was to determine the extent to which the availability of immovable resources affects the successful completion of a project. The responses are provided in Table 3.7 below.

- Results: The results are presented in Table 3.7.

Table 3. 7: Availability of immovable plant resources (immovable)

	Frequency	Percent
Not at all	0	0
Low extent	12	20.0
Moderate extent	29	48.3
Extreme extent	19	31.6
Total	60	100

Analyses of the results

Based on the above responses, most of the respondents (79.9%) perceived the availability of immovable resources as a factor that could affect the successful completion of a project.

3.9.3.5 Availability of labour workforce

- The objective of the question (Question 5 of Questionnaires)

The objective of this question was to determine the extent to which the availability of labour affects the successful completion of a project. The responses are provided in Table 3.8 below.

- Results: The results are presented in table 3.8.

Table 3. 8: Availability of labour workforce

	Frequency	Percent
Little extent	7	6
Moderate extent	11	9
Great extent	26	20.9
Very great extent	79	64.2
Total	60	100

Analyses of the results

Based on the responses as outlined in Table 3.8, most of the respondents (64.2%) indicated that the availability of labour workforce influences the success of construction projects in South Africa to a very great extent, 20.9% said to a great extent, 9% said to a moderate extent while 6% of the respondents were of the view that the availability of labour workforce influences the success of construction projects in South Africa to a little extent. Based on the survey, 85% of respondent indicated that availability of labour influenced the success of the projects.

3.9.3.6 The impact of project location, accessibility to the site, accessibility to resources, means of transport and weather on the successful completion of a project

- The objective of the question (Question 6 of Questionnaires).

The objective of this question was to determine the extent to which project location, accessibility, accessibility to resources, means of transport and weather affect the successful completion of a project. The responses are provided in Table 3.9 below.

- Results: The results are presented in Table 3.9.

Table 3. 9: The extent to which factors listed impact on the resourcing and duration of the project and therefore on the successful completion of a project.

	Mean	Std. Deviation
Location of a project	4.6716	.56106
Accessibility to the site	4.5373	.63552
Means of transport to the site	2.1374	.95736
The distance between the site and the sourcing of materials	4.4925	.68253
The impact of the weather	4.1926	.68253

Analyses of the results

Based on the responses as outlined in Table 3.9, most of the respondents indicated that the location of the project, accessibility to the site and distance between the site and the source of building materials has an extreme impact, followed by the impact of weather conditions and lastly, to a moderate extent to means of transport to site.

3.9.4 Cost estimation in the construction industry (Section C)

3.9.4.1 Work method for construction projects

For this study, the following work methods are described:

- Labour only methods are methods whereby the contractor is required to supply only the labour workforce to undertake the required construction works.
- Machinery only methods are methods whereby the contractor is required to supply only the machinery plant to undertake the required construction works.
- Labour and machinery methods are methods whereby the contractor is required to supply both labour workforce and machinery plant to undertake the required construction works.
- Materials and labour methods are methods whereby the contractor is required to supply both materials and labour workforce to undertake the required construction works.

The objective of the question (Question 1 of Questionnaires)

The objective of this question was to determine the impact of various work methods on the successful completion of a project. These responses are provided in Table 3.10 below.

- Results: The results are presented in Table 3.10.

Table 3. 10: Work methods

	Frequency	Percent
Labour only	6	10.0
Machinery only	15	25.0
Labour and Machinery	19	31.6
Material supply and labour	20	33.3
Total	60	100

- Analyses of the results.

Based on the above, 33.3% identified “material supply and labour”, 31.6% identified “labour and machinery”, 25% identified “machinery” and 10% identified “the use of labour workforce only” as the work methods mostly affecting the success of construction projects in South Africa.

3.9.4.2 Aspects of cost estimates for construction projects

- The objective of the question (Question 2 of Questionnaires).

The objective of this question was to determine the extent to which selected challenges influencing cost estimation can affect the successful completion of a project. The responses are provided in Table 3.11 below.

- Results: The results are presented in Table 3.11.

Table 3. 11: Various aspects that influence cost estimates

	Mean	Std. Deviation
Labour unrest	4.4262	.54782
Increase in cost of labour	3.8441	1.06224
Increase in cost of materials	3.8113	1.10113
Not complying with applicable by-laws	4.0486	.71411
Scope change	3.0212	.846243

- Analyses of the results

Based on the above, labour unrest and non-compliance with applicable legislation have the greatest influence, followed by the increase in labour cost and cost of materials and to a moderate extent, the scope change.

3.9.4.3 Cost models for construction projects

- The objective of the question (Question 3 of Questionnaires).

The objective of this question was to determine the preferred costing models that provide the most realistic costs for the successful completion of a project. The responses are provided in Table 3.12 below.

- Results: The results are presented in Table 3.12.

Table 3. 12: Cost models for construction projects

	Frequency	Percent
Bottom-up costing	25	41.6
Analogue costing	19	31.6
Resource costing	16	26.6
Total	60	100

- Analyses of the results

Based on the above, bottom-up costing is the most preferred costing model for the construction industry. This is followed by the analogue costing model and lastly to a moderate extent by the resource costing model.

3.9.4.4 Escalation of cost within the construction industry

- The objective of the question (Question 4 of Questionnaires)

The objective of this question was to determine the extent to which cost escalations affect the successful completion of a project. The responses are provided in Table 3.13 below.

- Results: The results are presented in table 3.13.

Table 3. 13: Escalation of cost

	Frequency	Percent
Moderate extent	5	1.5
Great extent	15	28.4
Very great extent	40	70.1
Total	60	100

- Analyses of the results

Based on the above, the success of the completion of a project is affected by the escalation of cost to a very great extent (70.1%), followed by a great extent of 28,4% and lastly by a moderate extent of 1.5%.

3.10 Summary

In this chapter, a concise discussion of the research methods, sampling and design of questionnaires, data analyses and processing were provided. This was followed by concise analyses of the results. The following chapter provides a summary of the analysed results, a conclusion and recommendations to address the identified gap in the cost estimation for construction projects.

CHAPTER 4: CONCLUSION AND RECOMMENDATIONS

4.1 Introduction

This chapter concludes the study where critical assumptions are made based on the analyses of literature, research methods and data analyses and finally, recommendations for future research are provided. The recommendations section is one area of the chapter as it identifies shortcomings in the present research and areas that need to be addressed to provide an effective costing model for construction projects.

4.2 Analysis and conclusion

The study makes the following summative conclusion based on the variables analysed to see critical factors influencing cost estimates of construction projects within the South African construction industry.

4.2.1 *Demographics*

There were sixty (60) respondents who participated by answering questionnaires. Most of the respondents were well educated, older and had more than ten (10) years' experience in the construction industry. It could, therefore, be assumed that the information provided was a fair reflection of factors influencing the cost estimation of construction projects within the South African construction industry.

4.2.2 *Cost in the construction industry*

The literature on chapter two presented various factors that needed to be considered when compiling cost estimates, whereas the empirical study in chapter three presented the actual factors that constituted to cost estimates for construction projects. Based on the above, the following critical factors need to be considered by project estimators:

4.2.2.1 Accessibility to site

The literature has outlined that most of the construction projects on land mainly utilise roads as a mode of transport to reach the site, where most of the respondents perceived access to the site as a major factor that contributes to the cost estimates.

4.2.2.2 Accessibility to water

From the literature, it could be deduced that water has been outlined to be one of the core factors that needed to get the construction project undergoing. The literature furthermore indicated clearly that not all types of water can be used for construction purposes and that suitable water needs to be sourced based on the type of construction work to be done. Most of the respondents identified access to water as the most critical cost driver

4.2.2.3 Availability to plant machinery

The use of machinery for a construction project has been outlined by literature as the modern way of executing construction projects, depending on the type and magnitude of the project. The analysis of data shows that most respondents are in favour of the use of machinery, which shows the impact the availability of plant machinery has on the successful completion of the project.

4.2.2.4 Availability to labour workforce

The literature review highlights that the cost of the labour workforce must be aligned to the source of production. The respondents indicated that the unavailability of the correct labour workforce would affect the project negatively.

4.2.2.5 Cost overruns

The literature review highlights that cost overruns occur when the cost of the project increases far beyond the project's actual costs. In the analysis, the respondents also noted that the increase in the cost of labour and materials (critical factors towards

completion of a project) has major implications towards the successful completion of a project.

4.2.2.6 Preliminaries and general provision

From the literature, the preliminaries and general provision are the cost of overheads and the management of the entire project which are also dependent on the magnitude of the project. The preliminary and general costs are directly in line with the project duration. The respondents indicated that the increase in the duration of the project is of a major extent.

4.2.3 Cost estimation in the construction industry

Chapter two presented various critical factors that needed to be considered when compiling cost estimates, whereas the empirical study in Chapter three presented the actual factors that constitute to cost estimates for construction projects. Based on the above, the following critical factors need to be considered by project estimators:

4.2.3.1 Type of work method

The literature has outlined different types of work methods, depending on the type of work to be done. Most of the respondents perceived the supply of material and labour to be the most preferred work method for cost estimation and successful completion of construction works.

4.2.3.2 Compliance with applicable by-laws

Literature has outlined that, for a construction project to come into existence, it must pass through certain by-laws and a compliance process, for which there are costs associated when undertaking such a process.

4.2.3.3 Scope changes

Literature has described scope changes as an official decision made by project owners to change certain features of the project which may lead to change in the project specification, duration and cost. Most of the respondents outlined scope changes as one of the critical factors of cost estimates.

4.2.3.4 Type of costing models

From the literature, different types of costing models were outlined, whereby each costing model was discussed in detail. Based on the analyses of the results, most respondents indicated that the bottom-up costing model is the most preferred method for cost estimation for construction projects.

4.2.3.5 Cost escalation

A literature review has outlined that escalation of costs for construction projects occur due to different factors. It can be because of project duration, an increase in the cost of materials and labour. Based on the analysed data, most respondents deemed escalation of cost as one of the critical factors.

4.2.3.6 Project estimator

The literature has indicated that a project estimator provides fairly accurate costs (Material, labour and plant) required for the implementation of construction projects.

4.2.3.7 Contingency amount provision

The literature review states that contingency allowance is an amount set aside to mitigate the project risk associated with unforeseen project deviations. The analysis indicated that the effect of a change in the costing of construction projects is of great importance. The results support the need for the project estimator to make an adequate contingency amount provision to minimise the excessive change in the overall cost of the project.

4.3 Conclusion

Based on the literature and empirical survey results it is imperative that the project estimator must provide for the following conclusion in respect of critical factors identified.

4.3.1 Cost in the construction industry

4.3.1.1 Accessibility to site

The literature study and the results from the survey indicate the fact that project estimators may need to investigate making adequate allowance, to cater for all factors that are site related.

4.3.1.2 Accessibility to water

It is concluded that without access to water, a construction project cannot function properly and thus construction activities progress may suffer and may result in a lengthy period to complete such a project

4.3.1.3 Availability to plant machinery

It is concluded that the use of plant machinery is the preferred method of project execution, the methods might costly but is deemed effective.

4.3.1.4 Availability of labour workforce

It is concluded that labour workforce plays a vital role in the successful implementation of a project, where in the absence of labour workforce or inadequate labour workforce the project may incur time and cost overrun.

4.3.1.5 Cost overruns

The ideal process where cost estimates are concerned is that the project must be completed within a financially acceptable deviation from the estimated project cost while remaining in the targeted scope and quality.

4.3.1.6 Preliminaries and general provision

It has been noted that an increase in the duration of the project results in an increase of preliminary and general costs.

4.3.2 Cost estimation in the construction industry

4.3.2.1 Compliance with applicable by-laws

It is concluded that in a case where there is non-compliance of applicable by-laws it may lead to a lengthy period to complete the project which in turn may result in a cost overrun.

4.3.2.2 Scope changes

It is concluded that scope changes cannot be avoided in a project since these are complex and vary in magnitude and scope of works.

4.3.2.3 Type of costing models

It has been concluded that the bottom-up costing model is the most preferred costing model. Therefore It is vital for the estimator to have the ability to align preferred costing model to the proposed construction work so that it provides the estimator with the most accurate estimates for projects.

4.3.2.4 Cost escalations

It is concluded that cost escalation in a project cannot be avoided since it is purely based on inflation.

4.3.2.5 Project estimators

Project estimators have been identified as the key personnel where project estimates preparations are concerned. They play a vital role in ensuring that all the aspects (labour, plant, materials etc.) required to complete a project are correctly budgeted for. He/she needs to have the ability to do risk matrix about project cost, for him/her to put adequate

risk mitigation elements in place. The lack of a qualified and experienced project estimator on its own poses a risk for a project not being properly budgeted for and be completed within the allocated project cost.

4.3.2.6 Contingency amount provision

It is concluded that it is vital for the project estimator to make provision for a contingency amount to be included in the overall cost estimation of the project, which shall cater for any unforeseen circumstances which may arise during the project.

4.4 Recommendations on how cost estimates can be improved in the construction industry

This study aimed to investigate critical factors that influence cost estimates in the construction industry. The analysis substantiates that, indeed there are challenges in the construction industry relating to cost estimation. The following are listed as recommendations to address the identified gap:

4.4.1 Cost in the construction industry

4.4.1.1 Accessibility to site

It is therefore recommended that in a project costing allowance is made for the following factors:

- Non site based factors
 - ✓ Mode of materials transportation for delivery to site
 - ✓ To determine the primary of materials whether local or international
- Site based factors
 - ✓ To make adequate provision for all site-based personnel
 - ✓ To make adequate provision for site office and related operating resources

4.4.1.2 Accessibility to water

Estimating the amount of water needed in a project might be challenging but to avoid underestimating cost about water needed in a project, it is recommended that project estimators make use of historical data to check the availability of water where the project is based and further assist in determining the quality of such available water. This shall assist the project estimator to make proper cost allowances, where there is less available water and where the quality of water is of unacceptable quality.

4.4.1.3 Availability to labour workforce

It is recommended that the project estimator needs to pay attention to the following:

- ✓ To properly align the labour workforce with the correct tasks.
- ✓ To make provision for labour workforce training.
- ✓ To make provision in case a project experience delay.

4.4.1.4 Availability to plant machinery

It is recommended that the project estimator to assess the nature of the project, which shall guide him/her on the type and size of machinery needed for coming up with realistic cost estimates of the project.

4.4.1.5 Cost overruns

It is recommended that to avoid cost overruns; the project estimator needs to work closely with the project owner who understands what the scope of work entails. Proper identification of scope supports preparation of more realistic cost estimates. This will lead to projects being completed within cost, time and quality. If a project gets completed within time, it eliminates additional costs relating to preliminary and general costs. Therefore, this implies that, whenever the project estimator embarks on preparing an estimate, he/she will need to bring a balance on the cost at the commencement of the project and throughout the project duration, by preparing a realistic estimate in line with the scope, time and quality.

4.4.1.6 Preliminaries and general provision

It is recommended that the project estimator, undertakes the planning and costing needed to cover the project scope fully. The project estimator also needs to allocate enough time frames to allow the project to be implemented within the specified time frame to avoid an increase of time related factors.

4.4.2 Cost estimation in the construction industry

4.4.2.1 Compliance with applicable by-laws

It is recommended that it is necessary for a project estimator to have an in-depth knowledge of all the required by-laws and compliances needed for a project to come into existence and to factor such cost into the overall cost estimates.

4.4.2.2 Scope changes

It is recommended that the project estimator needs to consider making a provision to cater for unforeseen circumstances, where there is a need for scope change, all relevant stakeholders need to agree and sign off such a change request. This will minimise scope creeps, which may result in cost overruns.

4.4.2.3 Type of costing models

It is recommended that the project estimator familiarise him/herself with various cost estimates that revolve around the choice of costing models to be chosen when busy with costing of the project, in order to align each costing model to the proposed project to be undertaken, since different projects require different costing models and this shall enable project estimators in producing proper realistic sound cost estimates.

4.4.2.4 Cost escalations

It is recommended that the project estimator ensures that project cost escalation is factored-in into cost estimates of the construction projects, to cater for project cost

inflation (labour, time, material and plant), that may arise during the project lifecycle. It is therefore critical that project estimators make provision for cost escalation in project cost estimates.

4.4.2.5 Project estimators

It is recommended that:

- Estimators must have the ability to work under pressure.
- Estimators need to have an interest in market related prices and financial viability for the construction industry.
- Estimators need to be inquisitive about the construction industry market conditions and newly used construction methods.
- Estimators need to have a good, high level of accuracy in cost estimates.
- Estimators need to have qualifications and skills, to enable them to pay attention to details, it is important for estimators to involve themselves in continuous professional development regularly.
- Estimators need to be allocated enough time to complete cost estimation processes.
- Estimators need to be provided with enough information in terms of designs, stakeholder's needs, site related information and more during the cost estimation process.
- Estimators need to possess a high level of experience and skills in cost estimation for construction projects.
- Development of good communication mechanisms between project stakeholders and project estimator.
- Estimators need to make provision for enough contingency amount allowance, to cover for any unforeseen circumstances that may arise during the project lifecycle.
- There is a need for project estimators to start a process and put structures in place, whereby actual construction costs are compared with estimated costs, to inform the estimator of his or her performance during the estimating phase.

4.4.2.6 Contingency amount provision

It is recommended that the project estimator makes an adequate provision of contingency amount in line with the scope and magnitude of the proposed project to be undertaken.

4.5 Recommendations on future studies on cost estimation in the construction industry

- What are the pitfalls to consider during cost estimation?
- The need to develop a model for the successful completion of construction projects.
- The need for continual professional training, particularly on aspects of cost estimates.
- Involvement of clients and all stakeholders in the project, from inception to completion.

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Appendix A - Questionnaires

INVESTIGATION OF CRITICAL FACTORS OF COST ESTIMATES IN THE CONSTRUCTION INDUSTRY

The purpose of this questionnaire is to collect data for purely academic purposes. All information will be treated with strict confidence. Do not put any name or identification on this questionnaire.

Answer all questions as indicated by either filling in the blank or ticking the option that applies.

SECTION A: DEMOGRAPHIC INFORMATION

SECTION A: Background Information (Please tick (√) appropriate answer)

1) Please indicate your gender:

Female	<input type="checkbox"/>	Male	<input type="checkbox"/>
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2) For how long have you been working in the South African construction industry?

Less than 5 years	<input type="checkbox"/>	5 to 10 years	<input type="checkbox"/>	11 to 15 years	<input type="checkbox"/>	Above 15 years	<input type="checkbox"/>
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3) State your highest level of education.

Matric	<input type="checkbox"/>	Certificate	<input type="checkbox"/>	Diploma	<input type="checkbox"/>	Degree	<input type="checkbox"/>	Masters	<input type="checkbox"/>	PhD	<input type="checkbox"/>
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4) Please indicate your age bracket.

18 to 30 years		31 to 40 years		41 to 50 years		Above 50 years	
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5) What type of organisation do you represent?

Government institution		Professional consulting firm		Construction company	
------------------------	--	------------------------------	--	----------------------	--

Other? (Please specify):

SECTION B: COSTS IN THE CONSTRUCTION INDUSTRY

1) To what extent does changes in costing of a construction project affect the completion and success of the project?

Not at all		Low extent		Moderate extent		Major extent		Extreme extent	
------------	--	------------	--	-----------------	--	--------------	--	----------------	--

2) To what extent do the following aspects affect the success of construction projects in South Africa?

	Not at all	Low extent	Moderate	Major extent	Extreme
Increase in cost of materials					
Increase in cost of labour					
Increase in the duration of the project					
Accessibility to water					
Accessibility to power					

3) To what extent does the availability of machinery (Movable) affect the completion and success of construction projects in your area?

Not at all		Low extent	Moderate extent		Major extent		Extreme extent	
------------	--	------------	-----------------	--	--------------	--	----------------	--

4) To what extent does the availability of resources Plant (Immovable) affect the completion and success of construction projects in your area?

Not at all		Low extent	Moderate extent		Major extent		Extreme extent	
------------	--	------------	-----------------	--	--------------	--	----------------	--

5) To what extent does the availability of labour workforce affect the completion and success of construction projects in your area?

Not at all		Low extent	Moderate extent		Major extent		Extreme extent	
------------	--	------------	-----------------	--	--------------	--	----------------	--

6) To what extent do the following aspects affect the time and resources spent in a construction project?

	Not at all	Low extent	Moderate	Major	Extreme
Location of a project					
Accessibility to the site					
Means of transport to the site					

Distance between the site and the sourcing of materials					
The impact of the weather					

SECTION C: COST ESTIMATION IN THE CONSTRUCTION INDUSTRY

1) In terms of choosing the best work method in the construction industry, choose one of the followings:

Labour only		Machinery only		Labour and machinery		Material supply and labour	
-------------	--	----------------	--	----------------------	--	----------------------------	--

2) To what extent do the following challenges influence cost estimate in the construction industry?

	Not at all	Low extent	Moderate	Major	Very great
Labour unrest					
Increase in cost of labour					
Increase in cost of materials					
Not complying with applicable by-laws					
Scope change					

3) Which costing model do you prefer in coming up with the project cost estimate?

Bottom-up cost estimate		Analogue cost estimate		Resource cost estimate	
-------------------------	--	------------------------	--	------------------------	--

4) To what extent does escalation of cost within the construction industry affect the rate of growth in construction?

Not at all		Low extent		Moderate extent		Great extent		Very great extent	
------------	--	------------	--	-----------------	--	--------------	--	-------------------	--

Appendix B – Title registration



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02 June 2017

Dear Mr Vukeya

REGISTRATION OF TITLE

At the recent Faculty Board meeting, the faculty of **Economic and Management Sciences** approved your title as follows:

Investigating critical factors of cost estimates in the construction industry

The abovementioned title may under **no circumstances** be changed without consulting your supervisor/promoter and obtaining the approval from the Faculty Board.

Should you wish to submit for examination, please inform your supervisor. If you intend on not submitting, please submit the Notice of not submitting form. The form is available at the M & D department or the administrative manager of the faculty.

Dates of submission of copies for examination:

- 1 April 2017 to 30 April 2017 to qualify for the September/October 2017 graduation ceremony
- 1 October 2017 to 31 October 2017 for the May 2018 graduation ceremony

Should you neglect to submit by 30 October 2017, the possibility exists that you will not qualify to graduate in May 2018. You will then be required to register again for 2018 to qualify for the next graduation ceremony in September/October 2018.

Your attention is drawn to the following publications / web addresses:

- A Rules:
http://www.nwu.ac.za/sites/www.nwu.ac.za/files/files/i-governance-management/policy/7P-Arules2015_e_1.pdf
- Manual for Postgraduate Studies:
<http://www.nwu.ac.za/sites/www.nwu.ac.za/files/files/i-research-support/Manuals/ICRI/2016-04-06%20ICRI%20Manual%20for%20M%20and%20D%20students.pdf>

We wish you a pleasant and successful period of study.

Yours sincerely

Ms N Pretorius
FOR CAMPUS REGISTRAR

Original details: (1051217) C:\Users\10512187\Desktop\Title registration.docm
9 March 2015

File reference: 7.1.11.1

Appendix C – Language and Technical editing letter



Dynamic Language &
Translation Specialists

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language@dlts.co.za
CC No: 1995/017794/23

Saturday, 23 June 2018

To whom it may concern,

Re: Letter of confirmation of language editing

The dissertation **Investigating critical factors of cost estimates in the construction industry** by **ML Vukeya** (25806610) was language edited. The referencing and sources adhere to NWU guidelines. Final corrections remain the responsibility of the author.

Antoinette Bisschoff

Officially approved language editor of the NWU (since 1998) and UKZN (2018)
Member of SA Translators Institute (no. 100181)

Precision ... to the last letter

Appendix D – Solemn Declaration and Permission to Submit



Higher Degrees Administration

SOLEMN DECLARATION AND PERMISSION TO SUBMIT

1. Solemn declaration by student

I, **MIYELANI LARS VUKEYA**

declare herewith that the thesis/dissertation/mini-dissertation/article entitled (**exactly as registered/approved title**),

INVESTIGATING CRITICAL FACTORS OF COST ESTIMATES IN THE CONSTRUCTION INDUSTRY

which I herewith submit to the North-West University is in compliance/partial compliance with the requirements set for the degree:

MASTERS OF BUSINESS ADMINISTRATION

is my own work, has been text-edited in accordance with the requirements and has not already been submitted to any other university.

LATE SUBMISSION: If a thesis/dissertation/mini-dissertation/article of a student is submitted after the deadline for submission, the period available for examination is limited. No guarantee can therefore be given that (should the examiner reports be positive) the degree will be conferred at the next applicable graduation ceremony. It may also imply that the student would have to re-register for the following academic year.

Signature of Student **Mr Lars Vukeya** University Number **25808610**

Digitally signed by Mr Lars Vukeya
Date: 2018.06.26
09:33:56 +02'00'

Signed on this **20** day of **June** of 20 **18**

2. Permission to submit and solemn declaration by supervisor/promoter

The undersigned declares that the thesis/dissertation/mini-dissertation complies with the specifications set out by the NWU and that:

- the student is hereby granted permission to submit his/her mini-dissertation/ dissertation/thesis:
 Yes No
- that the student's work has been checked by me for plagiarism (by making use of TurnItIn software for example) and a satisfactory report has been obtained:
 Yes No

Signature of Supervisor/Promoter

Prof AM Smit
Digitally signed by Prof AM Smit
DN: cn=Prof AM Smit, o=NWU,
ou=Business School,
email=asmit@nwu.ac.za, c=ZA
Date: 2018.06.21 09:57:02 +02'00'

Date

21/06/2018

Original details: Mefelje Ackermann(10512187) R/Ssupport doc's/SOLEMN DECLARATION AND PERMISSION TO SUBMIT.docx 28 July 2017

File reference: 7.1.11.3.2/3