

**PROCUREMENT GUIDELINES FOR PROJECT SUCCESS IN
COST PLANNING OF CONSTRUCTION PROJECTS**

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APPROVAL

The thesis of Molusiwa Stephan Ramabodu is approved by

Signed: Date:

Dr. M.M. Campbell (Study Leader)

DECLARATION

I, Molusiwa Stephan Ramabodu, declare that:

The thesis that I hereby submit for the degree Philosophiae Doctor (PhD) at the University of the Free State is my own work and that I have not previously submitted it at another academic institution.

I furthermore cede copyright of the thesis in favour of the University of the Free State.

Signed: Date:

Molusiwa Stephan Ramabodu (1997249667)

SYNOPSIS

A number of factors contribute to cost overruns and delays in projects, some within the control of the project team, most of them not. These cost overruns and delays lead to additional costs and loss of productivity on work sites because of time lost. These factors are also not limited to certain regions, but occur in similar projects across the globe. Optimism bias and strategic misrepresentation are identified as the main causes of cost overruns in construction projects, estimates and costs. While the estimation process for this type of project is very complicated, certain techniques have been developed to assess risk and to plan for contingency for these types of problems.

This is significant because the cost performance of construction projects is a key success criterion for project sponsors, since construction projects are notorious for running over budget. The concept of cost contingency, estimates, cost overruns, procurement, risk management and value management will be dominant in this study.

The aim of this study is to propose a project flow chart model. When followed correctly, this model can reduce the risk of project overrun from the cost plan point of view. The results of the research indicate that the estimator must have the experience and skill to be able to produce accurate estimates. A model is proposed to guide the estimators on what to do before they can start with the estimating process.

Key words: Cost overruns, estimates, skill, experience, cost plans.

OPSOMMING

'n Aantal faktore dra tot koste-oorskrydings en vertragings van projekte by, sommige binne die beheer van die projekspan, die meeste nie. Hierdie koste-oorskrydings en vertragings lei tot bykomende kostes en verlies aan produktiwiteit op werkterreine weens tyd wat verlore gaan. Hierdie faktore is ook nie tot sekere streke beperk nie, maar kom regoor die wêreld by soortgelyke projekte voor. Optimistiese partydigheid en strategiese wanvoorstelling word as die hoofoorsake van koste-oorskrydings by konstruksieprojekte, beramings en kostes geïdentifiseer. Terwyl die beramingsproses vir hierdie soort projek baie ingewikkeld is, is sekere tegnieke ontwikkel om die risiko te evalueer en te beplan vir hierdie tipe probleme vir gebeurlikheid.

Dit is betekenisvol omdat die kosteprestasie van konstruksieprojekte vir projekborge 'n kernkriterium vir sukses is, aangesien konstruksieprojekte berug is dat hulle begrotings oorskry. Die begrippe, kostegebeurlikheid, beramings, koste-oorskrydings, verkryging, risikobestuur en waardebestuur, sal die oorheersende faktore in hierdie studie wees.

Die doel van hierdie ondersoek is om 'n projekvloekaart-model voor te stel. Wanneer dit korrek gevolg word, kan hierdie model die risiko van projekoorskryding ten opsigte van die kosteplan verlaag. Die resultate van die navorsing dui aan dat die beramer ervare en vaardig moet wees om akkurate beramings te maak. 'n Model word voorgestel om die beramers te lei ter voorbereiding van die beramingsproses.

Sleutelwoorde: Koste-oorskrydings, beramings, vaardigheid, ervaring, kosteplanne.

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PART1: CHAPTER 1

RESEARCH PROPOSAL

1.1 Title

Procurement guidelines for project success in cost planning of construction projects

1.2 Introduction

Various studies have indicated that cost overruns are part of the life cycle of construction projects. These overruns differ greatly from project to project and are influenced by various factors. While they are seen as a norm in modern project management, they may cause friction between clients and project stakeholders if not managed and planned for properly and can lead to great financial loss or even project failure in the event of non-contingency. Considering the great financial implications of construction projects, cost estimation and cost overruns have become a focus point in the field of construction project management and studies are ongoing into this phenomenon.

The process of cost estimation is not an exact calculation. Instead, a number of fixed and hypothetical costs and costs arising from situations are taken into account and used as a template for the total cost of the project. In determining these costs, the factors affecting the total sums can range from social to political to natural, i.e. environmental conditions and events.

1.3 Problem statement

Cost and time overruns in project scheduling are problems that are often experienced in construction projects. While there is no clear way of avoiding cost overruns, proper planning and estimating can decrease the chances of these

overruns occurring, thereby contributing to project stability. As with risk, there is an element of probability in the occurrence of cost overruns. Delays in projects cause time overrun and these can affect not only current projects, but future projects as well, as time constraints and adjusted deadlines affect their implementation

1.4 Research questions

1.4.1 The following five research questions will be posed:

- 1.4.1.1 What are the pitfalls quantity surveyors should avoid during initial estimating?
- 1.4.1.2 How can project cost estimates be improved?
- 1.4.1.3 Can taking the profile of the estimator into account improve project cost estimate?
- 1.4.1.4 Which cost estimating factor will contribute to project success?
- 1.4.1.5 How can a procurement system be customised to yield project success?

1.5 Hypotheses

1.5.1 The following five hypotheses will be posed:

- 1.5.1.1 Adequate or sufficient provision for contingencies is a major pitfall to be considered during cost estimating.
- 1.5.1.2 Sound knowledge, experience and adequate consideration of market conditions can improve project cost estimates.
- 1.5.1.3 Major factors for successful projects are allowing adequate time in preparing initial cost estimate with good level of accuracy to minimise the risk of cost overruns.
- 1.5.1.4 Contractors perform poorly because they take on too much work and plan badly.
- 1.5.1.5 Selecting the correct procurement method is a major factor for a successful project.

1.6 Limitations

The study does not attempt to analyse existing cost planning techniques, but is limited to improving on existing techniques and researching external factors affecting cost-planning tools.

The thesis will furthermore include a casestudy on school projects, which will be limited to schools completed in the Free State province of South Africa. This will be addressed by sending out questionnaires to construction professional firms within the Free State province.

1.7 Acronyms

The following acronyms are used in the study:

9MP	Ninth Malaysian Plan
AACE ¹	Association for the Advancement of Cost Engineering
AACE	American Association of Civil Engineers
ANNs	Artificial Neural Networks
APRAM	Advanced Programmatic Risk Analysis Management Model
AS/NZS4360 1999	Australian/New Zealand Standard
ASAQS	Association of South African Quantity Surveyors
BBBEEA	Broad Based Black Economic Empowerment Act
BoQs	Bills of Quantities
CALM	Contingency Allocation and Management Model
CBS	Cost Breakdown Structure
CIB	Conseil International du Bâtiment
CII	Construction Industry Institute
CIOB	Chartered Institute of Building
CM	Contract Manager
CPM	Critical Path Method
CTS	Contingency Tracking System

D&C	Design and Construction
DBM	Driver-based Monte Carlo
DCI	Design Changes by Improvements
DCO	Design Changes Originated by Owner
DCP	Design changes initiated by a professional
DTI (dti)	Department of Trade and Industry, South Africa
EEA	Employment Equity Act
ERA	Estimating using Risk Analysis
ETA	Event or Probability Tree Analysis
EV	Expected value
FAA	Federal Aviation Administration
FIFA	Federation of International Football Association
FSH	Fiona Stanley Hospital
FTA	Federal Transit Administration
GDP	Growth Domestic Product
GIFA	Gross Internal Floor Area
HDI	Historically disadvantaged individual
ICT	Information and Communication Technology
IIM	Integrity Institute of Malaysia
IPA	Independent Project Analysis
IRR	Internal Rate of Return
ITF	Industrial Training Fund
JCT	Joint Contractor Tribunal
KPMG	Klynveld Peat Marwick Goerdeler
LCC	Life Cycle Cost
LEED	Leadership in Energy and Environmental Design
MARA	Malaysia
MERA	Multiple Estimating using Risk Analysis
MRR2	Middle Road Ring Two
MCS	Monte Carlo Simulation
NDDC	The need for adoption of project management strategy

NEDO	National Economic Department Organisation
NPV	Net Present Value
NSW	New South Wales
OR Tambo	Oliver Tambo (Airport)
OGC	Office of Government and Commerce
OLS	Ordinary least-square
PDRI	Project Development Rating Index
PERT	Programme Evaluation and Review Technique
PF	Probability of Failure
PIREM	Principal Item Ratios Estimating Method
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PPPFA	Preferential Procurement Policy Framework Act
PPPs	Public-Private Partnerships
QS	Quantity Surveyor
RBE	Risk-Based Estimating
RCF	Reference Class Forecasting
RDP	Reconstruction and Development Programme
RIBA	Royal Institute of British Architects
RICS	Royal Institution of Chartered Surveyors
ROCKS	Road Cost Knowledge System
RP	Risk Profile
SACQSP	South African Council for Quantity Surveying Profession
SCEA	Society of Cost Estimating and Analysis
SMART	Simple Multi-Attribute Rating Technique
SMMEs	Small, medium and micro enterprises
SPSS	Statistical Program for the Social sciences
SVM	Soft Value Management
ToR	Terms of Reference
UK	United Kingdom
USA	United States of America

USGBC	United States Green Building Council
VM	Value Management
WBS	Work Breakdown Structure
WTO GPA	World Trade Organisation Government Procurement Agreement

1.8 Methodology

The methodology followed was to acquire valid support for the hypotheses through an in depth review of the literature that interprets and discuss current knowledge on the subject matter, followed by empirical research to test these theories.

Two case studies were also used to contribute to this study, The first case study dealt with estimating problems on schools projects in the Free State and the second one dealt with procurement irregularities, which contribute to projects failures or project exceeding their initial budget.

Research was also collected by distributing and interpreting questionnaire received from construction participants.

1.9 Literature review

The literature review attempts to analyse theories on cost planning and procurement theories that lead to project failures and the following sources were consulted in support of the research:

- Books
- Journal articles
- Dissertations and theses

1.10 Assumptions

Some construction projects experience significant cost overrun and this is caused by internal and external factors such as design, brief, unsuitable method of procurement, economic problems, political factors and time and risk.

1.11 Significance of the study

The aim of this study is to develop a model that will determine factors contributing the most to cost overruns on construction projects, and how these cost overruns can be minimised in future projects.

1.12 Framework of study

Part 1: Introduction to the study

Chapter 1: Research proposal

Part 2: Literature review

Chapter 2: Clients in construction

In Chapter 2, a comprehensive overview regarding the role and functions of the construction client will be presented.

Chapter 3: The quantity surveyor in the built environment

In Chapter 3, the roles and competencies of the quantity surveyor will be investigated, both from an ethical and practical point of view.

Chapter 4: Estimates

In Chapter 4, accuracy of estimates will be reviewed, mainly because estimation is one of the key skills of the quantity surveyor as it is at the heart of the initial financial planning phase of the construction project.

Chapter 5: Risk management for contingencies

In Chapter 5, risk management tools will be examined for the accurate contingency allocation.

Chapter 6: Contingency allowance in estimate

In Chapter 6, the allowance for contingencies will be reviewed. This review will be done based on a number of methods used to calculate contingency for construction projects.

Chapter 7: Cost overruns and performance

In Chapter 7, cost overruns are examined.

Chapter 8: Procurement

In Chapter 8, procurement are investigated, including unethical behaviour in the procurement process.

Chapter 9: Management of a construction project

In Chapter 9, a review on management of construction projects will be investigated.

Part 3:

Chapter 10: Case study on schools projects in the Free State Province

In Chapter 10, a case study on comparison of schools projects in the Free State Province regarding estimates, contract sums and final accounts will be reviewed.

Chapter 11: Case study in procurement irregularities

In Chapter 11, a second case study in procurement irregularities in South Africa will be reviewed.

Chapter 12: Empirical study

In Chapter 12, the empirical data will be analysed to determine findings on the role of the quantity surveyors during estimating, determining appropriate procurement method, managing cost and allocating appropriate contingencyies during estimating.

Part 4:

Chapter 13: Summary of study, finding and conculsion

In Chapter 13, the literature review and the empirical data will be compared to construct deductions, leading to findings and conclusions.

Chapter 14: Proposed project flow chart model

In Chapter 14, a flow chart model in project estimate management and procurement will be proposed, which may assist in reducing project cost overruns.

1.13 Conclusion

This chapter highlights the problem statements related to the aim of this study, examines the hypotheses for and limitations to the scope of the study and serves as an introduction to the following chapters and the main subject of the study. There are a number of reasons and factors causing projects overruns and while these are not universal, a number of them share definite similarities.

The next chapter focuses on the role of the construction clients in the planning process and how their actions may or may not lead to cost overruns in a construction project as well as focus on the various aspects of cost and cost management in a project.

PART 2: CHAPTER 2

CLIENTS IN CONSTRUCTION

2.1 Introduction

Clients procure construction works for strategic reasons that can be defined broadly in terms of the client's ultimate use of the facility on completion. The strategic nature of construction raises two pertinent issues, namely, the manner in which construction works are procured and the measures applied to determine project success. In essence, all activities related to the process of procurement should be informed, structured and carried out in a manner designed to meet or enhance those objectives strategic to the needs of the construction client. Typically, this would include all the procurement activities, from the evaluation of environmental conditions affecting delivery up to operational use. Consequently, any measure of project performance ought to be tied to the strategic outcome required by the construction client: in terms of the investment/business case, the product, and desired organisational and stakeholder outcomes.

Since few construction clients possess either the expertise or capacity to undertake building projects on their own, they typically engage external service providers (i.e. architects, engineers, management consultants, constructors and building suppliers) to deliver the building assets they require. For most clients the activity of building is a complementary or residual activity, and hence there is no economic case for them to retain these skills in order to carry on their primary business activities.

To engage the service providers, construction clients require contracts – not only to ensure full and adequate performance by the service providers on whom they depend, but also to provide a degree of certainty that the strategic objectives of the transaction are met in a controlled way. The contract thus assumes a pivotal role as a means towards these ends. It is therefore imperative that the contract's

philosophy, structure and parameters are consistent with the adopted procurement approach to deliver the necessary control over supply chain resources, the manner in which the project will be managed and controlled, and with the choice of criteria selected to measure project success at completion.

Construction contracts have evolved into standard contract forms, not only because of their advantages of familiarity and the prohibitive cost of customisation, but also to provide certainty on the nature of the transaction between parties on a project-specific basis (Masterman, 1997); in effect, to minimise transaction costs.

Fellows (1989) is very critical of this development, arguing that the practice is outmoded and that its practice has contributed significantly to many of the construction industry's recent and current difficulties, subsequently highlighted by Latham (1993, 1994). The development of these contract forms reflects the building industry's perspective. Terms and conditions are the product of an exclusive dialogue between building trade organisations and the built environment professions. The result is a compromise of beliefs between these parties to form a fair and equitable balance of risk and power in the contract terms. The business needs of the construction client, therefore, are very much a secondary consideration (Cox & Thompson, 1998). Whilst the client may accept this arrangement in order to gain the benefits of the reduced transaction costs within the construction project, the downside is that any resulting agreement between the contracting project, the downside of a "free" commercial negotiation only in a very narrow sense (Root, 2001) and the client, is limited in his ability to exercise any direct or meaningful control over the way the process is organised. However, these established contracting practices have come under sustained pressure as clients have started to exert pressure on the industry to better serve their needs (Egan, 1998) and have begun to look to their own sectors for innovative procurement practices (Root et al., 1999).

2.2 Strategic objectives of construction clients

The traditional criteria for determining a project's success are evident in the 'golden triangle' of time, cost and quality (refer, for example, to Project Management Institute, (PMI, 2000). The argument here is that the criteria apply primarily to the work of the project and are defined solely from the point of view of the contractor. They address neither the wider issues of the investment and business case, nor the vested interest of stakeholders, which is related to the performance of the building.

Based on the research undertaken in the United Kingdom between the 1960s and the 1980s, Turner (1993) distills a more complete set of criteria for performance measurement in construction. He therefore proposes the following set of project success criteria:

- It achieves the stated business purpose;
- It provides satisfactory benefit to the owner;
- It satisfies the needs of the owner, users and stakeholders;
- It meets its pre-stated objectives to produce the facility;
- The facility is produced to specification, within budget and on time; and,
- The project satisfies the needs of the project team and supporters.

Having proposed a more complete set of pro forma criteria, Turner (1993) makes a number of important observations on their nature and utility:

- Most of the criteria are subjective, with only time and cost being objective;
- The judgement is affected by the assessor's cover objectives; and
- The measures are not necessarily compatible, so judgement depends on a complex balance. They are not mutually exclusive, so it is possible to satisfy them together.

The measures are not judged simultaneously. They, therefore, cannot be forced to be compatible at the end of the project. For example, it is unlikely that the first two

measures will be assessed fully until sometime after commissioning and the product is in use.

Similarly, Bowen (1993) contends that the degree of client satisfaction revolves around two types of criteria: subjective criteria (for example aspirations, aesthetics, quality, value of money) and objective criteria (for example timescales, construction techniques and price).

This measurement of project success should define the strategy for project performance measurement, should also characterise the structure and process of planning, organising and control for each project phase, and should be the measure applied on completion to determine the extent to which the strategic objectives of the investment/business case have been met.

2.3 Construction clients

Construction clients are the initiators of projects and those who contract with other parties for the supply of construction goods and services (Atkin & Flanagan, 1995). In Sweden, the definition of a construction client is formulated in the Swedish *Planning and Building Act* (PBL, 1995), as a party who carries out or assigns others to carry out construction or demolition of land work. The Swedish Construction Clients' Forum (2006) has expanded this definition to include the following: The construction client is also responsible for interpreting and translating the user's needs, expectations and desires into requirements and prerequisites for the construction project based on society's need for a sustainable built environment.

The construction client is thus not just the person who pays for the construction, the client is also the bridge between the 'stakeholders' – all the people who have an interest in the final output from the project, as users, owners, financiers, 'the

public', etc. – and the people who will design and construct it – the architects, engineers, contractors, suppliers, etc. (Courtney, 2008).

2.3.1 Understanding the construction client

Client's role

The way construction clients perceive their role will affect their decisions in the early stage of the building process (Courtney, 2008). Construction clients can be divided into three main categories: the terms “users”, “managers” and “seller clients” are often used. A user client is a company, for example with a requirement for industrial or office space, who uses buildings for purposes where great flexibility is necessary, but where ownership of the property is not required. The manager client is involved in a long-term operation, managing housing, office premises or various types of facilities. A seller client (or developer) has a business concept that involves selling off the property as soon as the construction is complete to another owner, for example a building society (Vennström, 2008). Public construction clients can be regarded as manager clients whereby the main orientation is to develop facilities for public use, such as schools and libraries. The client creates the limits for how they think and proceed in the construction process and they relate their decisions to their own organisation's responsibility towards the society (Vennström, 2008).

The public construction client has an important role to play in the change and development of a community and society. A construction project can thus be seen as a national economic driver (Boyd & Chinyio, 2006). The construction client needs to understand the entire quality chain covering all decisions and activities leading to customer satisfaction. This approach combines the “right project” (building, installation, function) with the “right process” – “right” meaning what the customer wants in every link in the chain. In managing the citizens' needs and desires, the public client has to make decisions about the citizens' opinions of how a municipality should invest tax payers money and what kind of activities have to

be performed in a new public building (Swedish Construction Clients Forum, 2006). A cultural building project, as an example, is thus also about the building itself.

Stakeholders, strategic briefs and the client

End-users' functional and technical requirements are much more technically advanced today and put a new kind of pressure on the client, designer, developer and contractor in the different construction phases of a cultural construction project. The development and formulation of end-users' requirements are in general an activity performed by the architect, with a focus on the users' activities within the building and the building's expression in the public environment. When building a public cultural house, the challenge is not only to satisfy the users working in the building, but also end-users visiting the building and citizens who may have other interests in the building. With different stakeholders' aims and goals, the project performance and the building performance may be different. A successful construction project is not *per se* a successful building. On the other hand, an overdrawn construction project may eventually be a loved and useful building for its end-users.

According to Lindahl and Ryd (2007), the strategic brief involves the identification of the different stakeholders' aims and goals. All the players in the strategic part of the briefing process are responsible for adopting the operation's overall goals, developing them and realising them in the best possible way in the individual project. Olander (2007) discusses the impact of stakeholder influence on the construction project and, according to Olander and Landin (2008), there is a natural tendency for stakeholder groups to try to influence the implementation of construction projects in line with their individual concerns and needs. It is therefore important to identify the aims and goals of 'stakeholders'.

In starting a construction project, the public construction client has a purpose or meaning with the building leading to a realisation, i.e. the actual outcome of the adopted means may be quite different from the abstract end for which the means

were adopted in the first place. Boyd and Chinyio (2006) argue that both means and ends connect to an organisational value system and that value is not only identified with money in the industry today. Values are what clients and the industry use to make decisions and to take actions. Values determine what we think of as good and bad and tend to have a bipolar character, i.e. every good value has an opposite bad value, which can change, depending on circumstances. People and organisations determine their objectives based on their values, search for suitable solutions, evaluate these solutions and finally make a choice (Boyd & Chinyio, 2006).

Spencer & Winch (2002) suggests that an integrated project team that collaborates, achieves the best possible solution in terms of design, environmental performance and sustainable development. Furthermore Spencer & Winch (2002) suggests that an integrated perspective on construction briefings should create balanced and on-going synergies between the construction sector's production demand and the clients' and end-users' operational demands.

Clients' needs

The recognition that clients are the core of the construction process reveals the importance of achieving their satisfaction (Bennett et al., 1988; Kamara et al., 2000; Latham, 1994). Two objectives have to be met in order to achieve client satisfaction. Firstly, the translation of client needs into a design which specifies technical characteristics, functional performance criteria and quality standards and secondly, the completion of the project within a specified time and in the most cost-effective manner (Bowen et al., 1999). Clients are most likely to be satisfied when the final product matches or exceeds their expectations (Ahmed & Kangari, 1995; Hudson, 1999). Smith and Wyatt (1998) state that the early stages in the development of a project are crucial to its success. This is because the significant decisions made during these early stages influence the characteristics and form of the project. Once these decisions have been made by their very nature, they cannot be readily deleted or dramatically changed in subsequent stages.

Changing the project brief after it has been established, and, in particular at later stages, has an impact on project cost, time and quality. Late changes to the brief are globally considered a major source of dispute and litigation throughout the construction industry (CIC, 1994; Kubal, 1994; O'Brien, 1998; Veenendaal, 1998). In an endeavour to eliminate brief changes during the construction process, the Royal Institute of British Architects (RIBA) Plan of Work, updated and approved by the RIBA Council in 1998, freezes the modification of the project brief after the detailed proposal stage (RIBA, 2000). This is not reflected in practice, however. Emerging client requirements, the construction industry's fragmented nature, long investment terms, risk exposure, time consumption and a myriad of other internal and external influences may urge client organisations and construction professionals to change what was established at earlier stages.

2.4 Management of cost

The basic goals of cost management and the pricing of a project or product relate to the link between price and intrinsic value, affordability in relation to needs or investment, and managing the procurement process. Cost managers (cost planners) should therefore understand that they need to work with clients (investors) from the very inception of a project, even earlier, and then throughout the process to ensure the best results. This does not mean that a cost planner or cost manager is a "cost cutter" (Ferry & Brandon, 1991).

Sound investment has proved its value, been a safeguard against ill fortune, produced income, provided security and shown itself to be a way of producing wealth (Nel, 1992). Using funds to the best effect will improve these benefits even further. The cost manager needs to understand that the type of construction required for a building will also influence the performance of the building over time, including the functional performance of the users' environment (Mole, cited in Venmore-Rowland, Brandon and Mole, 1991).

Ashworth (1994) proposes that the emphasis should always be on securing developments that best satisfy the criteria identified by the developer (client) at inception, including the type, scale, standards, funding, cost and timing of a project. Different tasks need to be performed by different people involved in respect of design, cost, forecasting, planning, organising, motivating, as well as controlling and co-ordinating the management functions (Ashworth, 1994). The cost managers should be continuously involved from the design to the co-ordination and auditing, to ensure best cost results, specifically in commercial property, where investment is required to yield the best financial returns. Other areas of cost management that need attention are cash flow, the timing of payments, interest rates and the availability of funds at specific times. These aspects also influence the total financial outlay and eventual returns on a property investment.

Kenley (2003) stresses the potential value of improved and strategic cash flow to enhance the profitability of the construction industry, with the further potential to offer reduced costs to the client and improved contractor performance. Cash-flow forecasts and management should therefore be part of the cost manager's service to ensure that the developers receive the full benefit of proactive attention. The cost manager's (quantity surveyor's) involvement must go beyond a reactive service. It should also include a service that takes the following aspects of value into account:

Physical: a quality building

Psychological: a pleasant looking building which is good to live in, "places of the soul"

Real quality: cost effective but with specifications that fit the purpose

Durability: taking life cycle costs and whole-life costs into account

Design: design-to-cost, cost design and appearance

Affordability: budget and returns are important

Timelessness: short-term fashions as opposed to design that will withstand the pressures of current whims

Although cost management may be seen as an obvious and simple process, in reality it is not. All aspects associated with a project have a direct impact on costing and how it is managed (Knipe et al., 2002). The quantity surveyor is ideally placed to manage this complex process. If the methods are followed diligently and the tools used effectively, cost management may produce exceptional results.

2.4.1 Design-to-cost (cost design)

This process is based on design, aimed at satisfying the parameters dictated by cost, cost of acquisitions operation and management. The process may also be described as cost design, where such design is defined as designing a project in economic terms, taking into account the cost and cost benefit of each element of the project in an effort to balance the interrelationship of all cost elements and the reason for its existence (Knipe et al., 2002; Verster & Berry, 2005).

2.4.2 Cost planning

Cost planning is used to ensure that, in the early stages of project, the developer knows what the anticipated final cost of the total development may be, including the cost of land, legal issues, demolitions, buildings, professionals, furniture, connections, tax, financing and management. Building cost is only one of these items, but the quantity surveyor or cost manager should include all costs in the cost plan or estimate of final cost. The cost planner should have a clear understanding of cost and budget targets to enable him to advise the developer about possible future overruns and proactively provide alternative solutions (Ferry & Brandon, 1991). One of the most effective tools that the quantity surveyor uses to assist with the planning and design process, is the elemental cost plan. The theory behind the analysis of building costs per element is that the total cost is a sum of the cost of individual “so-called” elements such as walls, roofs, foundations, etc. (Morton & Jaggar, 1995). A complete system of cost planning must comprise cost planning

and control during the design process as well as the construction procurement stage. During the design stage, the system includes finalising the brief, investigating solutions and developing the design (Ferry & Brandon, 1991).

The model for cost plans, endorsed by the Association of South African Quantity Surveyors (ASAQS, 1998), includes ten sections and 68 elements. The ten sections are:

- Primary elements
- Special installations
- Alterations
- External works and services
- Training
- Preliminaries
- Contractor's fee
- Contingency allowances
- Escalation
- Value added tax

The primary elements of the structure of a building are the following: foundations, ground floor construction, structural frame, independent structural components, external envelope, roofs, internal divisions, partition floor finishes, internal wall finishes, ceilings and soft fits, fittings, electrical installation, internal plumbing, fire services, balustrading and miscellaneous items (Association of South African Quantity Surveyors (ASAQS), 1998).

Effective cost advice will place the client in a position where strategic budgeting can be performed based on sound knowledge of all influences (Knipe et al., 2002). According to Knipe et al. (2002) the estimating process should add to a more comprehensive understanding of all benefits and associated costs.

2.4.3 Cost control

Linked to auditing, cost control is an activity aimed not only at reactive reporting of decision results, but also at accounting for the decisions and visions of the client and advising the client on how best to achieve desired outcomes (Knipe et al., 2002). Cost control occurs throughout the deployment process, from the briefing stage to completion. Benefits are derived during all stages including the briefing, sketch plan, approved sketch plan, production drawing, receipt of tenders, and construction stages (Ferry & Brandon, 1991).

2.4.4 Cost checking

This process is necessary to ensure that the client is always informed about the actual performance of the building in cost terms in relation to the budget or cost plan. The actual cost of each element or section of the building as the detailed designs are developed, is checked against the cost target or cost plan, or specific elements in the cost plan (Seeley, 1983). Cost checking is a continuous process and should be an important element of proactive cost management.

2.4.5 Cost analysis

Cost analysis supports the quantity surveyor's service to the client and can provide the quantity surveyor with useful cost information and data. Three forms of cost analysis are identified by Ashworth (1994), namely

- Identification of major cost items;
- Analysis of the annual user cost of building ownership; and
- Identification of those groups of items (elements) of cost importance.

The identification, analysis and comparison of costs and items, as well as element-related costs, enable the quantity surveyor to assist the developer and designer in

investigating more cost-effective alternatives, enabling them to deliver a project that yields the best results.

2.4.6 Cost-benefit analysis

The aim of cost-benefit analysis is to establish the real benefit of expenditure, not only in financial terms, but also in terms of time and energy expended by human resources and the social benefits (Ferry & Brandon, 1991), or in the words of Ashworth (1994: 60), "... to evaluate the economics of costs incurred with the benefits achieved".

Although this technique is largely discredited, it still provides support to evaluate aspects, which have a monetary value, while intangibles, such as social benefits are merely assessed and shown separately to be decided on in objective terms (Ferry & Brandon, 1991).

2.4.7 Whole-life appraisal (life cycle costing)

Life cycle costing, also known as "cost-in-use", describes the modelling technique aimed at coping with the mixture of capital and running costs of buildings and the effect on ownership of a building. This technique does not only analyse the effect of using different materials, finishes and equipment over time, but also investigates running cost in terms of water, energy, maintenance, electricity, heating, etc. It also takes the future value of money into account (Ferry & Brandon, 1991). The quantity surveyor must be very sensitive to the influence of all cost factors so that the client receives advice that is practically applicable, timeous and effective. In respect of whole-life appraisal, it is important to remember that the result should be value for money that will flow from giving full consideration to maintenance aspects and possible future costs at the design stage (Seeley, 1983).

2.4.8 Cost reporting

The quantity surveyor should ensure that continuous, accurate cost information, analysis, cost results and cost influences are reported to the client and design team. The report must be based on sound information and data, ensuring continuous proactive action and effective management of the whole process.

The effective implementation of the above tools, techniques or methods should result in a better product at a better price (or cost), with lower maintenance cost and an increased return potential over a longer period. The quantity surveyor is the cost expert on the development team; indeed, he is the usual source of price information and should always be a viable source of critical information (Harvard, 2002).

To be most effective, the services of a quantity surveyor should be used proactively from the earliest stage to the final stage of a project. Of all resources, money is probably one of the most limited, and the challenge is to use this resource optimally. The quantity surveyor is ideally positioned to continuously play an active role, but should also become more involved in strategic decisions to empower clients even further.

2.5 Conclusion

Clients of construction projects are becoming increasingly involved in the projects that they procure from construction companies and, against this background, a comprehensive look is needed at their roles and functions in the construction project life cycle. Large projects are contracted out to third parties who have the experience and expertise that the client lacks and with these contracts, both parties have a responsibility to ensure that goals and objectives are clearly set out. The client's involvement is not limited to "looking over the contractor's shoulder", but active participation in the processes of the running project such as cost

management and decision making. The quantity surveyor plays a key role in all these processes.

The next chapter investigates the functions and duties of the quantity surveyor in the construction project life cycle.

CHAPTER 3

THE QUANTITY SURVEYOR IN THE BUILT ENVIRONMENT

3.1 Introduction

The quantity surveyor plays an important role in the construction project lifecycle and has a number of duties that require certain competencies to be fulfilled, from both an ethical and practical perspective. These competencies and general skill as a quantity surveyor varies in age groups and experience in the profession. Various committees and standardisation organisations are in place to regulate the standards that practitioners in the profession adhere to, which is currently going through a period of rapid transformation on a global scale. This transformation occurs across social, political, gender and ethnic backgrounds, which contributes to diversity in the field as well as to the principles of equality. Quantity surveyors are central to the cost estimation process and work with the construction agency as well as the client who puts them in a precarious leadership position as far as the financial aspects of the project are concerned.

3.2 Quantity surveyor in the built environment

3.2.1 Surveying and built environment

Despite quantity surveyors' traditional expertise in feasibility and viability appraisal of construction investments; drafting, compilation and documentation of construction contracts; preparation and subsequent analysis of construction contract bids, quotes or tenders; contractor selection advice and financial management of all construction works; and allied reporting, including auditing, cost planning, cost indexing etc., they are also very relevant in construction project management, value management, facilities management, management contracting, construction dispute resolution and research consultancy (Seeley, 1983; Nkado, 2000). Interestingly, quantity surveying practice is gaining more relevance in asset management, project management, taxation, law, insurance,

banking and manufacturing, especially oil and gas (Yakub, 2005). The profession yet still needs much publicity (Poon, 2004b; RICS, 2000) through enterprising packaging and marketing of an attractive image of professionalism; not only technicalities but in ethical discipline. Traditional ideals of quantity surveying practice and professional conduct have been challenged by recent social, political and technological changes (Fan et al., 2003). It is inevitable that, as the profession rapidly expands in relevance and demand within and outside construction, there is the need to sustain the growth as it changes with time and demand proliferation with an enterprising service attitude and the right mind of professional indemnity through the duty of care to sustain productivity exclusively in the industry.

Professional ethics justifies the acceptability of abstract standards of behaviour against practical tasks, not exclusively limited to technologies, transactions, activities, pursuits and assessment of institutions, but includes more practical conceptualisation and public expectations in the interest of responsibilities, willingness to service the public and astute competencies (Fan et al., 2003; Carey & Doherty, 1968; HKEDC, 1996; Chalkey, 1990; Poon, 2004a). As requisite responsibilities increase and the professionals produced by academic and professional establishments proliferate, there is the need to sustain the maintenance of public trust and confidence in quantity surveying professional practices of both the new entrants and old generation practitioners, the duo, of whose professional perceptions are always dichotomous. Conduct of practitioners has to be correlated with intentions, means and ends of constituent members in relation to perception instinct and variables such as self, employer/company clients, superiors, colleagues, family and general public (Poon, 2004b).

For instance, new entrants, junior, technician, graduate and associate members with minimal professional exposure differ in technical and ethical perceptions compared to more experienced senior members with higher academic and professional qualifications and experience, especially during systemic dilemma and economic recessionary periods. This may be as a result of different academic

exposures and backgrounds, length of time in professional practice, age and the cumulative exposure of quantity surveyors to systemic challenges, position in organisation hierarchy as it affects corporate decision making, instinct and so on (Fan et al., 2003). Furthermore, (Carroll 1978, cited in Alfred, 2007) adds economic influence through contingent rewards and organisational policies while Nyaw and Ng (1994) believe that the nature and role of professionals in an establishment's business may affect their professional disposition to ethical discipline and conscientiousness.

As challenges and ubiquitous demands expand with new entrants of quantity surveying practice professing different goals, it may be difficult to hold them under serious legal obligation to uphold ethical practices. This is because they may not be recognised as members of professional bodies until they are duly examined and registered, which may not be a mandatory requisition to operate within their delimited scope. Also, except in exceptional cases, academic establishments are not so keen in monitoring the ethical conducts of their products out of school. Available educational facilities are set up to produce more technical skills in graduates than the ethical aspect (Fan et al., 2003). Overall, it has also been difficult for professional bodies to track down incidences of professional misconduct because there are no incentives or reward either by government or professional bodies to recognise or applaud practitioners' desire or attempts to challenge serious ethical confrontations. There have been various scholarly attempts to define ethical conceptualisations and the routinisation of their application to demystify what constitutes professional misconduct and the corresponding effects on the image of professionalism in the sensitive roles of quantity surveyors in the construction industry. Vee and Skitmore (2003) and Tranfield and Gleadle (2003), cited in Alfred, (2007) studied ethical dilemmas of construction managers. Fan et al. (2003) studied factors affecting ethical perceptions and decision instincts of construction administrators. Poon (2004 a & b) also examines the relationship between behavioural or professional ethics in quantity surveying, construction management and project performance. Although, Badger and Gay (1996) believe

in personal ethics whereby everybody is treated with the same level of sincerity, Borkowski and Ugras (1992) opine that the ethical perception of quantity surveyors can be affected by some demographic variables, which are likely to cause intrinsic conflict of interest between practitioners operating in the identified variables. This include age, position in organisation, education level, nature of business and nature of assignment in business in relation to strictly guided employment conditions and gender.

It is possible to considerably identify professional misconduct and where to attribute them in the ethically polarised cadres of quantity surveyors. Ferrell and Weaver (1978) identified negative tendencies like quantity surveyors' frequent temptation to provide trade secrets in exchange for unscrupulous inducements, compromise to dispense professional service with a very low level of honesty, especially when faced with competency challenges traceable to negligence and stern denial of fault. Also common is the tendency to exaggerate services provided to deceive clients into paying more than necessary. There are reported cases where quantity surveyors, employed to protect client's interest, connive with greedy contractors to defraud the unsuspecting clients (McDonald & Zepp, 1988).

Notorious quantity surveyors also frequently falsify reports to favour selfish interests without considering the professional implications and employers' ambition. They also conceal systemic errors to justify negligence, 'adapt' trade/contract figures for unprofessional reasons or compromise to pressure inducement or express threats to deter professional opinions and standards. Because of quantity surveyors' ubiquitous relevance in construction cost management, they are more prone to 'conscience auction' through undeserving bribes, inducements and gifts, most particularly during site visitation and valuation at the inception of construction, such that the erudition of the professional responsibility is fouled and pocketed at the "payer's" will. There have also been reports of abuse of office especially in cases like misappropriating organisation or official time and resources for personal use (Dubinsky et al., 1980), spend longer

time on a job than envisaged (Ferrell & Weaver, 1978) and exhibit indolence at work (Albratt et al., 1992). Dolecheck and Dolecheck (1987) further add the tendencies to compromise personal standards or professional principles to fulfil employer's demand at the expense of the client or the public at large. Apart from vices identified from literature, experience shows that some consultant quantity surveyors can stoop as low as to change tender figures for contractors in order to win client's interest, especially under a lowest bid atmosphere where contractor selection is driven subjectively by a price/data only paradigm. There are also cases where allegations were made of releasing very delicate and confidential contract secrets, while a good number of client's quantity surveyors engage in bid pricing for candidate contractors. From latent records, it is predictable that professional bodies in some countries may be politicised in future to rail or indict members unjustly, in which case the professional body is hired or pressurised to dent the image of members aspiring in bigger politics. Judicial procedures have been powerless in many similar circumstances in some developing countries at the expense of consultant quantity surveyors, while others refuse to whistle-blow the defaults of corrupt senior executives perpetrating illegal deals with contractors.

3.3 Competencies of a quantity surveyor

3.3.1 Competencies in professional quantity surveyors

Stewart and Hamlin (1992) define competency as that which a person who works in a given occupational area should be able to do. Holmes and Joyce (1993) view competency as the description of an action, behaviour or outcome which a person should be able to demonstrate, or the ability to transfer skills and knowledge to new situations within the occupational area. Meyer and Semark (1996) describe competence as the demonstration of an integration of knowledge, skill, personal attributes and value orientation.

The quantity surveying profession faces threats to its traditional roles and functions as a result of changing client needs in the construction industry, advances in technology and the particular needs of a developing economy (Matzdorf et al., 1997; National Economic Development Office, 1985). Brandon (1990) suggests that a justification for a study of the competencies required by quantity surveyors, is the ability of the quantity surveying profession to meet differing and changing client needs and that the base to grow the market for quantity surveying services, would depend on the knowledge base of the profession. Prokesch (1997) advocates that building and leveraging knowledge is the key to success in this age of globalisation while Male (1990) opines that knowledge is an important power base for professions in general.

The profession's continuing relevance and growth could require enhancing its knowledge domain so that it can rapidly move into new areas of service as opportunities arise. At the same time, it should be prepared to move away from old methods when technology and competition make them redundant. Competent quantity surveyors must have a range of skills, knowledge and understanding which can be applied in a range of contexts and organisations (Hassal et al., 1996). Yet pressing issues confronting the quantity surveying profession today include increasing the relevance and level of awareness of the profession's services in the built environment and increasing the range of business opportunities for continued growth. These issues may be addressed by a competency-based review of the profession (Mole et al., 1993).

3.3.2 Perspectives on quantity surveying competencies

The Royal Institution of Chartered Surveyors (RICS) (1971) and Male (1990) emphasise that the distinctive competencies or skills of the quantity surveyor are associated with measurement and valuation which provide the basis for the proper cost management of the construction project in the context of forecasting, analysing, planning, controlling and accounting. Leveson (1996) indicates that

quantity surveying competencies lie in the financial and contractual control of the building project, but advises quantity surveyors to pay attention to developing soft skills.

According to Hassal et al. (1996) the process of professionalisation demands that a profession should take responsibility for a prescribed body of knowledge by first defining the substantive field of knowledge that the professional should command and secondly the process of applying that knowledge. Willis et al. (1994) have described that body of knowledge of the quantity surveyor as incorporating the services of: preliminary cost advice; cost planning including investment appraisal, life cycle costing and value analysis; procurement and tendering procedures; contract documentation; evaluation of tenders; cash-flow forecasting, financial reporting and interim payments; final accounting and the settlement of contractual disputes; cost advice during use by the client; project management; and specialist services.

The Royal Institution of Chartered Surveyors RICS (1998) sets out the requirements and competencies for the assessment of professional competence by listing the competencies required of quantity surveyors in three categories: basic competencies, core competencies and optional competencies. The basic competencies are common to all construction professions under the RICS structure (land surveying, building surveying, etc.); the core competencies are uniquely required of quantity surveyors while the optional competencies reflect areas of specialisation or future career diversification.

The Educational Advisory Committee and the Educational Standards Committee of the South African Council for Quantity Surveying Profession (SACQSP) agreed on ten outcomes of an accredited quantity surveying tertiary educational programme at a two-day workshop held in Port Elizabeth during September 1999. These outcomes were seen as domiciled in five fundamental knowledge domains: Economics, Law, Management, Science and Technology. Within these five

domains, the following ten general outcomes were adopted as prerequisites and specialised competencies leading to registration with the SACQSP as a quantity surveyor or quantity surveyor in training: Analysis and Problem Solving; Commerce, Entrepreneurship and Management; Communication; Information Technology; Interdisciplinary Teamwork; Law; Numeracy; Quantification; Research; Technology.

3.4 Transforming the quantity surveying profession

3.4.1 Role of leadership in transforming the profession

Organisations in all sectors of the economy are under increasing pressure to offer value-added services, innovate and learn to survive and grow in the face of increased competition and rapid change. Business enterprises are under threat from their competitors, which may be able to offer superior and more comprehensive services. The changing landscape of the construction industry also demands that current practitioners as well as future professionals should be proactive to drive change instead of merely coping with developments.

The construction industry faces several technical, social, financial, political and cultural challenges (Toor & Ofori 2008a). These include the growing volume of construction demand and activity in many countries which are resulting in severe pressure on resources (Ofori, 2003); increased private-sector participation in infrastructure projects (Raftery et al., 1998); and lack of quality people and an ageing workforce (Songer et al., 2006). Projects are becoming bigger and more complex in nature with higher numbers of stakeholders with different intentions for the project who may have multi-ethnic and multi-cultural backgrounds (Ofori & Toor, 2009). Clients are also becoming more knowledgeable and hence more demanding and selective in what they want from consultants and to whom they award the work (Preece et al., 2003).

Consequently, there is a need for changes in many aspects of the operations of the construction industry (Ofori, 2003). There should be greater focus on how project procurement processes can be improved (Kumaraswamy & Dulaimi, 2002); how the construction value chain can be made more efficient (Atkin 1998); how the concerns of sustainable development, health and safety in project delivery can best be addressed (Lingard & Rowlinson, 2006); how the level of professionalism in the industry can be enhanced (Vee & Skitmore, 2003); how the adversarial mindsets of practitioners can be transformed and a collaborative and partnering approach promoted (Li et al., 2001); how corruption in the industry can be eradicated (Stansbury, 2005; Transparency International, 2006); how the social image of construction can be enhanced (Rameezdeen, 2007); and perhaps above all, how to attract, retain and develop talent (Toor & Ofori, 2008b).

The quantity surveying profession is also going through a period of rapid transformation. A profession that was considered to be facing extinction a decade ago has been revitalised, and faces a high demand for its services in the construction market in many countries (Cartlidge, 2002). There is a new optimism about the future of quantity surveying as a profession and quantity surveyors are now seen as significant players in the construction industry (Smith, 1995). The trends highlighted in the preceding paragraph show that there is even greater potential for the quantity surveyor as there are many areas where innovative application of the existing skills of the surveyor, as well as judicious extension and enhancement of these skills, can result in progress in the industry.

Quantity surveying is not a new profession. Historians suggest that the Egyptians had some systems of quantity surveying. The profession first developed more formally in the 17th century in the UK. Primarily, the quantity surveyor is the project cost consultant, and the adviser to the client and other members of the project team on matters relating to procurement and the contract (Fellows et al., 2003). In a contractor's organisation, the functions of the surveyor centre on cost and contract management.

Over the last few decades, quantity surveying as a profession has undergone a number of transitions. The advent of information technology and the potential it offered, coupled with the downturn in construction activity in the UK and a number of other countries during the mid-1980s and late 1990s, and the challenges that included those discussed above, which saw even more intense competition in the construction industry with firms seeking opportunities beyond their professional domains, led many observers to predict, and many within the profession to fear, that quantity surveying might disappear as a formal profession. When Cartlidge wrote the first edition of his book *New Aspects of Quantity Surveying Practice* in 2002, he noted that the profession was facing several challenges and it was thought that it was on the verge of being extinct (Cartlidge, 2002). However, in 2006, Cartlidge noted that there was a severe shortage of quantity surveyors. He cited the survey of the Royal Bank of Scotland which found that quantity surveyors were the best paid graduate professionals in 2005 (Cartlidge, 2006). The reasons for the 'new' rise of the profession include an increase in the volume of construction activity, growing scarcity of other construction professionals and demand for experts in cost engineering and financial management

The changes in the construction industry discussed above, pose a number of challenges to all who work in it. They also offer business opportunities and avenues for greater achievement. Two examples of these may now be discussed from the perspective of the quantity surveying profession. The first of these challenges is the movement for sustainability. The development and application of comprehensive assessment tools for green buildings incorporating the existing tools which focus only on the environmental aspects [such as the Green Mark in Singapore and the Leadership in Energy and Environmental Design (LEED) in the US], is an area in which quantity surveyors can play a significant role. They need to further enhance their skills, and help to develop the technologies and innovations to achieve sustainable buildings.

The many recent scandals show that the business world faces corporate malfeasances and ethical transgressions (Mehta, 2003; Revell, 2003; Treviño & Brown, 2004; Manz et al., 2008). Unethical leaders have been able to exploit the loopholes in management systems to fulfil their personal desires at the expense of their organisations and employees (Padilla et al., 2007; Schaubroeck et al., 2007). In many countries the construction industry is perceived as one of the most undesirable sectors to work for (Toor & Ofori, 2007). Transparency International (2006) found construction to be the most corrupt industrial sector. Some researchers have studied the reasons for unethical behaviour in construction. Fan et al. (2003) suggest that the increasing ethical problems in construction professions may be due to the perception gap about ethical issues between senior and relatively younger professionals.

The quantity surveyors responding to their survey ranked employer, self and client as more important when they faced any ethical dilemma. On the contrary, the interest of the public was ranked relatively low. Ho and Ng (2003) discovered a significant impact of education and experience on the attitude of quantity surveyors toward sacrificing their self-interest for the greater good. They found that more junior quantity surveyors place more emphasis on duty whereas more senior professionals are more concerned about process and consequence. As quantity surveyors are responsible for cost engineering and financial management on construction projects, they are in a strong position to help establish higher standards of transparency and accountability. They can establish mechanisms which can ensure greater financial transparency on projects. They can use technology to integrate the cost and other relevant data to institute accountability and responsibility for all stakeholders. These challenges call for transformation in the way quantity surveyor's function. For example, Harun and Torrance (2006) suggest that quantity surveyors should not contain themselves within the traditional boundaries of cost management; they need to develop new niches, cultivate new knowledge and break into new areas in order to enhance their competitiveness. Smith (1995) suggests that there is some uncertainty about the capacity in which,

and for whom, the quantity surveyor would work, and the nature of quantity surveying firms in the future. Brümmer (2004) also suggests that quantity surveyors should play a more effective and proactive role across all stages of the project life cycle. He draws attention to constantly changing procurement systems, necessitating refinement in the services that quantity surveyors render.

3.5 Conclusion

Quantity surveyors have an obligation to both the client and other construction project stakeholders, to act in a fair and ethical manner in the conduct of their duties. They require certain competencies and a number of personal skills in order to conduct those duties. These competencies are regulated by established organisations, committees and bodies of knowledge that oversee activities in the field of quantity surveying. The field itself is undergoing a process of rapid transformation, which is attributed to changes in the global landscape and innovations in various areas of society. Their role is crucial to the estimation process, which is the fundamental costing process in the initial construction project stage. This cost estimation process and its sub-processes and variations are examined in the next chapter.

CHAPTER 4

ESTIMATES

4.1 Introduction

Estimation is one of the key skills of the quantity surveyor as it is at the heart of the initial financial planning phase of the construction project. Various techniques are used to gauge the approximate values in construction projects of various sizes. Accuracy in cost forecasting is a sensitive issue as the accuracy of an estimate relies on a number of factors, including the experience of the quantity surveyor. It is an on-going process that may yield different values at different stages of the project. These aspects need to be kept in mind by both clients and contractors, especially those involved in high-risk construction projects where internal and external factors contribute to uncertainty in cost structures. This chapter examines the techniques used to estimate cost and the skills and necessity of estimators in construction projects as well as the role played by risk in the estimation process.

4.2 Estimating accuracy

4.2.1 Definition of estimating accuracy

The accuracy of an estimate is measured by the deviation from the lowest acceptable tender received in competition for the project. Unfortunately, few estimates are prepared in the early design stages for schemes, which subsequently remain unaltered prior to the invitation of tenders and, in consequence, the lowest tender cannot realistically be compared with the estimate as each relates to a different scheme. It has, therefore, been assumed that cost estimates produced during the various design stages of a construction project have the objective of predicting the tender price level (i.e. lowest tender) which might be expected to be achieved if that same scheme were assumed to be fully detailed and competitive tenders could be invited on the relevant contract particulars. The significance of this assumption is discussed at some length later in the study but

for now it is worth noting that the decision to measure quantity surveyors' estimating performance against lowest tenders means that the assessment of accuracy must in part be dependent on the variability of these lowest tenders.

4.3 Accuracy of the cost estimate

Bennett et al. (1988) state that cost estimating is the key activity in the quantity surveying profession's cost planning service. They further conclude that if cost estimating is effective, then cost planning can achieve its objectives. Without good estimating, cost planning is frail and ineffective on cost.

The quantity surveying profession has developed a number of estimating techniques designed to cope with the many and varied instances in which predictions of cost are required during the development of a building design. These range in detail from simple lump sum evaluations and single unit methods to the measuring and pricing of very detailed approximate quantities or even pricing full bills of quantities. Quite naturally one would expect the accuracy of price predictions to increase as the level of detail in which estimates are prepared increased and the knowledge of proposed designs are increased. However, few attempts have been made in the past to quantify the range of performance, which is achieved, achievable or acceptable.

4.3.1 Accuracy of risk-based cost estimate

Large infrastructure projects are constantly subject to delays and large cost overruns. Studies by Flyvbjerg et al. (2003) place these overruns between 20.4% and 44.7%, depending on the type of project, and 50-100% for fixed prices in major infrastructure projects with overruns exceeding 100% not being uncommon. These amounts are relatively unchanged over the last 70 years. According to Bruzelius et al. (2002), Risk-based Estimation (RBE) has been adopted by construction companies, governments and insurance organisations to quantify uncertainties, particularly for large infrastructure projects. Little is known about the effectiveness

of RBE, reference class forecasting and the conventional approach. Two main factors were identified as the reason for inaccuracy in cost forecasting for infrastructure projects, namely optimism bias and strategic misrepresentation. According to Lovallo and Kahneman (2003), optimism bias is the overoptimistic estimation of benefits and underestimation of costs while strategic misrepresentation is the deliberate misrepresentation of cost and risk for political, financial and other benefits.

These factors lead to the false belief that the results are determined by own and organisational actions, flawed planning, relationship breakdown between contractor and client and delays and cost overruns. Flyvbjerg et al. (2005) recommend using reference class forecasting (RCF) to overcome these effects. This method uses actual and estimated data from similar previous projects in determining possible overruns. The difficulty with this method is acquiring samples of similar projects and accurate cost information as developing a database of this information takes time. For projects that are rare to a country, this data may be impossible to retrieve or use. Moreover, private companies are unwilling to share this data with competitors or government agencies.

Where this information is not available, the outsider's view (which is a key factor in RCF effectiveness), may still be used in a collective decision-making process that minimises the effects of optimism bias and strategic misrepresentation. This particular study was based on case studies conducted on eleven water infrastructure projects in the Sydney region, which provide a good indicator for the effectiveness of RBE in determining underruns or overruns in cost. The accuracy of RBE is further measured by comparing this data to thirty other construction projects that used the conventional approach. A series of interviews with individuals experienced in RBE were performance drivers, conducted to establish the main factors in improving RBE's predictive validity.

4.3.2 Literature in estimating

Globally, infrastructure projects of all types are subject to cost overruns. Flyvbjerg et al. (2003) name this a “performance paradox”. A number of academic sources have attempted to explain this phenomenon by referring to the uncertain and unique nature of these projects. McMillan (1992) states that the projects’ uniqueness limits the learning process and that the variability of the project negates the potential usefulness of past project experience. Touran and Lopez (2006) indicate that the multidisciplinary nature, long workflow (from planning/tender to completion) and cost estimations with fluctuating prices, make for a difficult process. Other sources, however, reject these explanations by referring to the fact that these differences are too consistent and one-sided and state that the decision-making process, biased by political and managerial interference, causes these overruns. These authors argue that estimate errors resulting from uncertainty are systematic biases that will correct themselves in time as errors and their sources are identified and addressed, whereas strategic misrepresentation is non-systematic and will continue regardless of improvements in other areas (Fellows, 1996; Kujawski et al., 2004; Flyvbjerg, 2006).

These non-systematic biases occur at all levels of the construction industry such as self-protective predictions by estimators who have self-serving interests, for instance. Another ill is the price adjustment by managers to unrealistic levels, to “get the job” when tendering, according to Kujawski et al. (2004), while Mak and Picken (2000) note that clients strategically underestimate costs in order to get a go-ahead for that project. To include a fixed contingency in project estimate is the most common approach to gauging risk; for example, if the project cost is \$20 million and the organisation allows for 10% contingency, the total cost will be \$22 million. This method is subject to bias because of its arbitrary nature (Molenaar, 2005; Flyvbjerg, 2006).

RCF extends this by basing the contingency decision on statistical modelling of similar projects. According to Flyvbjerg (2006), this method has also been found to mitigate the effects of optimism bias and strategic misrepresentation. Through simulating the distribution of probabilistic cost overruns within a similar class, an objective reference point for cost estimates is produced. Thus, the estimator adds uplift to the base estimate as contingency for overrun which counterbalances optimism bias and strategic misrepresentation. The reliability of RCF, however, depends on access to databases of information on similar projects done in the past and, as previously mentioned; this information may not be accessible owing to the sensitive nature of pricing in the construction industry, or to exposure of political influence. It may also be that only data on successful projects is available. Using outside view as a mitigating factor against optimism bias and strategic misrepresentation, means that data cannot only be drawn from databases of past projects as with RCF, but also from opinions of project stakeholders as with RBE, where outside views are incorporated through risk workshops where a wide spectrum of parties is involved. This process therefore uses outside views of both quantitative and qualitative sources.

4.3.3 Risk-Based Estimating (RBE)

According to Ali (2005) and Molenaar (2005), RBE divides project costs into smaller components and models, these components on the sum of the base estimates with a probabilistically distributed risk contingency that reflects all the uncertainties of the corresponding base estimate. The base estimates are quantified by a process where the subjective judgement of estimates, team, risk experts and objective data on previous projects are used (Trueman, 2004). The final step being a Monte Carlo simulation that runs random samples of very large numbers and combinations of potential cost outcomes to produce an aggregate of all the components. This output is usually a cumulative distribution probability graph indicating the range of values above and below the estimated project cost, giving an idea of the final value (Thompson & Perry, 1992).

The basic rationale is that probabilistic distributional information is critical to the accuracy of the estimation. Kahneman & Tversky (1979) note that ignoring the distributional information or risk is one of the major errors of forecasting; they suggest using all available information in the estimation process. The distribution of risk contingency is a function of two types of risks: inherent risk (the uncertainty in pricing or work scope) and contingent risk (the risk associated with unforeseen and uncontrollable events that occur during the life cycle of a project). RBE modelling is similar to probabilistic modelling, as in Ali (2005) and Molenaar (2005), the main difference being the consensus building during the workshop process that draws views from various relevant parties. RBE usually follows a risk management process and the primary purpose is to quantify the effects of these two types of risks on the schedule and the budget.

4.4 Realistic first estimate

A realistic estimate means that it is neither overoptimistic nor too pessimistic. Flanagan and Tate (1997) suggest that when estimating, the target must be constant and that the first estimate should be as accurate as possible as this figure will set the parameters for the budget.

4.4.1 Project estimating

According to Ganiya and Zabairu (2010), a successful project means that the project has accomplished its technical performance, maintained its schedule and remained within budgetary costs. However, there has been a greater awareness of cost prediction by prospective building clients because of the prevailing economic condition, which has placed severe restrictions on the availability of capital and thus made it essential to ensure that whatever amount is available is judiciously used to secure best economic advantage.

In these days of ever-increasing costs, the majority of promoters of building projects are insisting on jobs being designed and executed to give maximum value for money. Hence, quantity surveyors are employed to an increasing extent during the design stage to advise designers on the portable cost implications of their design decision. All this has encouraged building clients to demand improved and refined cost control tools from their professional advisers, to provide a balanced cost in all parts of the building as well as an accurately forecast overall cost (Seeley, 1983). In the same vein, Lowe et al, (2006) also explained that construction clients require early and accurate cost advice, prior to site acquisition and the commitment to build, to enable them to assess the feasibility of the proposed project. This is performed by construction contract price forecasters (usually a quantity surveyor).

A client is concerned with quality, cost and time and wants the building to be soundly constructed at a reasonable cost and within a specified period. For these reasons, it is incumbent upon an architect, who may or may not be supported by a quantity surveyor, to exercise the greatest care and skill in the design of the project with constant checks on cost. Songer and Molenaar (1997) identified a list of metrics that measure and compare the performance of construction projects. Other studies (Akintoye and Fitzgerald, 2000; Chan, 2001) identified the determining factors and assessed their impact on project cost. Integrated efforts of the various parties and their decisions regarding the design, technology and implementation of the project can have a significant effect on the overall project cost. It is clear that the need for a virile construction industry cannot be overemphasised. There is an urgent need to address some of the fundamental problems plaguing its growth and viability, one of which is the spate of uncertainties brought by the prevalent wide discrepancies between planned and actual construction cost due to the lack of effective prediction cost models. This thesis seeks to replicate the research conducted by Chan and Park (2005) in Singapore using Nigeria as a case study. The research aims (i) to identify the factors that contribute to project cost, (ii) to examine the importance of the identified factors based on the significance of their

contribution and (iii), to develop a predictive project cost model from the selected components using principal components technique.

4.4.2 Cost forecasting methods and their relative estimation accuracies

Three dominant methods occur in the construction industry: Reference class forecasting (RCF); conventional contingency approach and risk-based estimation (RBE).

Conventional contingency approach

These are techniques such as subjective judgement, sensitivity analysis, real options analysis and Monte Carlo simulations (Akintoye & MacLeod, 1997). The most commonly used is the deterministic contingency application, also called the Conventional Contingency Approach (Tummala et al., 1997) , as normally used by contractors in Australia to assess risks and opportunities in projects (Fayek et al. 1998). This approach adds a percentage to the base estimate to account for risks. This amount is usually based on the estimator's intuition or past experience. The contingency percentage depends on the type and life cycle phase of the project with little consideration for component risks involved. Because of the arbitrary nature of this approach, it is especially susceptible to optimism bias and strategic misrepresentation.

Reference class forecasting

The RCF approach mitigates optimism bias and strategic misrepresentation by using an "outside view" that uses databases of actual performance of comparable projects completed in the past within a given reference class, giving an objective reference point for cost estimates (Flyvbjerg, 2006). The distribution of cost overruns in this class are derived through Monte Carlo simulations (such as the S-curve) from which an uplift percentage is added to the base estimate as risk contingency. It is a relatively new practice and is being adopted by the construction industry such as the British Department for Transport and the State Road and

Traffic Authority in Australia, but there are limited studies in its effectiveness. Flyvbjerg, et al. (2005a) were the first to provide a comprehensive guideline on how to use RCF to mitigate optimism bias, but in practice, there is no standard code of practice for this method. The main challenge in its implementation is the accumulation of similar sample projects with a large enough sample size and accurate cost information and, in some projects that are very rare in some countries, it may be impossible to acquire a sample size for statistical analysis. This is further compounded by the fact that private companies may not be willing to share commercially sensitive information with competitors or government agencies.

Risk-based estimating

RBE models the costs of individual components with the base estimates and stochastic risk contingencies. The distribution of the overall cost is derived by summing up the stochastic cost components (Shaheen et al., 2007). The S-curve relates specific project budgets with corresponding probability of cost overrun. The cost estimate is determined using the S-curve based on the organisation's estimation procedure and the estimating team's preference for risk of cost overrun. This method starts with the identification of two categories of risk: inherent risks (internal to the project, uncertain in quantity, rates and scope) and contingent risks (external events beyond the project team's control) (Aspinall & Trueman, 2006). These two are handled differently in that contingency risks are assigned a probability of occurring while inherent risks are assumed to exist throughout the life cycle. The RBE approach also takes into account outside views from a number of sources and objective data (if available). The process typically entails a risk workshop conducted by professionals during which the time and base estimates and corresponding risk contingencies for individual components are determined through a consensus building process (Aspinall & Trueman, 2006). A Monte Carlo simulation is then done for the total project budget (Napier & Liu, 2008). Although RBE has only been introduced in Australia recently, preliminary findings indicate

that ten of the eleven projects had an actual cost within the range of the risk-based estimate.

4.4.3 Early cost estimates using multiple regression techniques

Sanders et al. (1992) use the term “early estimate” to describe the process of predicting the cost of a project before the design of the project is completed. This technique is used to estimate a single characteristic of a system, such as the cost, from other physical or performance characteristics (Rose, 1982). This technique involves life cycle costs, detailed database and the application of multi-variable correlation (Black, 1984).

According to Sodikov (2005), the most significant starting process to influence the fate of a new project is the early cost estimate. The accuracy of cost estimation improves with the progression of the project due to the availability of detailed and precise information; during the early stages the need is examined, alternatives are assessed and objectives of the project are established and a sponsor is identified (Holm et al., 2005). According to Schexnayder et al., (2003), estimate accuracy during this phase is between 25% and 50%.

Cost estimation for construction projects is crucial for planning and feasibility studies during their early phases. Construction clients require early and accurate cost advice before project commencement for decision making; however, a number of problems occur in early phase cost estimation, including major problems such as lack of preliminary information, lack of database of work costs, lack of cost estimation methods and environmental, political, social and external uncertainties. Conventional tools such as regression analysis are employed because of their significance in tackling these problems.

From cost estimating literature

Ahuja et al. (1994) state that estimating is the primary function of the construction industry and that the accuracy of cost estimates throughout the duration of the project can determine its success or failure and that a number of project failures are attributed to inaccurate estimates. The cost estimate establishes a baseline for total cost at different stages of a project and Hendrickson and Au (1989) indicate that a cost estimate at a given stage of a project represents the prediction by the cost engineer or an estimator based on available data. Gould (2005) defines the estimate as an appraisal, an opinion or an approximation of the cost of a project prior to the actual construction. Jelen and Black. (1983) state that estimating is at the heart of the cost engineer's work and has, as such, received appropriate attention over the years.

Holm et al. (2005) list several reasons for doing an estimate, including feasibility studies, selection from alternate design, selection from alternate investment, appropriation of funds and presentation of bids and tenders. A number of cost prediction models have been developed. Bell and Bozai (1987) developed multiple linear regression models for preliminary cost estimation as used by the Alabama Highway Department for long-range cost forecasting, stating that the total cost per mile is a function of a list of probable predictors comprising line items such as quantities of work items per mile.

Mahamid and Amund. (2010) developed multiple linear regression models for preliminary cost estimating of road construction activities as a function of the project's physical characteristics, including terrain conditions, ground conditions and soil drillability. Hegazy and Ayed. (1998) use a neural network approach to construction cost data management and developed a parametric cost estimation model for highway projects. They introduced two alternative techniques to train network weights: simplex optimisation [inherent to Excel's solver function and GAs (genetic algorithms)].

Christian and Newton (1999) developed three cost prediction models in the province of New Brunswick (based on historical data from 1965 to 1994) to determine accurate cost for road maintenance. Based on these models and the management review, it was found that maintenance funding needed to be increased by 25%. Lowe et al. (2006) developed linear regression models to predict construction cost of buildings based on 286 sets of data collected from the United Kingdom. Forty-one independent variables were identified. They showed five significant influencing variables such as gross internal floor area, function, duration, mechanical installations and piling.

Han et al. (2008) investigated the budgeting process in highway construction projects in collaboration with the Korean Ministry of Construction and Transportation, which led to the development of a two-tiered cost estimation model of highway construction projects which considers the target goals for forecasting, allowable accuracy and available information at each phase of project budgeting and initiation.

Recent work still indicates many problems with cost estimation at the conceptual stage. The World Bank developed an international database for road construction cost in developing countries and the data was yielded in the form of the Road Costs Knowledge System (ROCKS, 2002), which was designed to provide an international knowledge system of roadwork costs in obtaining average and range unit costs based on historical data to improve cost estimates. The study used data from 65 developing countries and comparisons were drawn between estimated costs at appraisal and actual cost at completion. Of these, 62% were overestimated, and the rest underestimated (ROCKS, 2002).

Background to building cost

Efforts have been made since the 1950s to understand the cause/effect relationship between design parameters and building cost, as well as developing models to estimate building cost. According to Holm et al. (2005), cost modelling

may be defined as a symbolic formation of a system and its content is defined with the factors affecting the cost. Based on the historical developments, cost models can be classified in three different groups, namely first-generation models that originated from functional elements of a building-oriented cost-planning approach in England at the end of the 1950s, which were used until the end of 1960s, second-generation models that were derived from regression analysis and have been used since the mid-1970s (McCaffer et al, 1984) and third-generation models that started to develop in the beginning of 1980s and were generally based on the Monte Carlo simulation technique (Touran, 1992).

Cost models can be divided into two groups namely, deterministic and probabilistic models. In deterministic models, it is assumed that the values can be qualified with any kind of variables and all these are exactly known or can be estimated accurately. In probabilistic models it is accepted that, although the values of some variables are not absolutely certain, they can be calculated. Cost estimation models can be classified further according to their characteristics such as traditional cost estimation models based on quantities, resource based models used in the construction phase and models based on functional elements and building operational units. There are also untraditional models that comprise new techniques and practices (Akintoye & Fitzgerald, 2000; Ashworth, 1988; Seeley, 1976; Bledsoe, 1992; Flanagan & Tate, 1997; Mann, 1992; McCaffer et al., 1984; Newton, 1991; O'Brien, 1994).

Recent works on cost estimation models include Chan and Park (2005), who identify factors that contribute to project cost in order to construct a predictive project cost-model using the principal component technique and to assess the relative importance of determining factors. Serpell (2005) assesses the quality of an estimate by applying expertise and experience with the help of the knowledge-based assessment model. Oberlender and Trost (2001) present findings of a research effort that developed an estimate scoring system to measure the impact of four determinants on estimate accuracy, such as “who was involved in preparing

the estimate”, “how was the estimate prepared”, “what was known about the project” and other factors usually considered while preparing the estimate. Trost and Oberlander (2003) also tried to establish a model that enables estimators and business managers to evaluate the accuracy of early estimates objectively. Ellis et al. (2005) examined the addition of qualitative exploration of Value Management by investigating the attitudes and experiences of Value Management facilitators in major UK cost consultancies. Yu (2006) proposes the Principal Item, Ratios Estimating Method (PIREM), that integrates several existing conceptual estimating methods, including parametric estimating, ratios estimating and cost significant model with advanced nonlinear mapping techniques and adopts a scheme that separates unit prices with the quantities of a cost item. Lowe et al. (2006) describe the development of linear regression models to predict the construction cost of buildings. Liu and Zhu (2007) attempted to identify the critical factors involved in effective estimation at various stages of typical construction projects and developed a theoretical framework that identifies these factors.

4.4.4 Preliminary cost estimating

According to Sanders et al. (1992), the term “preliminary estimate” describes the process of predicting a project’s cost before design of the project has been completed. Rose (1982) said that this technique is used to estimate one characteristic of a system, usually cost, from other physical and/or performance characteristics of the system.

Construction clients require early and accurate cost advice before the site is acquired and commitment to build, to make the right decision on the feasibility of the project. The accuracy of this estimate is highly dependent on the available information at the time.

Preliminary cost estimates are required early in the conception phase, which makes the estimate less accurate. According to Sodikov (2005), preliminary cost

estimation is considered the most significant starting process to influence the fate of a new road construction project and according to Jelen and Black (1983), estimating is the heart of the cost engineer's work and has therefore received appropriate attention in the past. Major difficulties that occur during cost estimation in the conceptual phase are lack of preliminary information, lack of database of road-works costs and, lack of up to date cost estimation methods. Additional difficulties occur because of engineering solutions, socio-economic and environmental issues.

Parametric cost estimation or estimation based on historic database during the conceptual estimate phase is widely used in developed countries; however, Sodikov (2005) state that developing countries face difficulties related to the creation of a road-work costs database, which may be used for cost estimation in either the conceptual stage or the feasibility study of a project cycle.

Wilmot and Cheng (2003) developed an application of the model in forecasting highway construction costs in Louisiana, which shows that the model closely replicates past construction costs for the period 1984-1997. When applied to forecasting future highway construction costs, the model predicted that highway construction costs in Louisiana would double between 1998 and 2015. The results indicated that applying cost-cutting policies and assuming input costs are 20% less than anticipated; the model estimates highway construction costs will increase by 75% between 1998 and 2015. Sodikov (2005) discussed how to handle missing data, analysed the impact of a different set of variables on the project cost and evaluated the proposed cost estimation model, which proposes a cost estimation technique for developing countries and criteria for using an artificial neural network.

Oberlender and Trost (2001) were more concerned with improving prediction accuracy by deriving four determinants influencing the accuracy of early cost estimates. They then established a multiple regression model, which derived a significant relationship between estimate accuracy and influencing factors such as

basic process design, team experience and cost information, time allowed to prepare the estimate, site requirements, and bidding and labour climate.

Han et al. (2008) investigated the actual budgeting process in a highway construction project while collaborating with the Korean Ministry of Construction and Transportation. They then developed the two-tiered cost estimation models of highway construction projects, considering the target goals for forecasting, allowable accuracy and available information level at each phase of a project.

4.4.5 Two-staged early cost estimation

Early cost estimates are critical factors to the initial decision-making process in capital projects. For infrastructure providers, accurate cost estimations allow for effective budgeting and financing. Early estimates are typically plagued by limited scope and are often prepared under stiff time constraints. Furthermore, reliable cost data is difficult to obtain during the conceptual stages of a project. Early estimates become the basis on which future estimates are judged.

The conceptual cost estimates for capital projects have been a major concern for both project owners and contractors. Hackney (1985) published a checklist for establishing a detailed definition rating for capital projects which proposed the use of the definition checklist for applying contingency to capital cost estimates and validating this checklist against the definitions ratings of 30 projects and their respective levels of cost overrun. Hegazy and Ayed (1998) developed a neural network model for parametric cost estimation of highway projects and considered that characteristics of early cost estimates of the conceptual estimation process are determined by some parametric values. They then derived parametric values related to cost, such as construction region and total length of highway.

Kim et al. (2005) applied hybrid models of neural networks and genetic algorithms to cost estimation of residential building to predict preliminary cost estimates, based on the data samples constructed from 1997 to 2000 in Seoul, Korea.

Lowe et al. (2006) developed linear regression models to predict the construction cost of buildings, based on 286 sets of data collected in the United Kingdom. They identified 41 potential independent variables and showed five significant influencing variables such as gross internal floor area (GIFA), function, duration, mechanical installations and piling.

Oberlender and Trost (2001) concentrated on improving prediction accuracy by deriving four determinants influencing the accuracy of early cost estimates and established a multiple regression model which identified a significant relationship between estimate accuracy and influencing factors, such as basic process design, team experience and cost information, time allowed to prepare the estimate, site requirements and bidding and labour climate.

Existing studies on cost predictions are limited to their applicability to actual highway projects as they focus on a specific phase and use restricted information, while the amount of information collectable differs from one another, along with the planning and preliminary design stage.

The success or failure of a project depends on the accuracy of several estimates done throughout the course of the project. This is a serious industry problem due to inaccurate estimating (Ahuja et al., 1994). Cost estimating is one of the most difficult tasks in project management because it must be done before the work is accomplished (Oberlender & Trost, 2001). According to Kim et al. (2005), estimating has been recognised as an important element of construction projects and is prepared in a systematic manner appropriate to the size and complexity of the project and to a level of accuracy commensurate with the available information and intended use of the information developed (Hendrickson and Au, 1989).

Cost estimating means assessing and predicting the total cost of executing an item of work in a given time using all available project information and resources (Kwakye, 1994). Owing to the competitiveness of the construction industry, this is no easy task and in order to secure a job, the cost estimate must be as accurate and competitive as possible (Marjuki, 2006). It is a seriously experience-based process, which involves evaluations of unknown circumstances and complex relationships of cost-influencing factors (Elhag et al., 2005) and is the process of analysing a specific scope of work and predicting the cost of performing the work, which involves collecting, analysing and summarising all available data related to a building construction project (Holm et al., 2005).

Inadequate estimating leads to misallocation of resources and if estimates are consistently high compared to bid costs and final costs, fewer projects will be authorised, resulting in loss of benefits. If estimates are consistently low, more projects can be authorised than can be fully funded, resulting in project slowdowns, scope changes, performance shortfalls and generally higher costs and lower benefits. If estimates are consistently neither high nor low, but still inaccurate, the estimated benefit to cost ratio will not be correct (Flyvbjerg et al., 2002).

Pre-tender cost estimating provides an indication of probable costs of construction at a very early stage in a construction project and is one of the most important factors influencing the client's decision to build. An approximate cost estimate that is too high may result in lost opportunities or scope reconsideration. Conversely, if the estimate is too low, it may result in wasted development efforts, dissatisfaction on the part of the client or even litigation (Shash & Ibrahim, 2005).

According to Marjuki (2006), the complexity of construction projects and the lack of time allocated for cost estimating often leads to a poor performance of the estimate. The outcome of an estimate can be accurate, underestimated or overestimated. An accurate estimate generally results in the most economical

project cost, while an underestimate and overestimate often lead to greater actual expenditures. Inaccuracy in the estimate occurs because of bias associated with the project itself and bias associated with the estimating technique used and the environment (Aibinu & Pasco, 2008).

Cost estimating has many different definitions and the following paragraphs state some of them. The Project Management Institute (PMI) defines cost estimating to involve developing an approximation of costs of the resources needed to complete project activities. Hendrickson and Au (1989) specify design, bid and control and state that at the very early stage of design, the screening estimate is made before the project is designed and relies on the cost data of similar projects completed in the past. Preliminary or conceptual estimates are based on the conceptual design of the project when the basic technologies for the design are known. The detailed or definitive estimate is made when the scope of work is clearly defined and the completed plans and specifications ready for the owner to solicit bids from construction contractors (Hendrickson and Au, 1989).

The Association for the Advancement of Cost Engineering (AACE¹) International (2007) defines cost estimation as providing the basis for project management, business planning, budget preparation and cost and schedule control which include assessment costs and an evaluation of risks and uncertainties. Clough (1986) defines the construction estimate as the compilation and analysis of the many items that influence and contribute to the cost of a project. The Society of Cost Estimating and Analysis (SCEA) define it as “the art of approximating the probable worth or cost of an activity based on information available at the time”. Ritz (1994) gives another definition: “the project cost estimate is the predicted cost of executing the work”.

Cost estimation is defined as the technique that is followed to determine the amount necessary in monetary terms to undertake an activity. The determination accounts for materials, labour, equipment and many other variables that affect

conducting that activity (Al-Thunaiyan, 1996). Dysert (2003) defines cost estimate as “the predictive process used to quantify, cost and price the resources required by the scope of an investment option, activity, or project”, while Akintoye and Skitmore (1991a) defines cost estimate as “crucial to construction contract tendering, providing a basis for establishing the likely cost of resources elements of the tender price for construction work”.

Estimating is the process of looking into the future and trying to forecast project costs and resource requirements (Halpin, 1985). An estimate is a judgment, opinion, forecast or prediction. It is a judgment or opinion of the cost of a process, product, project or service. It is a prediction or forecast of what a work output or work activity will cost (Stewart, 1991). Estimating is a collection and analysis of the bill items which influence and contribute to the cost of the project (Macdonald et al., 2002).

The estimate is one of the most important pieces of information for decision making at the early stage of construction (Serpell, 2005). Cost information is developed for owners or managers by cost estimators to use in determining resource and material quantities, making bids for contracts, determining whether a new product will be profitable, or determining which products are making a profit for a firm (Dysert, 2006 and Schottlander, 2006). As regards the client, cost estimates act as indicators of probable cost at the early stage of construction. A cost estimate built with the assistance of a quantity surveyor will guide the client in evaluating the most competitive bid (Trost & Oberlender, 2003). The costs forecast depend on the requirements of a client and the information and data available (Elhag et al., 2005).

Sutherland (1999) explains the purpose of providing the client and design team with as precise an estimate of final cost as possible is that the project can be accomplished within the client’s budget. Weatney (cited in Marjuki, 2006) outlines the purpose of a cost estimate through the following: it provides an assessment of capital cost for a specified piece of work; it forms the basis for planning and control

by defining the scope of work and its associated estimated cost; it provides much of the basic information which is needed for preparing a schedule; it provides the financial input required to prepare a cash-flow curve; and it is a catalyst for discussion, idea generation, team participation, clarity and buy-in as it ties together much of the relevant project information within a simple document.

4.4.6 Estimator responsibility

Estimating is a vital part of the construction industry as the success or failure of a project depends on the accuracy of several estimates throughout its course (Enshassi et al., 2007). Accurate, reliable and realistic bid preparation requires good judgment and estimating skills (Skitmore et al., 1990; Dysert, 2003). The estimator is responsible for ensuring that a project team understands the information needs for the estimate and ensures that the information provided is of sound quality (Dysert, 2003).

A qualified cost estimator determines what the work defined in the contract documents should cost. In addition to having a thorough understanding of the contract documents and any unique project characteristics, the estimator needs to consider several other factors when preparing a construction cost estimate, including fluctuation of costs, traffic conditions, restrictive work hours or method of work, small quantities of work, separated operations, handwork and inefficient operations, accessibility, geographic location, construction season and material shortages (Hatem & Ponte, 2009).

4.4.7 Estimator skill

Dysert and Elliot (2000) and Leung (2003) state that an effective estimation requires highly knowledgeable personnel that have technical skills. They also define a skill set of estimation core competencies as follows:

Understanding of the capital project process and estimate requirements for each class of estimate; understanding of the contractual relationships; ability to identify important aspects of the contract; understanding of building design; ability to read and interpret drawings, documents and specifications; detailed understanding of the estimate requirements for each class of estimate; code of accounts/works breakdown structure/project breakdown structure; basic project controls on budget, schedule, cost control, change management, progress measurements, earned value, forecasting and data analysis on labour productivity; database standards and development; historical data analysis and benchmarking; strategic estimating skills (capacity factoring, equipment factoring, cost modelling, general factor and ratio development); detailed estimating skills (material takeoffs, pricing and costing); presentation skills including report writing and listening skills; communications and interpersonal skills; and organisational ability to communicate the estimate in a logical and clear presentation.

Construction estimating involves determining the quantity of work and the cost. Of these two independent processes, the most difficult is the determination of cost. Determining cost is not limited to the knowledge of costs of labour, material, equipment and other direct costs of doing the work, but is also dependent on the interplay of the design variables and the estimator's choice of alternative means of construction and methods of doing the work (Ibrahim, 2003). Factors that influence accuracy include the amount, type and quality of data available, the proficiency of the estimator and the way that the data is interpreted. The estimating expertise depends on factors such skill, experience, judgment, knowledge, intuition and luck (Ashworth, 1994). Akintoye and Fitzgerald (2000) mentions that the estimator should look for various factors that influence pricing, such as:

- Standard and completeness of the drawn information;
- Tolerances required;
- Clarity of the specification and the quality required;
- Buildability;

- Whether load bearing and non-load bearing areas can be identified;
- The extent of the use of standard details indicating previous construction experience;
- Evidence of design co-ordination of services and structural needs; and
- The amount of information on ground conditions and foundation.

4.5 An investigation into current cost estimating practice

Estimating is defined as “the technical process or function undertaken to assess and predict the total cost of executing an item(s) of work in a given time using all available project information and resources” [Chartered Institute of Building (CIOB), 1997:xiii; Kwakye, 1994; Brook, 2004; Ashworth, 2002]. Construction companies therefore need the ability to forecast the likely cost of proposed construction work to establish a baseline figure from which a price can be quoted to the client.

Cost estimating methods have been developed for preparing estimates of various types and for various purposes (Daschbach & Apgar, 1988). Akintoye and Fitzgerald (2000) report in their study of UK current cost estimating practices that the main method used by construction organisations is the standard estimating procedure, followed by comparison with similar projects based on documented facts and comparison with projects based on personal experience.

Curran (1989) argues that conventional or traditional methods of estimating often fail to cope with elements of uncertainty. Bryan (1991) argues that estimating a construction project is time consuming and often tedious and advocates the use of an assembly pricing technique to improve the quality of estimating. According to Uman (1990), it is difficult to develop a standard process from which to develop a cost estimating system for construction, due to factors such as extreme diversity in building systems, methods, projects, suppliers, contractors and workforce.

These methods rely on judgment and estimator's experience (experience-based models). Hegazy and Mosellhi (1995) argue that these methods are often inaccurate and unstructured and are based solely on contractors' own experiences and the general-purpose procedures dictated by software systems. Skitmore and Wilcock (1994) investigated estimating processes of smaller builders based on eight practicing builders' estimators, by investigating the process of estimating, rather than applying the practice of cost estimating and researching methods that estimators used to price selected items from bills of quantities and the variability associated with the outcomes. The results showed that over half of the items were rated by the detailed methods prescribed in the standard texts and the remaining items by experience.

4.5.1 Survey of current cost estimating practices

According to the CIOB, cost estimating is the technical process of predicting costs of construction. Cost estimating by construction contractors is geared towards the pricing of bills of quantities that are prepared in accordance with a standard method of measurement. Hegazy and Moselhi (1995) argued that often these methods are inaccurate and unstructured and are based solely on contractors' own experiences and the general-purpose procedures dictated by software systems. Curran (1989), identified a serious lack of generally accepted estimating guidelines, despite the availability of literature on the format, procedures and principles involved in cost estimating.

The construction literature on cost estimating has produced a theoretical basis for the principles involved in the process of cost estimating. The study examined, by means of empirical analysis, the cost estimating practices of various categories of contractor such as the uses and techniques of cost estimating and causes of inaccurate cost estimates.

The cost estimating function provides a basis for the contractor to submit a tender sum for a project. Skitmore and Wilcock (1994) contest the assumption that tender prices are based on builders' estimates of future expenditure is questionable. Skitmore and Wilcock (1994) argued that tender prices are based on the character of the finished product rather than the processes involved in producing the product with evidence showing that estimators try to avoid the real problems of their trades (uncertainty) by presenting socially acceptable forecasts.

Most published literature related to estimating concentrates on the principle and process involved in its function, as it would appear that the process has suffered the expected shortcomings in extreme competition involved in construction bidding and the limited understanding of the underlying drivers of construction cost performance. Uman (1990) contends that it is difficult to develop a standard process from which to develop a cost estimating system for construction, due to such factors as extreme diversity in building systems, methods, projects, suppliers, contractors and workforce. Bennett and Barnes (1979), state that ideal cost models cannot be developed, as the actual costs of construction will depend on many factors such as contractors' individual selection of construction resources and methods and the timing and sequence of operations.

Green (1989) used a case study approach to identify factors considered by contractors' estimators in pricing a bill item and the number of these factors that are included in the item and how many are accounted for elsewhere, all dependent on the pricing policy of the individual company. Hegazy and Moselhi (1995) produced a research report on the elements of cost estimating in Canada and the United States which investigated relationships between mark-up and competition, need for work and contract duration and variations between contractors' estimates of different cost elements. This report indicated that contractors estimate direct cost and project overheads in a detailed manner, but not so in the case of general overhead costs and the mark-up, due to the high level of uncertainty and lack of adequate decision support tools. It recommended that a set of estimating

standards should be established and development of more effective decision-support tools, for estimating purposes.

Cost estimating methods have been developed for preparing estimates of various types and for various purposes (Daschbach & Apgar 1988). The components of the cost estimate, can be grouped into either direct and indirect cost, or variable and fixed costs (Curran, 1989). Ntuen and Mallik (1987) identified techniques or modelling tools for cost estimating which are classified into four groups: experience-based (algorithms, heuristics, expert system programming); simulation (heuristics, expert models, decision rules); parametric (regression, Bayesian, statistical models, decision rules); and discrete state (linear programming, classical optimisation, network, PERT, CPM).

Daschbach and Apgar (1988) and Shash and Al-Khaldi (1992) documented the use of parametric cost estimating techniques such as simple arithmetic formulae and statistical formulae. Groen and Tan (1977) produced a detailed application of cost factor estimating, while Klumpar (1990) shows how cost estimates could be produced based on capital cost estimation. This method uses a combination of material, labour and plant cost factors to produce an installation cost for manufacturing equipment. Bryan (1991) advocates the use of an assembly pricing technique (also called work module pricing, system pricing, rapid pricing or aggregate pricing), which presents costs in composite pieces that can easily be related drawings. Beeston (1983) advocates a simple procedure to improve estimating performance involving the use of several methods for each estimate and maintaining records, which allow contractors to select the best method or combination of methods.

Vergara and Boyer (1974) have argued that the precision of estimates depends not only on the method, but also on the type of work and on the intended use of the estimate. They state that, to increase the reliability of estimates, the level of detail involved should be increased up to a limit (optimum level of detail) at which the

cost of increased reliability equals the value of the increased reliability using a probabilistic approach to cost estimating. Shash and Al-Khaldi (1992) identify factors affecting the accuracy of cost estimating such as financial issues, bidding situations, project characteristics and the estimating process itself. The main factor responsible for the accuracy of cost estimates, irrespective of the size of contractors, was previous experience of the contractor on the type of project. This factor was followed by anticipated or frequent delays in periodic payments, type and size of contract and project location.

The study by Al-Harbi et al. (1994 cited in Nwachukwu and Emoh 2011), shows that the major problems facing cost estimators in preparing cost estimates are: tough competition; contract period; incomplete drawings and specification; incomplete project scope definition; unforeseeable changes in material prices; changes in owners requirements; current workload; errors in judgement; inadequate production time data; lack of historical data for similar jobs; and lack of experience in similar projects.

4.5.2 Analysis of factors influencing project cost

Cost estimating provides a basis for establishing the likely cost of resource elements of the tender price for construction work. Overestimated costs result in a high tender price which may result in an unacceptable bid while an underestimated cost could lead to a situation where a contractor incurs losses (Akintoye & Skitmore, 1991a). Smith (1995) regards the process of cost estimating as very important as it enables construction companies to determine what their direct costs will be and to provide a 'bottom line' cost below which it would not be economical for them to carry out the work.

Cost estimating is the technical process of assessing and predicting the total cost of executing item(s) of work in a given time using all available project information and resources (Kwakye, 1994; Brook, 2004; Ashworth and Skitmore, 1983). The

Code of Estimating Practice produced by the Chartered Institute of Building (CIOB, 1997), defines estimating as “the technical process of predicting costs of construction” and tendering as “a separate and subsequent commercial function based upon the estimate”. Green (1989) compared estimating and tendering using systems concepts, estimating being classified as a closed system and tendering as an open system. Estimating takes place in a relatively sheltered environment and tendering in a changing and dynamic environment (Green, 1989). A tender sum combines a cost estimate and mark-up, where mark-up consists of an allowance for general overhead recovery, profit, etc. Betts (1990) reports that tenders are based on a detailed analysis of the project and a detailed costing of those parts of the work to be done. Ashworth and Skitmore (1983) and Smith (1995) argue that estimating cannot be a precise technical and analytical process but is, to a large extent, a subjective process.

Tender documentation used in the preparation of cost estimates includes drawings, specifications, conditions of contract, and bills of quantities. In collaboration with other departments, the estimating department undertakes various tasks to calculate the consolidated net cost estimate for the project. The estimating department takes an overall view of the project and considers factors that may have an impact on pricing for the project. This includes, production performance anticipated during the construction stage and considers the resources required for the project in terms of quantity, quality, cost and performance and other factors which may affect the performance of those resources to determine the consolidated cost estimate. The estimate of net cost is then presented to the senior management for addition of mark-up and subsequent adjudication in order to present a tender to the client. Azzaro et al, (1987) empirical study commissioned by the Royal Institution of Chartered Surveyors, investigated cost estimating from the viewpoint of the quantity surveyor working in the contracting sector. The study, based on a semi-structured survey of 11 main contractors and two subcontractors, sought to identify current estimating techniques and the types of data base used to arrive at tender prices. Issues covered in the study included the determination of

unit prices, preliminaries items and allowances for profits and overhead, as well as the adjustment of prices to take account of such factors as market conditions, site conditions, location and the nature of the tender documentation.

Tah et al. (1994) investigated current practices of estimating the indirect costs involved in tendering for construction work. The study concluded by indicating a high degree of subjectivity involved in indirect cost estimating. It also recognised that the percentage added to the cost estimate is based on the subjective judgement of senior management. The study reported that the subjective decision making processes involved in these tasks are characterised by qualitative data and knowledge that is often vague and difficult to structure and quantify.

Skitmore and Wilcock (1994) investigated estimating processes of smaller builders based on an experiment conducted with eight practising builders' estimators by looking at methods that estimators used to price selected items from bills of quantities and the variability associated with the outcomes. An important conclusion emanating from the research, was that not enough is known about factors involved in cost estimating in practice, although there is a wealth of prescriptive literature available on the subject.

The Code of Estimating Practice prescribes that the estimator, in the course of preparing a cost estimate, should carry out tasks such as a thorough examination of the tender documents, a site visit, the preparation of methods statement and tender programme, a visit to the project consultants and making enquiries and receiving quotations for materials, plant and subcontractors. These tasks are required to determine an approach to pricing the project at a level at which the costs of construction resources could be recovered. The Code of Estimating Practice also requests that the estimator should look for various factors, which may influence the approach to pricing, such as: standard and completeness of the drawn information; tolerances required; clarity of the specification requirements and the quality required; buildability; whether load bearing and non-load bearing

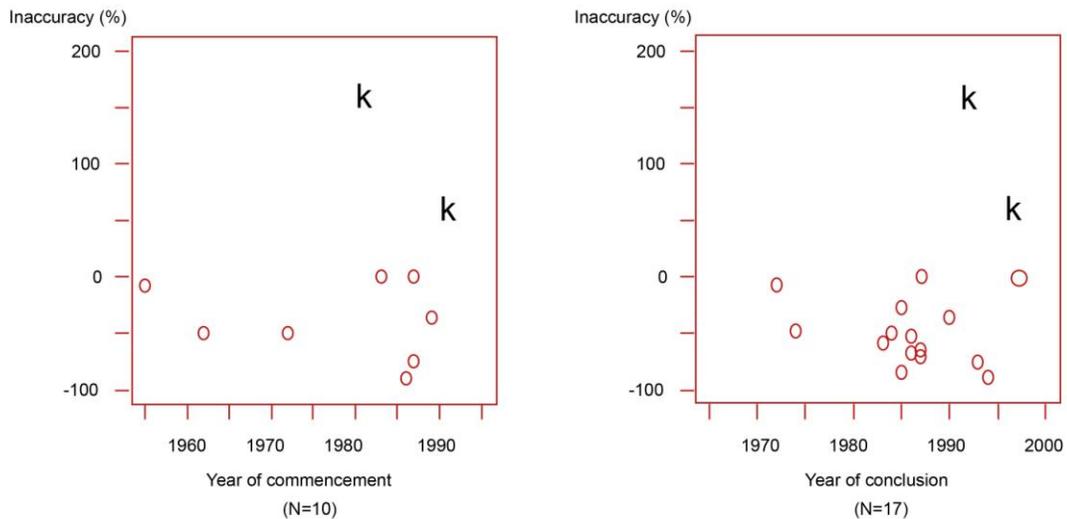
areas can be identified; the extent of the use of standard details indicating previous construction experience; evidence of design co-ordination of services and structural needs; the amount of information concerning ground conditions and foundations; and problem areas and restraints on construction in the design.

The advice provided in the Code of Estimating Practice, on the factors that the estimator should look for, appears inexhaustible. Akintoye and Skitmore (1991a) produced a conceptual model for construction contract pricing, which indicates that the construction pricing process should include factors that influence cost estimating practice and data input to cost estimate.

4.5.3 Estimating using risk analysis

Mak et al. (1998) used a risk analysis methodology to determine construction project contingencies called estimating using risk analysis (ERA). The multiple estimating using risk analysis (MERA) has been documented in Treasury HM as used by a government agency in the United Kingdom. The Hong Kong government introduced ERA in all public works project by identifying and costing risk events, associated with a project (Mak & Picken, 2000). Sonmez et al. (2007) and Singh et al. (1984), also analysed risk factors affecting contingency decisions.

4.5.4 Have forecasts become more accurate over time?



Note: "K" denotes statistical outlier

Figure 1: Inaccuracy over time in forecasts of passenger traffic for rail projects. Adopted from Flyvberg et al. (2005a)

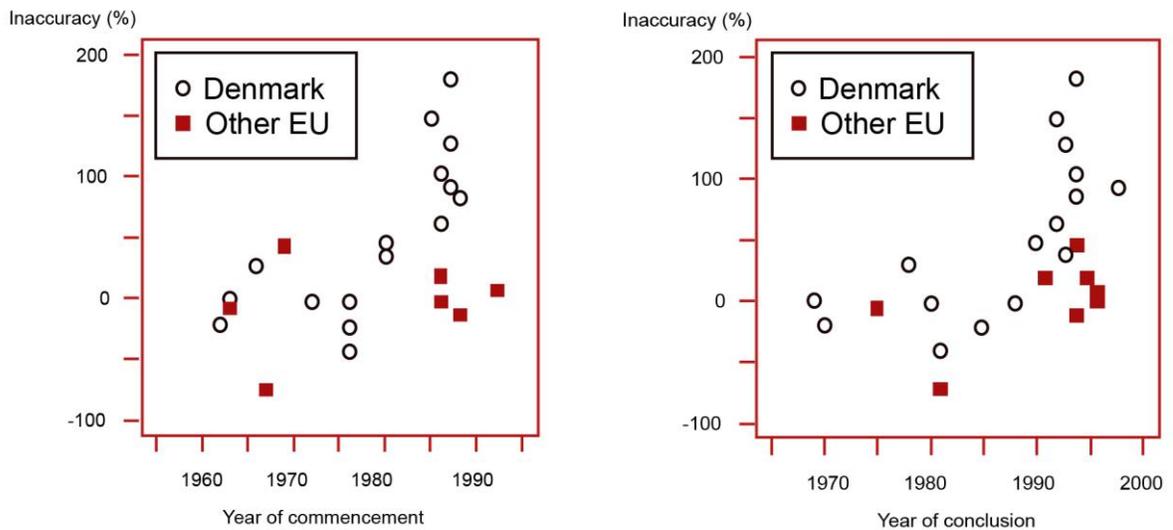


Figure 2: Inaccuracy over time in forecasts of vehicle traffic in road projects (N =24) Adopted from Flyvberg, et al. (2005a)

Figures 1 and 2 (above) show how forecast inaccuracy varies over time for the projects in the sample for which inaccuracy could be coupled with information about year of decision to build and/or year of project completion. Statistical tests

show there is no indication that traffic forecasts have become more accurate over time, despite claims to the contrary (American Public Transit Association, 1990:6,8). For road projects (Figure 2), forecasts even appear to become more inaccurate toward the end of the 30-year period studied. Statistical analyses corroborate this impression. For rail projects (Figure 1), forecast inaccuracy is independent of both year of project commencement and year of project conclusion. This is the case whether the two German projects (marked as “K”) were treated as statistical outsiders or not. We conclude that forecasts of rail passenger traffic have not improved over time.

Rail passenger traffic has been consistently overestimated during the 3-year period studied. The US Federal Transit Administration (FTA) had a study underway indicating that rail passenger forecasts may have become more accurate recently (Ryan, 2004). According to an oral presentation of the study at the annual Transportation Research Board meeting in 2004, of 19 new rail projects, 68% achieved actual patronage less than 80% of forecast patronage. This is a 16 percentage point improvement over the situation Pickrell (1990) depicted. It is unclear, however, whether this reported improvement is statistically significant and despite the improvement, the same pattern of overestimation continues. Risk of large errors remains. A report from the FTA study is underway.

For road projects, inaccuracies are larger towards the end of the period, with highly underestimated traffic. However, there is a difference between Danish and other road projects. For Danish road projects, we found at a very high level of statistical significance, that inaccuracy varies with time ($p < 0.001$). After 1980, Danish road traffic forecasts offered large underestimations, whereas this was not the case for Denmark before 1980, or for other countries for which data exist. During the decade between the second half of the 1970s and the second half of the 1980s, inaccuracy of Danish road traffic forecasts increased 18 fold.

The so-called energy crises of 1973 and 1979 and associated increases in petrol prices plus decreases in real wages had a profound, if short-lived, effect on road traffic in Denmark with traffic declining for the first time in decades. Danish traffic forecasters adjusted and calibrated their models accordingly, on the assumption that they were witnessing an enduring trend. The assumption was mistaken. When, during the 1980s, the effects of the two oil crises and related policy measures tapered off, traffic boomed again, rendering forecasts, made on 1970s assumptions inaccurate.

One concludes that accuracy in traffic forecasting has not improved over time. Rail passenger forecasts are as inaccurate (inflated) today as they were 30 years ago. Road vehicle forecasts even appear to have become more inaccurate over time, with large underestimations towards the end of the 30-year period studied. If techniques and skills for arriving at accurate traffic forecasts have improved over time, the data do not show it. For rail, in particular, the persistent existence over time of highly inflated passenger forecasts invites speculation that an equilibrium has been reached where strong incentives and weak disincentives for overestimating passenger traffic may have taught project promoters that overestimated passenger forecasters pay off in combination with underestimated costs, such forecasts help misrepresent rail projects to decision makers in ways that help get rail projects approved and built (Flyvbjerg, et al., 2003). This suggests that improved accuracy for rail forecasts will require strong measures of transparency and accountability to curb strategic misrepresentation. Such measures form part of what have become known as PPPs - public-private partnerships; and there is some indication that properly designed PPPs may help improve the accuracy of cost forecasts (National Audit Office, 2003). As far as we know, no studies exist regarding the effect of PPPs or similar arrangements on the accuracy of traffic forecasts.

4.5.5 Do project size, length of implementation and geography, matter to accuracy?

For rail projects, based on 17 cases, it was found that inaccuracies in passenger forecasts are not significantly dependent on costs ($p=0.177$), but do have significance dependent on logarithm of costs ($p=0.018$) with higher costs leading to higher inaccuracies. Based on 27 cases, inaccuracies in passenger forecasts are not significantly dependent on estimated number of passengers, neither directly ($p=0.738$) nor taking logarithms ($p=0.707$).

For road projects, based on 24 cases, inaccuracies in vehicle forecast are not significantly dependent on costs, neither directly ($p=0.797$), nor logarithmically ($p=0.114$). Based on 51 cases, inaccuracies in vehicle forecast are significantly dependent on estimated number of vehicles, both directly ($p=0.011$) and even stronger taking logarithms (<0.001), with smaller projects tending to have the most inaccurate (underestimated) traffic forecasts,

We know of only one other study that relates inaccuracy in travel demand forecasting with size of project (Maldonado, 1990, cited in Mierzejewski, 1995:31). Based on data from 22 US airports, this study found that inaccuracy in aviation forecasting did not correlate with size of facility. Additional results indicate no effect on inaccuracy from length of project implementation phase, defined as the period from decision to build a project until operations begin. More data are needed in order to study the effect on inaccuracy from geographic location of projects and type of ownership. With the available data, there are no significant differences among geographic areas, which suggest that until more data is available, planners may pool data from different geographic areas when carrying out risk assessment.

4.5.6 Causes of inaccuracies and bias in estimates

The striking difference in forecasting inaccuracy between rail and road projects documented above, may possibly be explained by the different procedures that

apply to how each type of project is funded. Competition for funds is typically more pronounced for rail than for road, which creates an incentive for rail promoters to present their project in as favourable a light as possible, with overestimated benefits and underestimated costs (see more in Flyvbjerg, 2006; Holm, et al., 2005). We further speculate that rail patronage will be overestimated and road traffic underestimated in instances where there is a strong political or ideological desire to see passengers shifted from road to rail, for instance for reasons of congestion or protection of the environment. Forecasts here become part of the political rhetoric aimed at showing voters that something is being done (or will be done) about the problems at hand. In such cases, it may be difficult for forecasters and planners to argue for more realistic forecasts, because politicians may use forecasts to show political intent, not the most likely outcome.

4.6 Purpose of cost control

Harris and McCaffer (2006) state that a budget acts as a standard of measure against which the actual performance of a project or company may be compared. Flanagan and Tate (1997) suggest that there are two options when formulating the first estimate:

- Cost limits stipulated by the client; and
 - Detailed descriptions of other building given to the design team by the client.
- Project budgets often range between the two extremes.

Flanagan and Tate (1997) state that clients want certainty of prices and that the project should be constructed and completed on time. Best quality, value for money and lastly no surprises are what the clients want. Therefore, the purpose of cost control is to ensure that the final account does not exceed the first estimate accepted by the project owner. This is the basis of cost control procedures.

4.7 Occurrence of variation orders

There are many reasons why variations occur. They may be due to extra work caused by subsurface conditions, errors in contract documents, additional quantities of work or materials, reduction of work, or lack of proper communication between the parties. The needs of the owner may change in the course of design or construction, market conditions may impose changes to the parameters of the project, and technological developments may alter the design and the choice of the engineer. The architect's review of the design may bring about changes to improve or optimise the design and hence the operation of the project. All these factors and many others necessitate changes are costly and generally unwelcome by all parties.

4.7.1 Definition of variation orders

There is no single definition of what constitutes a variation. Usually, any standard form of building contract will contain a definition of a variation in terms of specific actions and activities. Mohammad, et al., (2010) define variation as "an alteration or modification of the design, quality or quantity of the works as shown in the contract drawings and described by or referred to in the contract bills".

4.7.2 Classification of variation orders

Variation orders can be classified in many different ways depending on the basis and the purpose of classification. In this review, the most common classifications are presented. Changes in a construction project can be classified based on the cause that forced them. Burati et al. (1992) state that changes in constructions are caused by design, construction, fabrication, transportation or operability. Design changes, which were found to constitute 52.5% of all changes, fall mainly into three categories:

- Design changes caused by improvement through the design process (DCI). Examples are changes resulting from design reviews, technological advances or constructability reviews.
- Design changes originated by the owner (DCO). Examples are scope changes.
- Design changes initiated by an engineer or consultant familiar with the process (DCP). Examples are additions of pumps, valves or instrumentation that affect the operation of the facility.

4.7.3 When to apply risk analysis

Range estimates are dynamic, not static, and should be applied regularly through all phases of project design and construction. As the estimates go from an order of magnitude Class 5 estimate to a detailed Class 1 or 2 estimate, range estimates should be conducted to refine the contingency number. Then, as the project progresses, range estimates should be done at least quarterly to track the use of contingency and to reflect project progress. This enables contingency to be released when it is no longer needed. Contingency should never be held until project completion. Periodic range estimates will indicate when contingency can and should be released. Periodic range estimates will also highlight trouble areas, which have developed, or are developing, which may require corrective action and/or a revision of the project budget.

4.7.4 Factors affecting accuracy of estimates

The success or failure of a project depends on the accuracy of several estimates done throughout the course of the project (Ahuja et al., 1994). Therefore, the preparation of cost estimate of the project is one of the most difficult tasks in project management because it must be done before the work is accomplished (Oberlender, 1993). Pre-tender cost estimating is simply the final costing of the works carried out by a consultant (i.e. quantity surveyor or engineer) on behalf of

their client before tenders are received (Odusami & Onukwube, 2008). It sits somewhere between cost planning and the post-contract cost control, provides an indication of the probable construction cost prior to contract-awarding, and involves collecting, analysing and summarizing all available data related to the construction of the project (Holm et al., 2005). Thus, for the contractor to secure a job, their cost estimate must be as accurate and competitive as possible (Marjuki, 2006). Evidently, inadequate estimating invariably leads to misallocation of scarce resources (Flyvbjerg et al., 2002).

The outcome of an estimate can be accurate, underestimated or overestimated. An accurate estimate generally results in the most economical project cost, while an underestimate and overestimate often lead to greater actual expenditures. Inaccuracy in the estimate of a project may arise from two sources, namely bias associated with the project itself and bias associated with the estimating techniques used and operating environment (Aibinu & Pasco, 2008). Accurate estimation of construction costs is heavily dependent upon the availability of quality historical cost data and the level of professional expertise among other things. The limited information available at the early stages of a construction project may mean that the quantity surveyor must take assumptions about the design details of a project, which may not eventuate as project design, planning and construction evolve (Liu & Zhu, 2007).

Professional estimators have access to reliable cost and productivity references for estimating labour, material, equipment and other major work components. These major cost items have a high visibility factor and consequently receive adequate attention in the preparation of the pre-tender estimate. However, there are little known, low visibility factors affecting the estimate accuracy such as procurement form and contract arrangement which should be taken into consideration in the preparation of pre-tender estimates. Unfortunately, these factors are either entirely overlooked or sadly neglected by estimators.

Various studies focused on identifying the factors that have some influence on the accuracy of estimating the costs of construction work. Based on previous studies, Gunner and Skitmore (1999) identified twelve factors. These are building function, type of contract, conditions of contract, contract sum, price intensity, contract period, number of bidders, good/bad years, procurement basis, project sector (public, private or joint) and number of prices items of drawing. Ling and Boo (2001), using data from 42 projects in Singapore, found similar results when they compared five variables against Gunner and Skitmore's work. Skitmore and Picken (2000) studied the effect of four independent variables (building type, project size, sector and year) on estimating accuracy and tested these variables against 217 projects from a quantity surveyor based in the USA. They found that bias existed in project size and year, and consistency errors existed in project type, size and year.

By reviewing 67 process industry construction projects around the world, Trost and Oberlender (2003) identified and grouped 45 factors, contributing to the accuracy of early stage estimates, into 11 orthogonal factors. Of these 11 factors, the five most important are process design, team experience and cost information, time allowed to prepare estimates, site requirements, and bidding and labour climate. Elhag et al. (2005) state that technological and project design, contractor's expertise and management ability, and the client's desired level of construction sophistication, play an important role in determining the cost of the project. According to them, most of the significant factors affecting project costs are qualitative such as client priorities (i.e. completion time, procurement methods, market conditions, etc.).

Enshassi et al. (2007) examined cost estimating practices in contracting companies operating in the Gaza Strip. Their study revealed that the most important factors that affected contractors cost estimate are financial status of client, type of current contractor workload and project location relative to hostile 'hotspot' areas. According to Liu and Zhu (2007), two types of factors influence and contribute to the cost of a project, namely control factors and idiosyncratic factors.

Control factors are the factors that can be controlled by estimators to improve the performance of estimation while idiosyncratic factors influence cost estimation but outside the control of the estimators including market condition, project complexity, weather, size of contract, site constraints, resource availability, type of procurement system, contract work type, etc. (Liu & Zhu, 2007).

4.8 Estimating

Estimating is a fundamental part of the construction industry. The success or failure of a project depends on the accuracy of several estimates throughout the course of the project. Construction estimating is the compilation and analysis of many items that influence and contribute to the cost of a project.

Estimating, which is done before the physical performance of the work, requires a detailed study and careful analysis of the bidding documents, in order to achieve the most accurate estimate possible of the probable cost consistent with the bidding time available and the accuracy and completeness of the information submitted. Overestimated or underestimated cost has the potential to cause loss to local contracting companies.

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4.8.1 Factors affecting accuracy of estimates

According to Enshassi, et al., (2005) the construction industry in most countries is one of extreme competitiveness, with high risks and low margins of profit when compared with other key industries. Consequently, pricing is one of the most important aspects of marketing in construction (Mochtar & Arditi, 2000). Shash and Al-Khaldi (1992) identified factors affecting the accuracy of cost estimating. These were classified as financial issues, bidding situations, project characteristics and the estimating process itself. Ashworth (1994) summarised nine factors that have some influence on the accuracy of estimating the cost of construction work. These factors are availability of design information, type and quality of cost data, type of project, project size, number of bidders on competitive projects, stability of market conditions, personal factors, proficiency in estimating, and sheer quantitative experience. Additional factors that affect the accuracy of cost estimating were identified and classified as financial issues, bidding situations, project characteristics and the estimating process itself (Akintoye & Fitzgerald, 2000; Shash, 1993).

The cost estimator, in the course of preparing a cost-estimate, is expected to carry out tasks such as a thorough examination of tender documents, a site visit, the preparation of methods statement and tender program, a visit to the project consultants, and make inquiries and receive quotations for materials, plant and subcontractors (Akintoye, 1998). The major problems facing cost estimators in preparing cost estimates, in order of importance, are tough competition, contract period, incomplete drawings and specification, incomplete project scope definition, unforeseeable changes in materials prices, changes in owners requirements, current workload, errors in judgement, inadequate production time data, lack of historical data for similar jobs and lack of experience in similar projects (Akintoye & Fritzgerald. 1999; Shash, 1993). Project complexity, project information, technological requirements, contract conditions, contractor's efficiency, market requirements, project duration, and project's risks have been identified as the main

groups of factors which affect the accuracy of cost estimating. These eight groups were identified from previous studies (Shash, 1993; Shash & Al-Khaldi, 1992; Ashworth, 1999; Ahuja, et al., 1994; Baccarini, 1996; Akintoye, 1998; Akintoye & Fitzgerald, 1999).

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4.9 Cost in management

Despite the environmental, managerial and technological changes that have occurred in the last thirty years, the existing traditional cost management systems are very similar to the ones that have been used since the mid-twenties (Johnson

& Kaplan, 1987). In the face of all those changes, traditional cost account information has become mostly irrelevant and even dangerous for managerial purposes (Ploss, 1990). The failings of the traditional management accounting systems have three important consequences. Firstly, such systems cannot provide accurate product cost. Costs are distributed to products in a simplistic and arbitrary way that usually does not represent the real demand imposed by each product on the company's resources (Johnson & Kaplan, 1987). Secondly, traditional management accounting systems fail to stimulate decisions that can affect the overall production result. Managers are sometimes encouraged to accomplish short-term goals by reducing expenses with training and investment, or even produce to stock. Although effective in short term, such decisions can seriously affect future results (Goldratt & Cox, 1992). Finally, the cost management information provided by the traditional systems is of little help to managers in their effort to improve production performance. The information provided is past-oriented and too aggregated to be useful in planning and control decisions, because these systems are developed mostly to satisfy fiscal and financial needs. The lack of transparency allied with the lack of timeliness prevents the traditional cost information to help in the identification and correction of production flow inefficiencies. Particularly in the construction industry, the inadequacy of cost accounting systems has resulted in the dissociation between cost management and production management.

A review of existing literature indicates that the main problems that account for the poor performance of traditional cost management systems are related to flaws in the cost estimating and cost control processes, inadequate information modelling, and the lack of integration of cost management and production management systems (Ostrena & Ozan, 1992; Barnes, 1977; Fine, 1982). Traditional cost management systems are not linked to the goals set by the business (i.e. quality, time, profitability).

Ostrena and Ozan (1992) argue that cost estimates, in general, are not reliable due to the oversimplifications made when costs are attributed to products and services. By contrast, traditional cost control processes are also criticised because they simply identify variances by monitoring actual performance against cost estimates. Cost information is made available too late, and is too aggregated and too distorted to be relevant for production planning and control. This traditional cost management approach has also been adopted in construction, typically emphasising the production of external reports, and lacking managerial focus (Howell & Ballard, 1996).

The gap between the information made available by cost management systems and the goals set by the business makes project assessment in relation to strategic goals difficult. However, this kind of analysis is essential in order to reflect the real project dynamics and to signal situations requiring special attention (Ostrena & Ozan, 1992).

According to (Koskela, 2000) in the construction industry, traditional management was identified as ineffective mainly for the fact that it does not take into consideration the nature of the product and the production processes involved, due to the inadequacy of its conceptual base. Unlike other industries, the product of the construction industry is one-of-a-kind and most of the production takes place in a haphazard temporary environment, which is vulnerable to weather conditions. As a result, substantial changes may occur during product development and production processes and these pose a risk to the early estimates on which the business case is based (cost estimates, design, contracts, production planning). Owing to the unique characteristics of the product involved, specific information is necessary for each new project. This means that cost management models developed for industries in which processes are repetitive, cannot be easily adapted to construction projects. For this reason, uncertainty, variability, interdependence and complexity play a key role in the construction scenario and the challenge facing

management practices is to eliminate or to reduce the impact of these features (Koskela, 2000).

Horgren et al. (1990) regard a cost management system as a framework for project cost information. According to Berliner and Brimson (1998), those systems consist of set of principles, methods and tools whose main objectives are to estimate costs and to generate information in order to support different managerial decisions during the distinct phases of a project. Horgren et al., (1990) argue that cost management must not be isolated from other managerial functions, and should play a key role in the implementation of the company strategies. According to Kim (2002), particularly in the construction industry, cost management systems must include the processes required to ensure that the project is completed within the approved budget. These processes include cost estimating, cost control and cost projection.

4.9.1 Cost estimating process

The objective of a cost estimating process is to estimate the cost of products and processes involved in production. This requires a thorough understanding of the design, contracts and production in order to properly model the consumption of resources by transformation and flow (non-value adding) activities. In construction, the cost estimating process usually starts by producing a budget, normally at the early phases of the project (CII). As project cost estimating is a very complex task owing to the inherent uncertainty and variability of construction, the cost control process must provide feedback on the cost estimating process in order to improve the quality of the information available in the cost database that will be used in future cost estimating processes.

4.9.2 Cost planning and control processes

After costs have been estimated, the financial performance must be planned and controlled during the production phase by means of a cycle composed by two sub-processes, cost planning and cost control.

Cost planning involves refining the initial cost estimate and generating a project cash flow, based on additional information generated along the project, such as the schedule of payments for the main material suppliers and subcontractors, which should be based on production plans. In addition to cost estimating, this process relies heavily on feedback from the cost control process. Plans have to be changed whenever necessary and situations that need special attention must be highlighted.

4.9.3 Cost management processes

Cost estimating processes use information from existing cost databases, contracts, design and production plans. On the other hand the information generated by the cost management system supports the design and production planning and control process and should be used to update the cost database. Similarly, to production planning and control, cost planning and control is a cyclical process. It uses information from the cost estimating and production control processes to provide feedback to the cost database that will be used in future projects. As contracts, designs and production planning and control are dynamic, cost management systems must assume a proactive character and be flexible to absorb changes that may occur. Owing to the different processes and distinct objectives found in construction project cost management systems, it can be assumed that different management techniques and tools are necessary. This article suggests changes on the way construction costs are modelled, by introducing an operational approach to cost estimating.

4.9.4 Operational view of cost estimating

Traditional cost estimates are strongly based on the transformation view of production, usually containing activities that are measured according to the quantification of finished elements, for example walls (m²), concrete (m³), windows (units), obtained from design drawings. This approach is based on the standard cost method (Kaplan & Cooper, 1998). Because of this perspective, flow activities tend to be neglected in cost control. Such activities do not add value to the product but have a high impact on the final cost of the product. Moreover, factors such as production complexity, team productivity and the learning effect are not usually taken into consideration by traditional cost estimating practices for the same reason.

Fixed costs depend to a great extent on the duration of some construction stages (Barnes, 1977). By keeping the nature of the production process into perspective during the estimating process, for instance, by making flow activities more explicit, it is expected that it will become easier to align production planning and control and cost estimating.

4.9.5 Prime costs of provisional sums

According to Olusegun (2010), the Nigerian Institute of Quantity Surveyors, (1988) and JCT (1980), Ramus (1981), Seeley (1984) defined:

- i. Prime cost sum as a sum provided for work or services to be executed by a nominated subcontractor, a statutory authority or a public undertaking, or for materials or goods to be obtained from a nominated supplier. The sum shall be deemed to be exclusive of any profit required by the general contractor and provision shall be made for the addition thereof.

- ii. Provisional sum as a sum provided for work or for cost which cannot be entirely foreseen, defined or detailed at the time the tendering documents are issued.

The finding of Ayodele (2004) showed that the adjustments of prime cost and provisional sums are some of the causes of cost and time overruns in the construction industry. According to Giwa (1988) allowances made for prime cost in contract bills cause overruns in the contract sum because the actual costs are in most cases higher. This, according to Ogunsemi (2007), is because the quantity surveyor usually allows for arbitrary figures. In fact, the amount allowed for has often led to high figures in order to be on the safe side. Ogunsemi (2007) opined that the way and manner by which provisional sums are allowed for in the contract bill and later expended, has a lot of impact on the final cost of a construction project. The more the provisional sums are inserted into contract bills, the less precise and realistic the initial contract sum will be with respect to the final cost. According to Ogunsemi (2007) an ideal bill of quantities is one which contains neither prime cost nor provisional sum.

4.10 Variation orders

4.10.1 Managing project change orders

Very few projects are implemented without any change to the original scope of work (Hansen, 1994). Change orders are often taken as an indicator of someone's failure to fulfil his or her functions in the construction process. It is argued that no one benefits from change orders during the construction period. They are generally disruptive of the orderly progress of the work and are usually an economic burden on both client and contractor (O'Leary, 1992). Change orders are seen as a major cause of project delay and a source of many disputes in today's construction industry (Al-Khalil & Al-Ghafly, 1999; Hanna et al., 1999; Mezher & Tawil, 1998; Zaimi, 1997). On the other hand (O'Brien, 1998; PMI, 2000), client organisations use change orders to achieve their emerging requirements and adapt to influential

internal and external drivers, such as exploiting new business opportunities and installing an improved technological system not available during the brief and design stages. Smith and Wyatt (1998) state that the external forces may drive changes and clients respond to these forces by demanding a design that is more effective and more efficient. Chapman (1997) emphasises that effective client organisations are those that adapt and change in response to their environment and markets. In addition, successful design practices are those that manage changes successfully. As a result, the more influential the internal and external drivers, the greater the use of change orders, particularly during the construction and after practical completion stages. There is a need to decide on how to react to these drivers for the benefit of the project. This decision process should include the consideration of potential value and associated risk and be dynamic and ongoing.

4.11 Conclusion

This chapter examined the importance of accuracy in cost forecasting and estimation in construction projects, as well as the importance of gauging risk. There are a number of processes associated with estimation, cost management and risk mitigation strategies that are applied to financial aspects of the construction phase. Costs and budgets require careful consideration because of the amounts associated with large construction projects. If these values are not adequately determined, it could result in unnecessary increases in funding, work schedule and quality of work.

The next chapter examines the importance of risk management and contingency in the life cycle of construction projects and the importance of planning for contingency worst-case scenarios and other events.

CHAPTER 5

RISK MANAGEMENT FOR CONTINGENCIES

5.1 Introduction

Risk management is the process of considering and managing the risks associated with a construction project and using this information to plan for contingencies and outcomes that may have an undesirable effect on the work flow of the project lifecycle. A number of techniques are used to calculate values for risk, many electronic and using up to date technology and software to perform the calculations. Identifying risk is an important skill in the quantity surveying field as the quantity surveyor needs to take these risks into account when determining certain financial implications of a construction project. Risk is factored into the cost estimation process and contributes the fluctuation of project pricing schedules.

5.2 Risk management

Project risk management is the most important key factor in the success of engineering and construction projects. As the number, complexity and scope increase worldwide, the stakes may endanger the survival of corporations and threaten the stability of countries that approach these projects unprepared. The latest global boom in the construction industry, especially in the construction of high-rise buildings and bridges, has made it imperative that steps be taken to ensure that these projects are successfully executed to meet the expectations about time, quality and costs by implementing project risk management which is, in most cases, neglected, or not given attention in modern project management.

Chihuri and Pretorius (2010) state that there is a paradigm shift in the management of risk in projects due to a number of factors, for example, the increase of pressure from stakeholders, tight regulatory requirements, external environmental threats, global competition, and increased operational complexity. These factors have

influenced the elevation of risk management to senior management level, which has made project success more critical to business performance, but projects still suffer overruns, delays and failures. They further explain that research conducted has proven that project performance would improve considerably through the application of risk management since about 70 – 90% of challenges experienced on projects are anticipated in most cases.

Chihuri and Pretorius (2010) suggest that the complexity of modern capital and operational projects predisposes these projects to occurrence of risk more than traditional projects (which are less complex), and that the combination of these trends results in a disproportionate level of high likelihood and high consequence risk to the projects, hence the role of risk management in project execution is emphasised.

There are numerous examples of high-risk projects, for example Europe's Channel Tunnel, which was opened in 1994 at a construction cost of £10 billion; it is a typical example where several near-bankruptcies were caused by excessive overruns. Hong Kong's ± £-15 billion Chek Lap Kok Airport which was opened in 1998 had a ripple effect on the revenues at the airport to the wider Hong Kong economy; it had a negative effect on GDP growth and cost the Hong Kong economy ± £-350 million.

5.3 The South African project environment

According to Chihuri and Pretorius (2010), the construction industry plays a key role in South Africa and the selection of South Africa to host the 2010 FIFA World Cup led the country to embark on a number of large and complex projects. These projects had to meet FIFA's minimum required standards to make the event a success. This occurred while South Africa was already experiencing a booming construction industry. This included the construction and refurbishment of stadia, hotels, airports, roads, ports, telecommunication infrastructure and the Gautrain

Rapid Rail Link which is set to link Tshwane, Johannesburg and OR Tambo International Airport.

The Gautrain was a public-private partnership between Bombela and the Gauteng government. It is the first of its kind in South African and inherently complex and risky with substantial costs that affect the political, social, economic and financial aspect of the country; therefore specific project risk management was required.

Chihuri and Pretorius (2010) also explain that large and complex projects like the Gautrain and the media make risk management imperative in the South African context for the following reasons:

- Proper and careful management of risk would increase gains because their size implies that there may be large potential losses unless they are managed carefully – and conversely, large potential gains if risks are managed well.
- Gautrain, which is operated by the government, demands added focus on the risk to identify and manage any residual risk government
- It often involves unbalanced cash flows needing large initial investment before meaningful returns are obtained compounded by changing conditions and changing patterns of demand.

5.3.1 Major risks in South African projects

Chihuri and Pretorius (2010) outline the following as the major risks presently faced by South African projects:

- Escalating costs

The Gautrain and the World Cup stadia were initially estimated at R7 billion and R6 billion in 2002 and 2005 respectively, which ultimately cost R25 and R10 billion on completion. These increases have largely been attributed to escalating construction material costs, the unsteady rand exchange compounded by the downturn in the world economy and rising oil prices.

- Power shortages

The Eskom national electricity crisis threatened major projects and debilitated the industry and inhibited needed economic growth, but some players had contingency plans to ensure uninterrupted progress. In some instances, some sites resorted to non-disruptive load shedding, mostly at night, while others used alternative measures to minimise disruptors on site.

- Skills shortages

Skills shortages in the country, especially in engineering and construction, also had an effect on the performance of some projects, leading to sourcing skills from foreign countries, which also increased projects costs.

5.4 Identifying risk factors

Risk in construction has been the object of attention because of time and cost overruns, associated with construction projects. This project of construction is regarded successful when it applies the iron triangle constrains time, cost and quality. The construction industry is full of projects which completed with excessive time and cost (Ameh et al., 2010). This case study was conducted to identify the main causes of cost overruns in building construction projects. For the purpose of this research, cost overruns are defined as the difference between the final cost of a construction project at completion and the contract amount, agreed by and between the client and the contractor at the signing of the contract.

According to Ali (2005), most firms have adopted a rule of thumb which is applied during estimation to take care of risk in relation to cost on the project. Gunhan and Arditi (2005) posit that one of the simplest methods of estimating contingency margins for construction projects, is to consider a percentage of the estimated contract value such as 10%, across the entire project commissioned by the owner typically derived from intuition, past experience and historical data.

Hervert (2011) postulates that risk identification has revealed two categories of risk, namely:

Systemic and project specific risks: Systemic risk is that risk which can be identified at the onset of the project and can be predicted to impact a project which would likely result in cost overruns if good planning is not made towards it. Systemic risk is said to be an artefact of the project system, culture, process, technology or complexity. Systemic risks are more inclined to design factors, scope definition and factors within the direct control of the project team.

Project specific risks are factors that may affect the artefact of the project. These include delivery delays, constructability, site conditions, terms and conditions and can be termed as factors beyond the domain of the design team (Hervert, 2011). These risk factors are associated with the construction which can be neither determined now, nor be predicted in the future, However, systemic risk drivers may have a possible effect on cost growth includes basic design, level of technology, process complexity, material quality, soil requirement engineering design, schedule development, team experience, cost information, bidding and labour climate, and cost information available (Hollmann, 2006).

Molenaar and Wilson (2009) posit that, in the estimation of contingency using risk analysis, three-tier risk must be used. She defined risk type I, as risk identification using contingency and percentage, risk type II, as qualitative risk analysis and identified contingency items, and risk type III, as a quantitative risk analysis and active contingency management. The conceptual framework for the above work as depicted in Figure 3 reveals the most important aspect of project risk management as risk identification, which commences simultaneously with risk management planning. As already discussed, systemic risk is related to the artefact of the system, which can be predicted across projects, while project specific risk has its impact varying by project.

5.4.1 Modification of advanced programmatic risk analysis

Many engineering projects face budget and time constraints for various reasons, including the current world economic climate. A successful project is usually identified by its ability to be completed on time and within budget in conformance with technical requirements. In order to achieve these objectives, construction managers need to be equipped with efficient decision-support tools that help them to improve the distribution of the allocated project resources considering cost, time and quality, while simultaneously minimising the risks of project failure. Complicated as this is, balancing resource allocations and the risk of project failure becomes even more complicated, as the project's resources become more constrained. Managers need to make critical decisions that affect the project outcomes. They have to choose a feasible construction style, including both design and construction (D&C) issues for all potential technical and managerial failures as well as in-service problems that might affect the project's performance.

The literature shows that there is a variety of methods available for use in the management of risks in the construction industry (Abdou, 1996; Forbes et al., 2008); however, most of these techniques address either those risks relating only to cost, schedule or structural reliability, or those relating to a combination of cost and schedule risks (Imbeah & Guikema, 2009). In some projects, a large number of interdependent components are involved which lead to complicated trade-offs among the competing risk elements, including cost, schedule and technical performance.

The advanced programmatic risk analysis and management model (APRAM) was first introduced for the aerospace industry, particularly the management of the National Aeronautics and Space Administration's 'Faster, Better, Cheaper' unmanned space missions. These tasks are characterised by an attempt to produce a quality system in a shorter time and at reduced cost relative to traditional

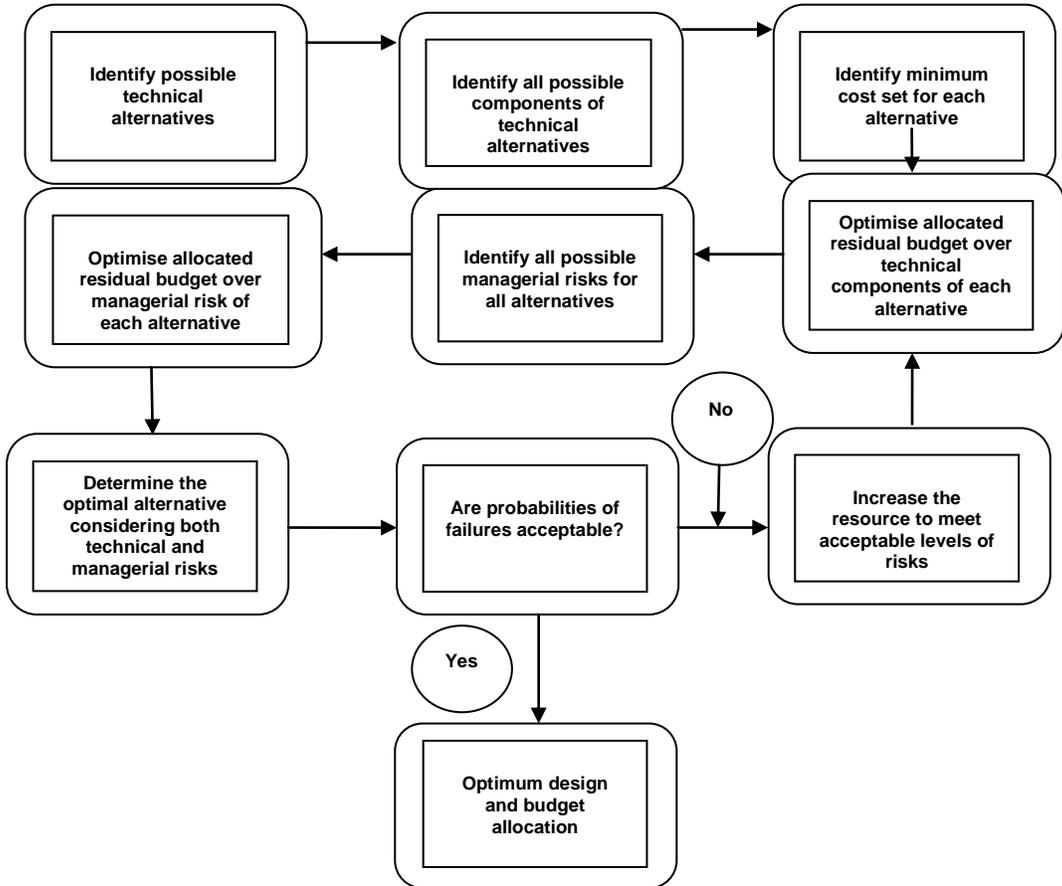
methods (Dillon & Pate-Cornell, 2001; Dillon et al., 2003). APRAM is one of the techniques that can be used as an efficient decision-support tool for the risk management of construction project failures (Imbeah & Guikenia, 2009). The model was developed to address the need to balance different types of project risks concurrently. APRAM permits explicit quantified optimisation of budget reserves allocation through trade-offs between technical and managerial failure risks based on the preferences of the decision maker(s). It also allows for checking whether technical and managerial risks meet the thresholds of acceptability (Dillon et al., 2003). Imbeah and Guikenia (2009) state that this method can be used in the housing industry to help project managers address all identifiable failure risks and compare different potential construction methods. In reaching this conclusion, they took into account only the design and construction parts of the project.

5.4.2 Advanced Programmatic Risk Analysis and Management (APRAM) Model

APRAM can be used by project managers to identify three sequential optimisation steps (Dillon, 1999). The first step is to identify all feasible technical design alternatives, considering the budgets that can be spent on the project in order to minimise the technical probability of failure (PF) for each alternative. In this step, all possible components for the major portions of the building such as foundation, roof and cladding as well as their preliminary cost estimation should be specified. Then the minimum cost set for each technical design alternative and its appropriate residual budget are identified. The residual budget refers to the difference between the total project budget and the minimum cost of each alternative that is available for improving the project either technically or managerially. The next stage in the first step includes optimising the allocated residual budget over the different components of each design alternative, and then choosing the optimum technical alternative. For this purpose, the possibility of enhancement of the technical aspects of each alternative, based on the allocated portions of the residual budget,

is investigated as a nonlinear optimisation problem. The allocated cost for solving the optimisation problems can vary from 0 to 100% of the total residual budget.

In the second step, managerial risks over the available range of potential reserve budget should be identified and then minimised for each alternative by using appropriate optimisation strategies. These strategies are chosen by the determination of all potential managerial risks that might occur for each technical design alternative as well as any possible mitigation actions that can be used for each managerial risk. This step is similar to the first step, except that the optimisation is applied in allocating a part of the budget to lowering managerial risks including schedule and budget issues.



**Figure 3: Steps and sub-steps involved in implementation of APRAM
Adopted from Zeynalian, Trigunaryyah, & Ronagh (2013)**

The final step is the determination of the optimum technical design alternative considering both technical and managerial risks. Each technical design alternative may need a different portion of the residual budget through trade-offs between technical and managerial failure risks based on the preferences of the decision maker(s). Finally, project managers should choose the alternative that offers the best value, considering probabilities of failures of the project and the associated failure costs. If this is not satisfactory, the allocated resource should be increased until the selected alternative meets the threshold of acceptability. Figure 3 (above) shows the steps and sub-steps involved in the implementation of APRAM

5.4.3 Life cycle cost

The life cycle cost (LCC) of a project is defined as the project's total costs that are spent throughout all phases of the entire life cycle of the project, including design, construction, operation, maintenance and repair, and even demolition as shown in Figure 4. LCC involves both operational and embodied energy, i.e., life cycle energy, attributable to buildings over their lifetime (Fay, 2000).

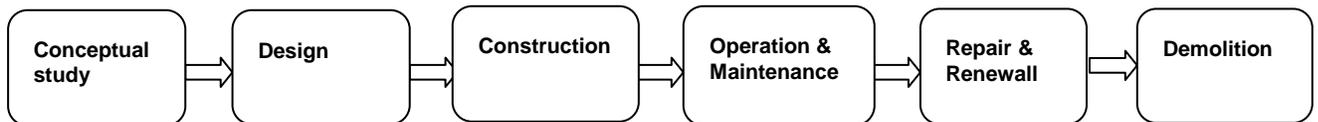


Figure 4: Life cycle phases of a project
 Adopted from Zeynalian, Mehran, Trigunarsyah, Bambang & Ronagh (2013)

APRAM should be modified so as to cover the whole life cycle cost of the project considering the time value of money. As the value of money changes with time, the expenditures made at different times are not equal.

5.4.4 Assessing risk probability: alternative approaches

Effective risk management requires assessment of inherently uncertain events and circumstances, typically addressing two dimensions: how likely the uncertainty is to occur (probability), and what the effect would be if it happened (impact). The

credibility and value of the risk process is enhanced if data are collected with care, taking the time and using the tools that are needed properly to develop information based on judgemental inputs. Conversely, the process is undermined when probability assessment appears to be wholly subjective (a guess). It is therefore important to be able to assess probability with some degree of confidence.

5.4.5 Two-dimensional risk

There is broad consensus on the definition of 'risk' among leading national and international standards and guidelines, as well as professional bodies (for example, Simon et al. 1997; Australian/New Zealand Standard AS/NZS4360 1999; Project Management Institute, 2000; British Standards Institute, 2000; Institution of Civil Engineers, 1998; UK Office of Government Commerce, 2002; Institute of Risk Management, 2002). Although the precise wording of different definitions may vary, all agree that risk has two dimensions. The first relates to uncertainty, since a risk is something which has not yet happened and which may or may not occur. The second is about what would happen were the risk to occur, since risks are defined in terms of their effect on objectives. A typical two-dimensional definition of risk in the realm of project management is "An uncertain event or condition that, if it occurs, has a positive or a negative impact on a project objective" (PMI, 2000:127).

It is common to use the terms 'probability' and 'impact' to describe these two dimensions, with 'probability' addressing how likely the risk event or condition is to occur (the uncertainty dimension), and 'impact' dealing with the extent of what would happen if the risk materialised (the effect dimension). Clearly an uncertain event which is likely to occur (i.e. it has high probability), but which would have little or no effect on objectives (low impact), is not significant. Similarly, a risk may have such a low probability that it might not be worth considering even if some significant impact were theoretically possible. Risk management processes often include frameworks for determining the significance of a risk based on both

probability and impact, such as the two-dimensional Probability-Impact Matrix (PMI, 2000:137).

For assessments of risk to be consistent and meaningful, attention must be paid to the way in which probability and impact are assessed. Assessing impact is an exercise in structured imagination: “If this were to happen, what would the effect be?”. The other dimension of risk, however, is less amenable to assessment. Risk practitioners and project teams alike, experience repeated difficulty in assessing the probability that a given risk might occur.

5.4.6 Problem with probability

The first problem in assessing the probability of project risks is the term itself. ‘Probability’ has a precise statistical meaning; for example, “a measure of the relative frequency or likelihood of occurrence of an event, whose values lie between zero (impossibility) and one (certainty), derived from a theoretical distribution or from observations” (Collins, 1979). However, its general usage is less clear, including its use within the risk management process. Confusion has also arisen as a result of the use of alternative terms in risk guidelines to describe the uncertainty dimension, such as ‘frequency’, ‘likelihood’ or ‘chance’, giving the impression that these are mere synonyms for ‘probability’ when in fact they are distinctly different. If the uncertainty dimension of risks is to be properly assessed and described using the term ‘probability’, it is essential that assessors understand what they are trying to assess. Projects themselves exhibit certain inherent characteristics that have a significant influence on assessment of risk probability.

5.4.7 Projects are unique

A project may be defined as “a temporary endeavour undertaken to create a unique product, service or result” (PMI, 2000), or as “a unique process, consisting of a set of co-ordinated and controlled activities with start and finish dates,

undertaken to achieve an objective conforming to specific requirements, including the constraints of time, cost and resources” (British Standards Institute, 2000; British Standards Institute, 2002). It is inherent in the nature of projects for at least some aspect of the undertaking to be unique. Consequently, for significant elements of the project, there is no body of relevant previous experience on which to draw. Since the objectives of a given project are likely to be different from those of previous projects, the risks affecting a new project are also likely to be different.

5.4.8 Non-availability of ‘risk actuals’

Some risks on a given project will have arisen previously, since not all aspects of every project are unique. Even for these risks, data are often not available from previous projects owing to the weakness of the project closure process in many organisations. It is widely recognised that project closure is the least well implemented of the project processes, and that many organisations do not have effective ways of learning lessons from completed projects in order to benefit future projects. Without an effective ‘lessons to be learned’ process, each new project has to face its challenges without access to the structured experience of past projects. This affects risk management in the same way as all other elements of project management. It is rare to find an organisation which conducts post-project reviews to identify and capture risk-related lessons to feed forward to future projects. Such lessons should include which identified risks actually occurred and why, and determine whether there are any generic risks that might affect similar projects. It should also address which identified risks did not occur and why, which responses were effective in managing risks, and which were ineffective. Without such “risk actuals” from previous projects, the task of assessing the probability of risks that recur on a later project is made more difficult.

5.4.9 Unknowable risks

Sometimes risks are identified for which some details are inherently unknowable. Where the impact of an uncertain event cannot be defined, it is arguable whether it should be raised as a risk at all, since a risk must by definition affect an objective if it occurs. An uncertainty that does not affect an objective is not a risk. It is, however, possible to identify a risk but for its probability of occurrence to be unknowable. This can arise where occurrence of the risk depends on influences outside the project (such as the decisions and actions of other stakeholders or competitors), or where the project team lack the necessary knowledge to understand and assess the risk, or in the case of uncertain events which are in the realm of pure chance.

5.4.10 Estimating vs. measuring

A further problem with assessing risk probability is that risks are possible future events that have not yet occurred, and as such, their probability of occurrence cannot be measured but can only be estimated. In a philosophical sense it can even be said that the risk does not have a real existence in the present, but it only exists in the future. It is therefore not possible to measure any characteristic of a risk since it is not present in reality. It is only possible to estimate what the risk might be like if and when it should arise. This is not too difficult when considering the impact of the risk, but estimation of risk probability is much more problematic. Consequently, estimation of probability tends to be influenced by a wide range of subjective and unconscious sources of estimating bias, making it even less reliable. Such sources of bias need to be understood and managed if realistic and useful assessments of probability are to be made.

5.4.11 Sources of estimating bias

The topic of estimating bias is too wide to be covered in this thesis, but it deserves mention since it has such a major influence on the ability to assess risk probability.

The area is also well covered in the literature (for example, Fischhoff et al., 1981; Janis, 1982; Fischhoff, 1985; Lopes, 1987; Slovic, 1987; Yates, 1992; Hammond et al., 1998). Here it is sufficient simply to mention the two main sources of estimating bias, and to emphasise that they need to be understood and addressed when assessing probability.

5.4.12 Perceptual factors

A wide range of factors influences the way uncertainty is perceived by both individuals and groups. Of these, four deserve special mention here, since they are particularly relevant to the assessment of risk probability.

Familiarity: The extent to which an individual, team or organisation has previously encountered the situation drives whether risk probability is perceived as high or low. Where there is little or no previous relevant experience, skill or knowledge, the degree of uncertainty is perceived as higher than is the case when individuals or groups who have encountered the situation before, assess it.

Manageability: The degree of control or choice that can be exercised in a given situation drives the assessment of uncertainty, even if the perception is illusory. Where a risk is seen as susceptible to control, risk probability is assessed as lower than in situations where controllability or choice are absent (or perceived to be so).

Proximity: If the possible occurrence of a risk is close in time or space to those assessing its probability, it will be seen as more likely than risks, which might occur later in time or further away in space.

Propinquity: This term is used to describe the perceived potential for the consequences of a risk to affect the individual or group directly. The closer the impact is to those assessing the risk, the higher is its perceived probability.

Each of these factors (and other similar perceptual influences) operates subconsciously when individuals and groups assess risk probability, making them hard to diagnose and correct. Work is, however, underway to develop approaches to understanding and managing the factors driving risk attitudes (Hillson & Murray-Webster, 2004).

5.4.13 Heuristics

Another group of subconscious influences also affects perception of risk probability, known as 'heuristics' or rules-of-thumb. Heuristics are internal frames of reference used by individuals and groups to inform judgement when no firm data are available. This is well described in the literature (for example, Tversky & Kahneman, 1974; Kahneman et al., 1986; Cooper & Chapman, 1987; Keeney & von Winterfeldt, 1989; Keeney & von Winterfeldt, 1991; Hillson, 2003), and the various heuristics need not be detailed here. It is enough to emphasise their influence in introducing bias into estimates or assessments in situations characterised by uncertainty.

Two types of bias are common as a result of the action of heuristics: motivational bias (where the assessor seeks to improve the apparent position of the situation by modifying the estimate of risk probability); and cognitive bias (arising from unconscious attempts to rationalise lack of certain knowledge). Of these two, motivational bias is perhaps more difficult to identify and manage. It arises when the person or organisation assessing risk probability has an interest in influencing the results of the analysis, and it seems to occur more often among more senior managers. The direction of the bias is usually to make the probability seem to be smaller than it really is, in order to reduce the perception of risk among key stakeholders. There may be occasions when the bias runs the other way, towards an increased perception of risk, although that is rarer.

5.4.14 Managing bias

A two-step approach is recommended for managing sources of bias when estimating uncertain situations, including assessment of risk probability. The first requires awareness of the issues, understanding sources of bias, whether they originate from perceptual factors or heuristics. Not only must these be understood in theory, but their operation in practice must be identified, drawing on previous experience wherever possible. This diagnosis allows the second step to be taken, namely action. Understanding one's preferred approach to uncertainty can open the door to managing it, reducing or removing sources of bias at both individual and group levels (Hillson & Murray-Webster, 2004).

5.4.15 Alternative approaches to assessing risk probability

Risk probability is inherently difficult to assess or estimate, particularly in the project context, and assessments involving uncertainty are subject to a wide range of sources of bias. Given this challenge, guidance is required on how to approach the assessment of probability. A range of alternative techniques can be identified, some of which are described below. No one technique is foolproof or applicable to every situation, and each has its own strengths and weaknesses. It is, however, recommended that risk practitioners and project participants who are required to assess risk probability should be aware of the variety of techniques available, and should consider using a range of different approaches as appropriate (Moore, 1983; Cooper & Chapman, 1987). Selection of techniques might be driven by the depth of the risk management process being applied to the particular project, or the size and strategic importance of the project, or the extent to which sources of bias have been identified as influencing assessments.

Three basic headings are used to outline alternative approaches to assessing risk probability. The first includes techniques, which attempt to define probability in various ways, in order to provide unambiguous language for describing probability.

The second group uses various comparators against which the probability of a given risk can be compared. The third approach infers risk probability based on a description of various 'states of nature' within the project environment.

Definitional techniques

Probability exists on a spectrum from impossibility to certainty. There are many ways of describing this spectrum, and definitional techniques for assessment of risk probability offer different ways of describing the scale to give assessors meaningful frames of reference against which they can estimate the probability of a given risk (Hillson & Murray-Webster, 2004). For example, positions on the probability spectrum may be defined using labels (for example low, medium or high), phrases (such as improbable, possible or likely), odds (for example, 1:50, 1:10, 1:3), numbers (i.e. either percentages such as 5%, 40%, 70%, or decimals like 0.05, 0.4, 0.7 etc.), or ranges (for example, 1-10%, 25-50%, 70-90%).

Risk practitioners most commonly use definitional approaches, but there are several issues affecting their effectiveness. For example, both labels and phrases are ambiguous and can be interpreted subjectively, with 'low' or 'unlikely' meaning one thing to one person but holding a different meaning for another. Figure 5 presents a summary of recent research by one of the authors (Hillson, 200) on the range of probability values associated with commonly used phrases, indicating very large variability of interpretation of phrases, which might be thought to be unambiguous. (Also refer to Boehm, 1989; Moore, 1983; Hamm, 1991; Lichtenstein & Newman, 1967; Conrow, 2003).

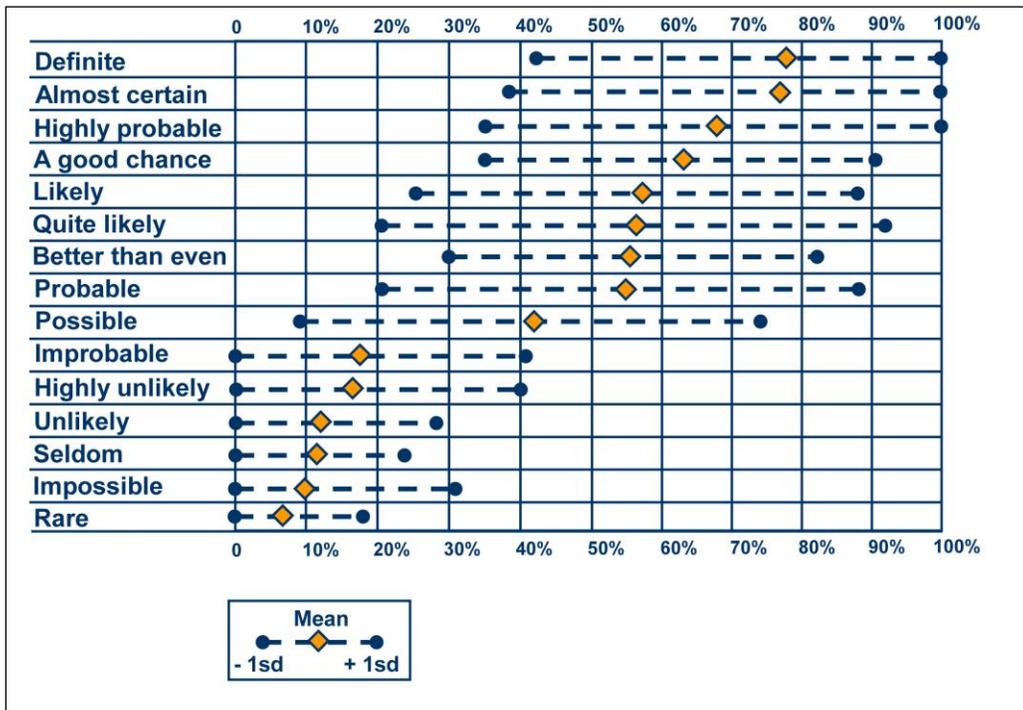


Figure 5: Interpretation of probability-related terms – Research results (Hillson 2004)
Adopted from Hillson and Hullett (2004)

Other definitional approaches also have problems, since odds are unfamiliar to many (the average person has some difficulty in ordering a series of odds such as 1:2 against, 4:3 on, 9:13, 15:1 etc.), specific percentage or decimal values introduce spurious apparent precision where reality is less certain, and fixed ranges are artificial and do not usually reflect the real range of probability for a given risk.

Comparative techniques

A number of techniques have been developed to assist in assessment of risk probability by providing values against which the likelihood of the risk occurring can be compared, asking whether the probability of the risk occurring is more, or less, or the same as the value being presented. The aim of all these techniques is to adjust the comparator until the assessor cannot distinguish between the risk probability and the value being presented. This value is then taken as the best

estimate of the risk probability. There are different ways of presenting probabilities against which risk probability can be compared. These include:

Wagers: The assessor is asked what odds they would give on the risk occurring (though the response is affected by the individual's utility curve, which must be known if the wager is to be properly interpreted).

Value-oriented: The risk probability is compared to an event whose probability is known; for example, is it more or less than the chance of obtaining 10 heads in a coin-toss experiment? Different events are presented until the assessor sees no difference.

Relative likelihood: Similar to the value-oriented approach, the assessor is asked how much more likely the risk is to occur than some other event whose probability is known. The process can be continued using a value-based approach until equality is reached, or the differential probability may be added to the comparator to give the estimated probability of the risk occurring.

While comparative approaches appear to be simple to use, there are various difficulties, including problems with understanding the comparators. In addition, assessments using comparative techniques are particularly subject to perceptual bias and heuristics as discussed above.

The 'state of nature' approach

A less commonly used technique has been developed for inferring risk probability from a description of the state of a project-related variable (hence, the approach is called the 'state of nature' technique). This involves describing a range of alternative situations or scenarios which might occur for a given risk source on a project, where each scenario has an associated probability of related risks arising. The assessor then identifies where the project is on the scale of scenarios, and the chance of risks occurring in this area is then inferred. Table 1 presents an example

where the probability of risks relating to vendors or suppliers is inferred from the status of the supply chain.

Table 1: ‘State of Nature’ example for vendor/supplier risk

‘State of Nature’ description for vendor/ supplier situation	Implied probability that vendor risks will arise
Sole source, no experience with vendor	Very high
Sole source, experience of late delivery/low product quality	High
Sole source, good experience	Medium
Multiple sources, some with good experience	Low
Acceptable product is off the shelf	Very low

Adopted from Hillson & Hullett (2004)

This approach has the benefit of being less subjective than others do, since the project situation is compared against a defined and objective set of alternatives, and assessment is based on known facts about the project rather than relying on subjective opinion. Of course, it requires scenarios to be developed and graded in advance for each source of risk. This can be done at a generic level or scenarios can be focused on specific risks; more detail is better but requires more work to develop sufficient scenarios to cover all risks.

The state of nature approach also allows comparison of exposure to risk from a given common source across related projects (for example in a portfolio), and facilitates learning from previous experience since ‘states of nature’ can be constructed based on past project performance.

Risk is defined in two dimensions: the uncertainty dimension (assessed as probability of occurrence), and the effect dimension (assessed as impact on objectives). Proper assessment of risks requires appropriate assessment of both probability and impact. The effect on objectives is relatively simple to estimate, as it

involves a simple exercise in imagining the situation where the risk happens. Assessing probability of occurrence is less straightforward, for the reasons outlined above. Proper assessment of risk probability, however, is critical to the effectiveness of the risk process, for the following reasons:

If risk probability assessment is faulty, the accuracy of risk prioritisation will be affected, leading to a potential failure to focus on the most significant risks. This in turn could lead to selection of inappropriate responses, with attention being paid to wrongly-prioritised risks. Inappropriate response selection results in failure to manage risks effectively, with the possibility of loss of confidence in the risk process.

Conversely, if assessment of risk probability is sound, then the resulting understanding of each assessed risk will be more accurate, supporting better decisions in terms of response selection and risk management strategy. The improvement in risk management effectiveness that follows will enhance the credibility of the risk process, and will ultimately lead to more reliable achievement of project and business objectives.

In order to ensure the most robust assessment of risk probability, a two-part solution is recommended. The first part requires awareness of the issues, including understanding the problems associated with assessing probability, the effect of psychological influences, the importance of reliable probability assessment, and the various alternative approaches available. This must be accompanied by action to address the concerns, by identifying and managing sources of bias (both perceptual and heuristic), modifying practice by using different probability assessment techniques, monitoring subsequent project and risk management performance to determine the accuracy of assessed risk probability, and learning lessons to further improve the effectiveness of the probability assessment process.

5.5 Monte Carlo challenge: a better approach

The definition of contingency and how to estimate it is among the most controversial topics in cost engineering. While there is consensus among cost engineers on what contingency is, there is much less consensus on how to estimate it. This lack of consensus and the unfortunate political nature of contingency issues partly explain why AACE International has never established a recommended practice for how to estimate contingency. In general, industry can agree that there are four general classes of methods used to estimate contingency. These include the following:

- Expert judgment;
- Predetermined guidelines (with varying degrees of judgment and empiricism used);
- Monte Carlo or other simulation analysis (primarily risk analysis judgment incorporated in a simulation); and
- Parametric Modelling (an empirically-based algorithm, usually derived through regression analysis, with varying degrees of judgment used).

In 2004, Independent Project Analysis (IPA) presented a paper that for the first time quantitatively explored the historical performance of the various techniques. The IPA authors found that, despite decades of discussion and development, "...contingency estimates are, on average, getting further from the actual contingency required." They further state that, "this result is especially surprising considering that the percentage of projects using more sophisticated approaches to contingency setting has been increasing." In particular, when they looked at projects for which the scope was poorly defined, they found that the more sophisticated techniques were "a disaster". The sophisticated techniques they referred to, were predominately Monte Carlo analysis of line-item ranges. Given how popular Monte Carlo has become, these are sobering findings that cost engineers may not ignore.

The IPA paper offered a partial remedy, namely that empirical, regression-based models “can be a viable alternative or an excellent supplement to the traditionally used methods for contingency setting.” This is particularly true when project scope is poorly defined. In summary, the lesson learned from the IPA study is that Monte Carlo, as practiced, is failing and we need to find better methods that incorporate the best of expert judgment, empirically-based knowledge, and risk analysis methods such as valid Monte Carlo.

5.5.1 Monte Carlo (as commonly ill-practised)

The most common method of Monte Carlo based contingency estimating used by industry is ‘line-by-line’ estimating of ranges with Monte Carlo simulation applied. In this approach, as commonly applied, the estimate line-items (for example, install steel structure, mechanical engineering, etc.), or estimate subtotals by work breakdown or other estimate categories, are entered in an Excel spreadsheet which serves as the starting basis of a Monte Carlo model. The more detailed the estimate, the more lines are usually modelled. Using @Risk® or a similar spreadsheet add-on program, the analyst/estimator then replaces each fixed line-item or subtotal cost entry, with a statistical distribution of cost outcomes for the line item. These line item distributions are the simulation model inputs. For simplicity, the distribution used is almost always ‘triangular’ with the line-item point estimate being the peak value, and the high and low ‘range’ points of the triangle being assigned by the analyst or the project team during a ‘risk analysis’ meeting. The high-low range is usually skewed to the high side (for example, +0 percent/-30 percent). The analyst then runs the Monte Carlo model simulation to obtain a distribution of bottom line cost outcomes.

Users like the simplicity of the line-by-line range estimating method. Management likes the graphical outputs. Unfortunately, the method as generally practised is highly flawed. First, the outcomes are unreliable because few practitioners define the ‘dependencies’ or correlation between the model inputs (i.e., between the

estimate line-items). Valid Monte Carlo modelling requires the analyst to quantify the degree to which each line item is related to the others. @Risk incorporates correlation matrices to facilitate this task. As an example of cost dependency, most estimators would agree that construction management costs are somewhat dependent on field labour costs. If field labour costs come in high, it is likely that construction management will also come in high.

With independent inputs, every Monte Carlo simulation iteration will pick high values for some items and low values for others. The highs and lows tend to cancel one another. The result is too low of a contingency (i.e., too tight of an outcome distribution). Analysts can easily bias the simulation outcome without changing any of the risk analysis ranges; all they need to do is change the number of line items represented by distributions in the model (for example, look only at subtotals). These quirks, intentional or otherwise, mean that results are not replicable among analysts. If Monte Carlo is used (in any kind of model), a best practice is to define dependencies between model variables. However, a possibly more serious shortcoming of the line-by-line Monte Carlo method is that it is inherently inconsistent with basic risk management principles.

5.6 Risk management and contingency estimating

Contingency estimating is one step of the risk management process. As defined by AACE International, the risk management process includes identifying and analysing risk factors or drivers, mitigating the risk drivers where appropriate, estimating their impact on plans (for example, including setting contingency after mitigation) and then, monitoring and controlling risk during execution. A key concept in risk management is that the contingency estimate must reflect the quantified impacts of risk 'drivers' or causes; the process seeks to mitigate and manage these drivers. Contingency estimating is not an end in itself; it is part of a driver-focused process.

In line-by-line Monte Carlo, users do not model how risk drivers affect cost outcomes. Sometimes the project team will go through the effort to identify and discuss risk drivers in the risk analysis meeting, but when it becomes time to quantify the risks and estimate contingency, they revert to applying high-low ranges to line items with only the vaguest idea of how any particular risk driver affects the cost of a given line item. In best practice, the contingency estimating method should explicitly model and document how the risk drivers affect the cost outcomes. Such a model would support risk management and contingency drawdown during project execution (i.e. as teams monitor and assess risk drivers during project execution, they can determine whether the risk drivers have or have not occurred, and the associated contingency can be rationally managed).

5.6.3 Probabilities, ranges and contingency estimating

There is industry consensus that probabilistic contingency estimating that addresses the predictive nature of cost estimating is a best practice. A cost estimate is not a single value, but a distribution of probable outcomes. As shown in Figure 6, using a probabilistic method, contingency is simply an amount of money that must be added to the point estimate (i.e., best estimate of all known items), to obtain a cost value that provides management with an acceptable level of confidence (for example, 50 percent) that the final cost will be less.

This is the point estimate before adding contingency

This cost different is the contingency (typically the cost at 50 percent confidence less the point estimate)

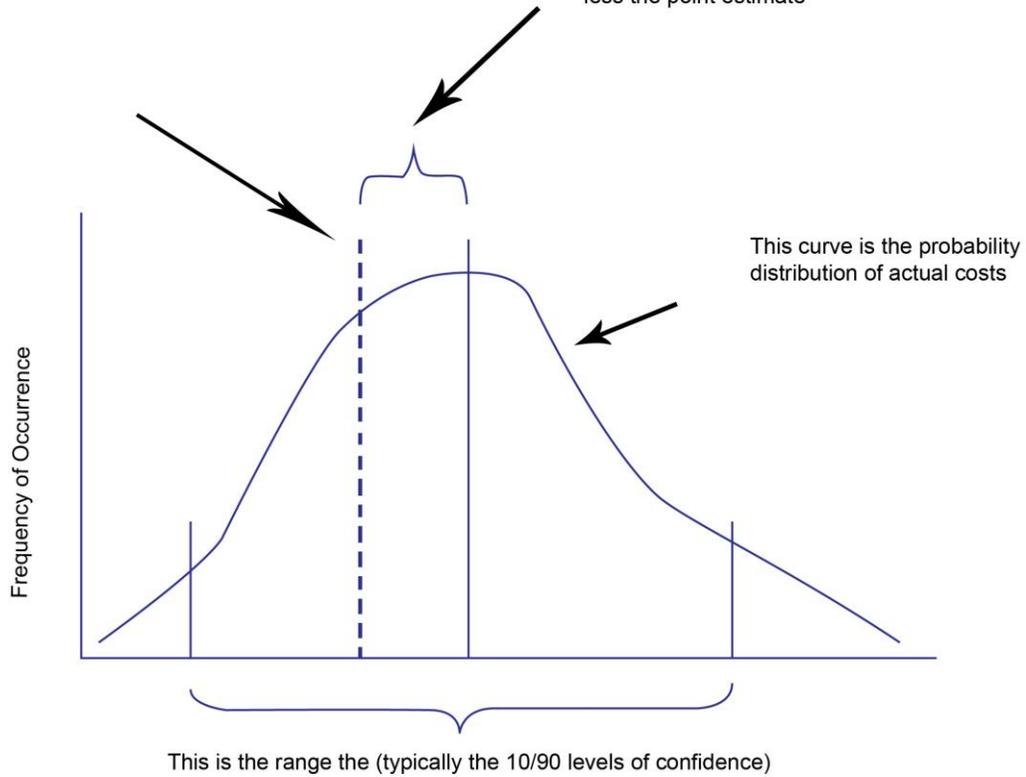


Figure 6: Probability concepts typically applied in contingency estimating
Adopted from Hollmann (2006)

Distributions and ranges are one area where Monte Carlo methods always shine. However, there is often a misunderstanding that only Monte Carlo can produce probabilistic outcomes. Parametric modelling methods can provide probabilistic information as well.

5.6.4 Driver-based methods: a better approach

In summary, line-by-line Monte Carlo range estimating for contingency is not working. In part, this is because the method is inconsistent with best risk management practice. The preceding assessment of line-by-line Monte Carlo's shortcomings highlighted that best estimating practice for contingency should include these features:

- Start with identifying and understanding the risk drivers;
- Recognise the differences between systemic and project- specific risk drivers;
- Address systemic risk drivers using empirically-based stochastic models; and
- Address project-specific risk drivers using methods that explicitly link risk drivers and cost outcomes. If the method uses Monte Carlo, address dependencies.

5.6.5 Empirical, driver-based stochastic contingency models in industry

IPA's 2004 research suggested empirical, regression-based contingency estimating models as one approach for improved contingency estimating. This approach is conceptually simple; just collect quantitative historical data about project cost growth, practices and attributes. Then, using regression analysis, look for correlations between the cost growth and the practices and attributes (i.e. risk drivers), keeping in mind that one is looking for causal relationships. Unfortunately, most companies do not have the historical data available for analysis. However, there are publicly available industry sources that provide the basic relationships. The primary sources include the work of the late John Hackney, the Rand Institute, and the Construction Industry Institute (CII).

John W Hackney (sometimes referred to as the father of cost engineering) first described the relationship between the level of project scope definition and project cost growth in his 1965 book, *Control and Management of Capital Projects* (given the book's long-term significance to industry, AACE International acquired the

publication rights; see the www.aacci.org bookstore). Hackney developed a definition checklist and rating system, and using data from 30 actual projects, showed how the definition rating was related to cost overruns and could be used as a basis of contingency estimating.

In 1981, Edward Merrow of the Rand Institute (he later founded IPA), led a study for the US Department of Energy on cost growth and performance shortfalls in pioneer process plant projects. The Rand study examined detail data from 44 projects from 34 major process industry companies, confirming and expanding on Hackney's findings, and providing a basic parametric cost growth model applicable to the process industries.

In 1998, an industry research team formed by the CII (lead researchers were Carol Oberlender and Steven Trost) developed a way to score an early estimate in order to "assess the thoroughness, quality, and accuracy and thus provide an objective method for assigning contingency". The team collected and analysed the data on 67 completed projects. Again, their findings generally confirmed the findings of the earlier models. In a related development, CII also introduced its project development rating index (PDRI). While the CII validated that the PDRI was correlated with cost growth, no PDRI-driven contingency model has yet been published.

Table 2 summarises the primary types of risk drivers included in the published cost growth models. Because these are empirical models, the results are influenced by the project types included in the study datasets. The Rand study was focused on pioneer process plants so it was better able to quantify the significance of process technology and complexity drivers. The CII dataset included more conventional projects and highlighted more risk drivers related to the estimating process itself. Each study defined and measured the risk drivers somewhat differently making direct comparison difficult. However, all studies have found that the level of process and project definition is the most significant systemic risk driver. The

impacts of estimating process drivers (for example, quality of estimating data available), are relatively less and only become significant when the project is otherwise well defined.

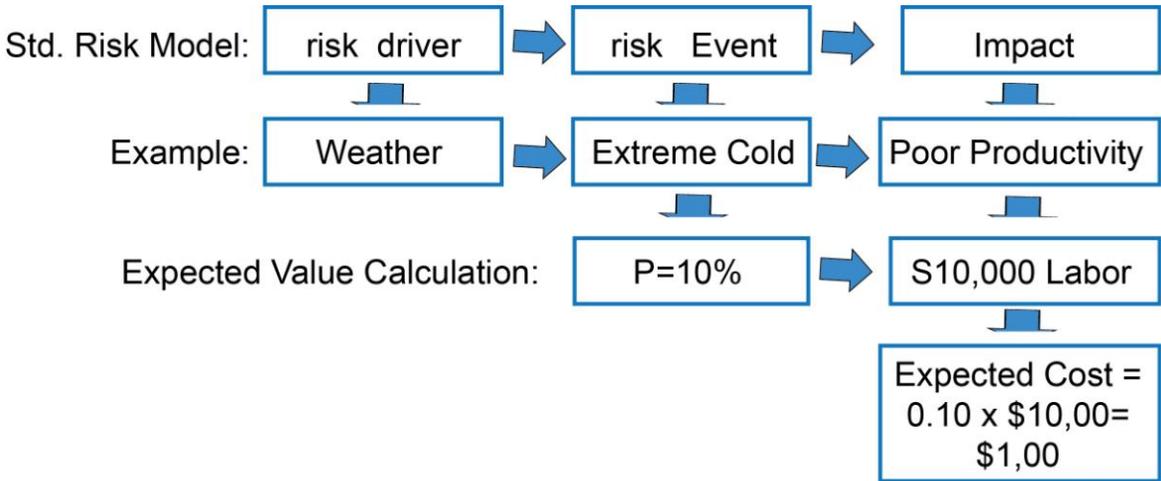
Table 2: Systemic Risk Drivers Included in Published Cost Growth Models

	Hackney (1965)	Rand (1981)	CII (1998)
Process Definition			
Basic Design	x	x	x
Level of Technology	x	x	
Process Complexity		x	
Material Impurities		x	x
Project Definition			
Site/Soils Requirements	x	x	x
Engineering and Design	x	x	x
Health, Safety, Environ.	x	x	x
Schedule Development			x
Estimating Process			
Inclusiveness	x	x	
Team Experience			x
Cost Information			x
Time Allowed			x
Bidding/Labor Climate			x

Adopted form Hollmann (2009)

In 2002, IPA published further empirical industry research that showed that project control practices were also a systemic risk driver. Poor control practices can negate the benefits of good project scope definition by allowing costs to grow unfettered during execution (i.e., good project definition practices before authorisation do not guarantee well-disciplined practices after). This industry research is reflected in AACE International's Recommended Practice for Cost

Estimate Classification. The document outlines the level of scope definition that is recommended for each class of estimate (for example, Classes 5 to 1). It also provides typical contingency and accuracy range ‘bands’ (i.e. a range of ranges) for process industry projects. These range bands represent the consensus of industry experts and are generally consistent with the outcomes of the studies discussed here. (Refer to Table 1: Systemic Risk Drivers included in Published Cost Growth Models and Figure 7: Expected Value in a Standard Risk Model).



**Figure 7: Expected value in standard model
Adopted from Hollmann (2006)**

Lacking in-house data, a company can use the information in these studies and standards to create a contingency estimating model based on systemic drivers. While not the most elegant approach, the tool can be developed through trial and error. First, substitute best and worst case ratings for every driver in every published model and assess the sensitivity of the outcomes to the drivers. After deciding how to rate the risk drivers for one’s company projects (for example, one can use the AACE International estimate classification attributes, PDRI, Lickert scale ratings as used by CII, etc.), create a first-pass trial model of factors and parameters along the lines of those published. One may also incorporate some obvious cost growth inhibitors such as how much of the estimate is fixed price or major equipment. Then, iteratively adjust one’s model until it reasonably replicates the results of the published models and standards. The last and most important

step is to use one's company's actual risk driver and cost outcome data to validate, calibrate and improve the model over time.

5.6.6 Project-specific, driver-based contingency estimating model

While there are a number of contingency modelling approaches possible for non-systemic, project-specific risks (i.e., event-driven), the method that is most accessible to the usual cost engineer is event or probability tree analysis (ETA). ETA uses the concept of expected value (EV) to quantify the likely cost outcome of a risk event. The event tree/expected value approach is used in what some call the 'standard risk model'. It is also used in decision analysis. Figure 7 provides a simple example of how the standard risk model, using the concept of EV, can be used to estimate the expected impact on a single cost account. Project contingency is then the sum of the expected impacts from all significant risk drivers. Terms such as 'cause-risk-effect' have been used instead of 'driver-event-impact,' but the concept is the same. A key advantage of this method is that it unambiguously ties the risk drivers to the cost impact and therefore allows for effective risk management. A drawback is that the method can become complex if the analyst does not screen the risk drivers/events and focuses only on those that have significant probability and impact.

The ETA/EV approach provides point-estimates of the most likely cost impacts of each risk driver. Without further analysis, the sum of the expected cost impacts for each risk event can be used as the contingency. However, the method supports probabilistic outcomes through Monte Carlo simulation. In that case, distributions are used to express the risk event probabilities and cost impacts. To obtain range information (i.e., cost outcome distributions), the user can enter the risk event model in a spreadsheet and apply Monte Carlo simulation to it (making sure to address dependencies). The author calls this approach driver-based Monte Carlo (DBM) to differentiate it from traditional line-item approaches.

5.6.7 Risk analysis and contingency determination

Risk management: identifying the critical items

The key to performing a project risk analysis using range estimating is to properly identify those items that can have a critical effect on the project outcome and in applying ranges to those items and only to those items. It is human nature to assume, for example, that a very large item in a cost estimate is critical simply because of its magnitude. That is not the case. An item is critical only if it can change enough to have a significant effect on the bottom line. The effect need not be negative (unfavourable). What matters is its degree, either in the negative or the positive direction.

Curran (1989) demonstrated that in virtually all project estimates, the uncertainty is concentrated in a selected number of critical items - typically 20 or less. Very few aspects are important. This is called the Law of the Significant Few and the Insignificant Many or the 80/20 Rule. Others refer to it as Pareto's Law after the noted Italian sociologist and economist, Vilfredo Pareto. On rare occasions there may be more than 20 critical items or fewer than 10. If this occurs, the risk analyst should carefully re-examine the items to be certain that the critical ones have been properly identified.

A critical item is one whose actual value can vary from its target, either favourably or unfavourably, by such a magnitude that the bottom line cost (or profit) of the project would change by an amount greater than its critical variance. The bottom line's critical variance is determined from Table 3: Bottom line critical variances.

Table 3: Bottom Line Critical Variances

Bottom Line Critical Variances		
Bottom Line (Cost or Profit)	Conceptual Estimates (AACE Classes 3, 4, 5)	Detailed Estimates (AACE Classes 1, 2)
Cost Δ	$\pm 0.5\%$	$\pm 0.2\%$
Profit Δ	$\pm 5.0\%$	$\pm 2.0\%$

Adopted from AACE International Recommended Practice No41R-08 (2008)

Critical items are those which can cause changes greater than the above deltas (critical variances), either in the negative or positive direction. It is important to link or combine items that are strongly related (i.e. when one item increases or decreases, the linked item also changes either directly or inversely). Such dependencies are generally obvious or become quite apparent during the process of evaluating the critical items and establishing their ranges. As an example, if the cost of concrete is the major cost driver in more than one estimate item and concrete costs may vary over a critical range, those items for which concrete cost is the major cost driver are dependent and must be combined in the analysis.

While the above Δ s may seem to be rather small to some observers, they have been proven valid on many thousands of projects and it is generally not recommended that larger values be assumed. The only exception would be if significantly more than 20 items are shown to be critical. In such a case, in keeping with Pareto's Law, it is useful to apply larger deltas to reduce the number of items to those which are most critical. In any event, limit any such changes to deltas with values no larger than twice the values shown in the table.

It is very important to understand that the magnitude of an item is not important. What is important is the effect of a change in the item on the bottom line. Relatively small items are often critical while very large ones may not be critical at all. Typically, there will be only 10 to 20 critical items, even in the largest projects with hundreds or thousands of components to consider. In identifying the critical items, it is necessary to link strongly related items together; not treat them separately.

It is also necessary in the range estimate, to apply ranges only to the items that are identified as being critical. The project team must know when an item is important and when it is not. If non-critical items are ranged, the inevitable result will be a far narrower predicted range of possible project costs than actually exists,

misstatements of risk and opportunity, and understatement of required contingency.

5.7 Risk in project contingencies

5.7.1 Individual risks – expected value

The expected value is the mean of the probability distribution of a risk. The amount of contingency reserve can be based on the 'expected value' for individual risk events. This is illustrated by the Hong Kong Government's Work Branch, which introduced estimating using Risk Analysis (ERA) for construction projects for determining contingencies using expected value (Mak et al., 1998; Mak & Picken, 2000). Firstly, a risk-free estimate of known scope is produced, then risk events are identified and costed in terms of an average, and maximum risk allowance is calculated.

According to Baccarini (2005), there are two types of risk in project cost contingency:

Fixed Risk – This event will either happen in total or not at all; for example, whether an additional access road will be required. If it occurs, the maximum cost will be incurred; if not, then no risk will be incurred. The maximum risk allowance will be the cost if the risk eventuates, while the average cost = the maximum cost probability of its occurrence.

Variable Risk – This is an event that will occur but to what extent is uncertain (for example, depth of piling foundation). The maximum risk allowance, which is assumed to have a 10% chance of being exceeded, is estimated by the project team based on past experience of records (for example, most expensive piling at the maximum length). The average risk allowance is estimated as the value that has a 50% chance of being exceeded, and may have a mathematical relationship

to the maximum or estimated separately. The 50% level is chosen on the rationale that the worst value for all risks will not occur, but rather there will be swings and roundabout effects of the totality of the risk events identified.

Table 4: The summation of all events' average risk allowance, becomes the contingency

Risk	Type	Probability (Fixed Risks only)	Average risk (R)	Max. Risk (R)
Site Conditions	Variable		525,000	1,000,000
Additional Space	Fixed	70	11,760,000	16,800,000
CONTINGENCY			12,285,000	

Adopted from Mak and Picken, 2000

The key attributes of the concept of project cost contingency are:

- **Risk** – The need for and amount of contingency reflects the existence of risk in construction projects (Thompson & Perry, 1992). According to PMI (2000) and Hillson (1999), it covers two categories of risk: known unknowns and unknown unknowns. Contingency caters for unforeseen events within the defined project scope (Moselhi, 1997; Yeo, 1990); unexpected (Mak et al., 1998), unidentified (Levine, 1995) or undefined (Clark & Lorenzoni, 1985; Thompson & Perry, 1992).
- **Reserve** – Cost contingency is a reserve of money (AACE, 2000).
- **Risk Management** – Contingency is used in conjunction with other risk treatment strategies for risk management. There are a number of risk management strategies for risk in projects such as risk transfer, risk reduction, and financial treatments for retained risks, for example, contingencies (Standards Australia, 1999).
- **Project Outcomes** – Contingency has a major impact on project outcomes for a project sponsor. If contingency is too high it might encourage sloppy cost management, cause the project to be uneconomic and aborted, and lock up

funds not available for the organisational activities; if too low, it may be too rigid and set an unrealistic financial environment, and result in unsatisfactory performance outcomes (Wideman, 1995; Dey et al., 1994).

- **Total Commitment** – Is the total cost of the project including prepared cost estimates and contingencies added in order to indicate the likely total cost of the project? The inclusion of the contingencies within a budget estimate means the estimate represents the total financial commitment for the project.

Baccarini (2005) further outlines two major categories of contingency for construction projects (HM Treasury, 1993):

- **Design Contingency** – This allows for changes during the design process in cases of incomplete scope definition and inaccuracy of estimating methods and data (Clark & Lorenzoni, 1985). According to Hartman (2000), the design contingency amount ranges from 5 to 10% of the overall construction cost. The owner should include these costs directly in the project budget. The design contingency should not be created by reducing the project budget by 5 to 10% but should be an additional amount to the total cost of the project. This involves the process of checks and balances between the owner and the architect to ensure that all the desired scope is covered. Hart explains further that the design contingency should not be used to accomplish the original scope of the project unless it is clear to all parties concerned that the potential for price changes in the marketplace are from the time the budget was finalised.

The design contingency should be used to

- resolve unforeseen issues during the initial period of design;
- enhance the project as recommended by the architect to eliminate 'Scope creep' and
- provide balance between the scope and the initial budget.

Effective management of the design contingency:

- The design contingency should be appropriately appropriated by the owner to different phases in the design development phase and the contract between the owner and the architect.
 - It gives the designer flexibility to explore ideas that will add value to the owner.
 - It enhances the ability to complete the project within an approved budget.
- **Construction Contingency** – This allows for changes during the construction process for variations allowable under the contract between the sponsor and the contractor. Mak and Picken (2000) state that contingency can be compared with the total approved value of contract variations to assess the accuracy of the contingency.

Hart (2007) expands further that construction contingency allows for flexibility and the owner should not view it as a lost cost but as a tool to complete the project within the budget, and the use of the contingency for the contractor's needs will vary with the type of delivery method.

- **Design-bid-build:** Hart (2007) ascertains that contingency is most difficult to manage with full control in this method of delivery owing in part to the bidding process.

The contractor who makes mistakes in the bidding process will be low and may or may not have held onto enough contingency to complete the project. In this instance, the construction contingency should be higher. Recommendation is that to handle this situation is to insert a contingency amount into the bid documents that a contingency will be negotiated at the time of award.

- **The Owner's Contingency** – This contingency is for changes in the scope of, or for errors and omissions. Another aspect of importance of the owner's

contingency is to account for risk. Risk is created when some aspects of the project are known or when certain project elements are likely to cause concern. Owner's contingency not managed properly during construction can result in cost overruns and unnecessary losses (Hart, 2007).

5.8 Conclusion

Various types of risk exist in the construction project environment and in order to deal with these potential risks, contingencies need to be in place. Planning for these contingencies is a process that requires input from all stakeholders of the project and, if not managed properly, can result in unnecessary cost or time overruns. Risk has a probability aspect attached and this makes it difficult to ascertain the value to attach to risk-based cost items in some cases. There are a number of established techniques used to calculate risk for standard risk items as well as critical risk items.

The next chapter examines the processes involved in estimating these contingencies as well as factoring these estimates into the total project financial schedule.

CHAPTER 6

CONTINGENCY ALLOWANCE IN ESTIMATE

6.1 Introduction

According to Baccarini (2005), estimation of project cost contingency and the cost performance of a construction project are the key success criteria for project sponsors. Cost contingency is included within a budget estimate so that the budget represents the total financial commitment for the project. Therefore, the estimation of cost contingency and its ultimate adequacy is of critical importance for projects since construction projects are notorious for running over budget (Hester et al., 1991; Zeitoun & Oberlander, 1993).

As Patrascu (1988) observes, there is no standard definition of contingency. Contingency is probably the most misunderstood misinterpreted and misapplied word in project execution. Contingency can and does mean different things to different people. Contingency has been defined as:

“An amount of money or time (or other resources) added to the base estimated amount to (1) achieve a specific confidence level, or (2) allow for changes that experience shows will likely be required” (AACE, 2000:28).

“The amount of money or time needed above the estimate to reduce the risk of overruns of project objective to a level acceptable to the organisation” (PMI, 2000).

According to Hart (2007), contingency is a helpful risk management tool that financially prepares owners for addressing risks within the project. It serves three core purposes to

- account for errors and omissions in the construction documents;
- modify or change the scope of the project; and
- pay for unknown conditions.

He explains three basic types of contingency in projects: tolerance in the specification, float in the schedule, and money in the budget (CIRIA 1996).

A range of estimating techniques exist for calculating project cost contingency – refer to Table 1.

6.2 Traditional percentage

In traditional terms, cost estimates are deterministic, i.e. point estimates for each cost element based on their most likely value (Mak et al., 1998). Contingencies are often calculated as an across-the-board percentage addition onto the base estimate, typically derived from intuition, past experience and historical data. This method of estimation is arbitrary and difficult to justify or defend (Thompson & Perry, 1992). It is an unscientific approach and a reason why many projects are over budget (Hartman, 2000). A percentage addition results in a single-figure prediction of estimated cost, which implies a degree of certainty that is not justified (Mak et al. 1998). This method of the traditional percentage addition approach for calculating contingencies has led to a search for a more robust approach, as evidenced by the range of estimating methods set out in Table 1.

6.3 Maturing concept of estimating project cost contingency

According to Oberlender and Trost (2001), accurate early cost estimates for engineering construction and building projects are extremely important to the sponsoring organisation. Sponsors require a budget estimate at an early stage of the project to manage its costs. The budget estimate has two main components: baseline estimate and cost contingency, which represent the sponsor's estimated final cost of the project. Cost contingency is therefore included in a budget estimate so that the budget represents the total financial commitment for the project sponsor.

Merrow and Schroeder (1991) highlighted the link between predicting cost growth and project cost contingency by stating that cost growth is an inadequate contingency in cost estimates. Their research showed that there is no discernable relationship between cost growth and the level of contingency provided. Projects need reasonably accurate forecasts of final costs of construction to justify the project on economic grounds and for efficient capital planning and financing.

6.3.1 Contingency – definition and attributes

Patrascu (1988) states that contingency is probably the most misunderstood, misinterpreted and misapplied word in project execution. Cost contingency has been broadly defined as “the amount of funds, budget or time needed above the estimate to reduce the risk of overruns of project objectives to a level acceptable to the organisation” (PMI). The key attributes of project cost contingency are:

Reserve – Cost contingency is a reserve of money (PMI). This is perhaps the most commonly understood component of project cost contingency (Baccarini, 2005).

Risk and Uncertainty – The need and amount for contingency reflects the existence of risk and uncertainty in projects (Thompson & Perry, 1992).

Total Commitment – The inclusion of contingencies within a budget estimate means that the estimate represents the total financial commitment for a project. Contingency should avoid the need to appropriate additional funds and reduce the impact of overrunning the cost objective.

Project Behaviour – Contingency can have a major impact on project outcomes for a project sponsor. If contingency is too high, it might encourage careless cost management, cause the project to be uneconomic and aborted, and lock up funds not available for other organisational activities; if too low, it may be too rigid and set

an unrealistic financial environment and result in unsatisfactory performance outcomes (Dey et al., 1994).

6.3.2 Contingencies in construction industry

A contingency is a predetermined amount or percentage of the contract held for unpredictable changes in the project. This contingency is a risk-managing tool that financially prepares owners for addressing risk within the project. Contracts are given for contingencies to pay for unknown conditions such as the price escalation of a product, design changes in scope or due to errors and omissions, or necessary construction changes that are realised on site during construction. Owners should strive to provide a healthy contingency for the project to address risk-related issues. If managed properly, a contingency can provide an insurance for the design, contractor and owner to complete the project on budget.

6.3.3 Contingency allowances

The Architect's Handbook of Professional Practice clarifies a contingency allowance as the amount or percentage that is included in the project to cover unpredictable changes in the work or items of work. It serves three core purposes to

- account for errors and omission in the construction documents;
- modify or change the scope of the project; and
- pay for unknown conditions.

Each project should include an owner's, contractor's and designer's contingency, all with the same objective to complete the project on budget. Each type of contingency will address aspects/issues of the whole project.

6.3.4 Client contingency

There is no such thing as a one-size-fits-all amount for the owner's contingency. Working on a standard amount for each project can lead to cost overruns, accusations and litigation. It is advisable that owners develop an internal process to assess project contingency needs. It is crucial to adequately establish an allowance of the right size, neither too low nor too high.

It is nearly impossible to produce a perfect set of construction documents, leaving no room for errors and omissions. Supposedly, it is amazing how few errors and omissions are in any given set of documents. In the author's observation, most errors and omissions amount to less than 5% of a project's budget. An owner's programme inevitably changes, if only seen during the life of a project, and changes or modifications to the scope of work occur in response to internal programmatic changes. The contingency is one way to prepare for changes in scope or errors and omissions.

Another vital aspect of the owner's contingency is to account for risk. Risk occurs when certain aspects of the project are likely to cause concern.

6.3.5 Good contingency management

Once the owner determines the contingency, the following step is to manage it accordingly. All three parties, owners, contractor and architect, may view the contingency differently, causing a concern for management. The issues can be restricted if all parties comprehend the purpose of the contingency and how it relates to their respective roles in the project.

Contingency funds are to be used first to complete the scope or deals with unknown conditions. Most of the owners tend to make the mistake of adding scope to their contingency. Architects should make sure that the documents are as

accurate as possible and understand that the contingency is not a method for addressing late design decisions.

The owner's primary management risk is from the contractor. As soon as the deal/agreement has been signed and the work begins, the creation of change orders is the most contentious act to their contingency in any construction project. This is where emotions develop and where litigation stems from. Owner contingency not properly managed during construction can result in cost overruns and unnecessary losses.

The contractor does not earn a fee on change orders. When a contractor receives a fee on a change order equal to less than a fee percentage they are earning for the project, they have little or no incentive to scrutinise the subcontractor's change orders. It is hard for anyone except the contractor to distinguish the price of a change order. Letting the contractor receive a fee on change orders places even the most honourable of contractors in a compromising position. The only time a fee should be paid on a change order to a CM or contractor is when there is a real and tangible change to their work, which is unlikely to occur. Change orders can erode the contingency a little at a time unless the owner requires the CM or the contractor to provide consistent documentation.

6.3.6 Project variables influencing contingency

In construction and engineering projects, plans and cost estimates are drawn to ensure that the work is carried out to the desired quality, within the allowed time and budget. The construction industry is inherently uncertain due to the nature of the industry itself. The competitive tendering process, the company's turnover, site production rates and the weather are all features that are characterised by variability and a degree of uncertainty (Harris & McCaffer, 2001). Unforeseen items and events are inevitable in the execution of any building project. The successful completion of any project is assessed on the basis of three parameters which

constitute risks: time, money and performance which, according to (Smith, 1999), are the three types of contingencies. The relative magnitude of these three types will be related to project objectives. Contingency is the budget that is set aside to cope with uncertainties during construction such as cost and schedule. Contingency allocation has been the subject of various research and various methods of contingency calculation and allocation have been described. One of the more common methods of budgeting for contingency is to consider a percent of estimated cost, based on previous experience with similar projects.

According to Thomson and Perry (1992), risk is either ignored or dealt with in an arbitrary way. Argenti (1969) predicted that model building will become a key technique for future generation managers and this manifests itself in the number of research reports in which models are developed to serve as a basis for construction cost estimate to maximise accuracy and reliability of cost estimate. Touran (2003) identified project size, type of construction, difference between low bid and owner's estimate among the factors that affect project cost overrun. Andi (2004) identified cost-risks factors influencing project cost elements.

Reliable construction contingency will assist consultant quantity surveyors in their estimating practice in knowing which project variables could affect their decision on the contingency sum applicable to construction projects. Many cost and time overruns are attributable to unforeseen events for which uncertainty was not appropriately estimated. An amount of money used to provide for uncertainties associated with a construction project is referred to as contingency allowance (Mak & Picken, 2000).

Contingencies are crucial to achieving project objectives and contingency funds are included in development budgets to allow managers to address uncertainties and deviations that threaten achieving objectives (Diekmann, et. al. 1988). This allowance is used to cater for events that are unforeseen within the defined project scope and added to indicate likely total cost of the project, which means that the

estimate represents the total financial commitment for a project. Contingency is used as a financial treatment in risk treatment strategies.

According to Yeo (1990), the objectives of the contingency allocation are to ensure that the budget set aside for the project is realistic and sufficient to budget for risk of unforeseen cost increases. Any realistic contingency must serve as a basis for decision making in the financial viability of the variations, and a baseline for their control (Akinsola et al., 1996).

6.3.7 Construction contingency and types of construction contingency

In engineering projects, two types of contingencies are used to compensate for different types of uncertainties. These are project contingency and process contingency (Parsons, 1999).

Project contingency is based on the project scope available at the time of making the estimate. It covers expected omissions and unforeseen costs caused by lack of complete engineering. According to HM Treasury, two major categories of contingency can be identified for construction projects and these are design and construction contingencies. Design contingency is for changes during the design process for such factors as incomplete scope definition and inaccuracy of estimating methods and data (Clark & Lorenzoni, 1985). Construction contingency is for changes during the construction process.

Process contingency is based on the degree of uncertainty caused by the use of new technology. It is an effort to quantify the uncertainty in performance because of limited technical data. It is important to note that project contingency is broader and could be a determinant of process contingency, which could be a variable of construction contingency in a construction project.

6.3.8 Contingency estimating

According to Bello and Odusami (2008), factors considered most important in making provision for construction contingency are size and complexity of project, assessed risk on the project and adequacy of information. Andi (2004) identified cost-risks factors influencing project cost elements, relationship among the risks themselves and proposed risk analysis methodology for allocation of contingency. Touran (2003) identified project size, type of construction, difference between low bid and owner's estimate among the factors that affect project cost overrun. Project size, type of construction, type of client, method of procurement, percentage of design completed before tender, adequacy of information, and number of subcontractors used were identified by Akinsola, Potts, Ndekugri and Harris (1997).

6.3.9 Correlation of project variables in contingency estimation

In estimating for contingency, major project factors or variables considered are project cost data and duration with their variabilities (Ahmad, 1992; Ranasinghe, 1994; Moselhi, 1997; Chen & Hartman, 2007; Nassar, 2002; Touran, 2003; Baccarini, 2004a; Rowe, 2006; Sonmez et al., 2007; Bello & Odusami, 2008) and significant risk factors (Mak et al., 1998; Mak & Picken, 2000; Chen & Hartman, 2000; Bajaj, 2001; Andi, 2004). Different methods and techniques have been proposed for contingency estimation in literature. The methods are primarily traditional algorithmic methods (Moselhi, 1997). Some of the methods are deterministic and others are probabilistic, accomplished by either expert opinion or statistical methods. They range from a simple crystal ball type estimate to elaborate Monte Carlo simulations (Moselhi, 1997). Statistical technique used to analyse contingency can range from Monte Carlo simulations to regression and variance analysis (Philip, 2001), but most cost experts and practitioners in the construction industry are yet to explore the benefits of these scientific methods as

they are still glued to the conventional method of lump sum and percentage addition (Bello & Odusami, 2008).

Baccarini (2005) researched the correlation between project variables such as project size, project duration, location, bid variability and concluded that there was no significant correlation between project variables and cost contingency. (Andi, 2004) posited that relationships among risks could be identified in his risk analysis methodology for allocation of contingency. Sonmez et al. (2007) used correlation and regression analysis to identify factors affecting cost contingency and presented a robust statistical approach for determination of contingency.

6.4 Practice of contingency allocation

In construction and engineering projects, plans and cost estimates are usually drawn to ensure that the work is carried out to the desired quality, within allowed time and within budget. Uncertainties and variations have been found to be inevitable in a construction project, which range from change of mind by the clients and their consultants, to unforeseen occurrences and issues raised by the main contractor and sub-contractors. In a construction project and from the owner's point of view, contingency is the budget that is set aside to cope with uncertainties during construction. According to Boukendour (2005), the objective of contingency is to prevent a project from experiencing cost overrun. Any realistic contingency must serve as a basis for decision making on the financial viability of the variations, and a baseline for their control (Akinsola, 1996). Contingency allocation has been the subject of various research and different methods of contingency calculation and allocation are described in several sources. One of the more common methods of budgeting for contingency is to consider a percent of estimated cost, based on previous experience with similar projects. According to Baccarini (2004a), contingencies are often calculated as an across-the-board percentage addition on the base estimate, typically derived from intuition, past experience and historical data.

Researchers also developed scientific and statistical methods of estimating and management of contingency; these methods including Monte Carlo simulation, artificial neural network, CALM, PERT, probabilistic model, standard deviation and more recently, the Contingency Tracking System (CTS). All these efforts are aimed at achieving accuracy and to establish effectiveness in contingency allocation in contract delivery in the construction industry.

Ashworth (1994) posits that risk could be mathematically predicted, whereas uncertainty cannot. Patrascu (1988) observe that contingency is probably the most misunderstood misinterpreted and misapplied word in project execution. Clark and Lorenzoni (1985) define contingency as “a specific provision of money or time in an estimate for undefined items which statistical studies of historical data have shown will likely be required.”

Touran (2003) identifies project size, type of construction, difference between low bid and owner’s estimate among factors that affect project cost overrun. Client, method of procurement, percentage of design completed before tender, adequacy of information and number of subcontractors used were identified by Akinsola et al, (1997). It becomes more difficult to determine overall estimate reliability because some sections of a project may be fully defined at the time of estimate and others only sketchily defined. Contingency estimation has been described as subjective and deterministic based on intuition (Moselhi, 1997; Hogg, 2003 and Baccarini, 2005).

Different methods and techniques are proposed for contingency estimation in literature. The methods are primarily traditional algorithmic methods (Moselhi, 1997). Some of the methods are deterministic and others are probabilistic, accomplished by either expert opinion or statistical methods.

Lump sum amount allowance: Hogg (2003) reports ‘intuitive perception’ as the most adopted method of assessing the amount of contingency whereby the

consultant quantity surveyor allows a single figure for risk that reflects the overall perception of the project.

Traditional percentage addition: This is a subjective method of percentage addition on the base estimate derived from intuition, gut feeling, past experience and historical data. This method has been described as 'Crystal ball' (Moselhi, 1997).

Cost item allocation: A contingency percentage is allocated to each cost item (Moselhi, 1997) in the work break down structure or several work packages.

Probabilistic itemised allocation: This method is similar to 'cost item allocation' method but it uses Pareto's law, known as the 80/20 rule, which is the law of significant few and insignificant many (Moselhi, 1997). For the estimation of contingency, it means that 80% of the risk will be associated with 20% of the cost items and it examines closely each item being considered significantly and allocate for each item a probability value, rather than percentage contingency, for not exceeding its estimated cost.

Programme evaluation review and technique (PERT): This method calls for some judgment about the probability density function, which describes each cost item as a random variable taking on values between its estimated lowest and highest costs. Yeo (1990) suggested using formulae similar to PERT according to a 595th percentile.

PERT with modified variance: This is a direct probabilistic method like PERT, but can model any correlation that may exist among the project cost items (Moselhi, 1997). Based on probability distribution used for each cost item, the mean of the project cost is the sum of those calculated for the individual items as in PERT and the variance of the project cost is calculated in a manner different from that used in PERT. Moselhi (1997) reported that this method is accurate and reliable.

Monte Carlo simulation: The Monte Carlo technique is a process for developing data through the use of a random number generator. This technique was developed a number of years ago and has become one of the most popular probabilistic risk analysis techniques (Smith, 1999). It was introduced as an improvement over and as an alternative to PERT (Moselhi, 1997). In this approach, a simulation model is created.

A triangular distribution is normally used or assumed (Ahmad, 1992; Moselhi, 1997). The triangular distribution can be described as an approximation of typical risk distribution. This is for simplicity (Ahmad, 1992), but not to simplify the maths. According to Moselhi (1997) this triangular distribution assumption has been tested and was found invalid, leading to unacceptable systematic error.

6.4.1 Cost contingency

A contingency may be defined as “the amount of funds, budget or time needed above the estimate to reduce the risk of overruns of project objectives to a level acceptable to the organisation” (PMI, 2008). A design contingency is typically allocated for changes during design for factors such as incomplete scope definition and estimating inaccuracies (for example, Clark & Lorenzoni, 1985). As a project becomes more defined, the design contingency is absorbed into the budget for specific cost elements (Gunhan & Arditi, 2007). At the initial budget stage a contingency of 30 to 50% should be allowed for incomplete scope and 5 to 10% for estimating inaccuracies (Clark & Lorenzoni, 1985). As a rule-of-thumb, a 35 to 60% design contingency should be added to the initial budget estimate figure. In the case of FSH and the Perth Arena, for example, the cost increase prior to contract award far outweighs the suggested design contingency. Predicting the cost overrun from the decision to build to contract award relies exclusively on a large data set, so the empirical distribution of cost overruns can be used to determine the best-fit statistical distribution for probabilistic analysis.

A construction contingency is used for changes that may occur during the construction process. Under a traditional lump sum contract based on bills of quantities (BoQs), scope and design are supposed to be fully defined and developed. Clark and Lorenzoni (1985) suggest using a contingency value of 3 to 5%. In practice, complete drawings and BoQs are generally not available when a project goes to tender (Rowlinson, 1999). A similar situation arises when non-traditional methods are used to deliver projects. It is suggested that a construction contingency value in excess of the average cost overrun of 12.22% be used to determine known unknowns (i.e., identifiable risks). For example, design errors and omissions contained within contract documents have been found to contribute as much as 50% of a project's cost overrun (Love et al., 2009). From a client's perspective, design errors and omissions are identifiable risks and should be accommodated within a contingency. The probabilities derived from the statistical distributions provide the basis to monitor and reassess project costs. Identifying the key factors contributing cost overruns from contract award and assessing their likelihood of occurrence can enable clients and contractors to implement appropriate risk management strategies.

6.4.2 Conclusion

Two different viewpoints exist on the point at which a cost overrun is determined. Within the infrastructure and transport literature, cost overruns are invariably calculated from the decision to build. In contrast, within the construction and engineering management literature, cost overruns are determined from contract award. Using the contract award as the reference point, cost overruns from 276 construction and engineering projects were calculated. The research revealed a mean cost overrun of 12.22%. No significant differences for cost overruns were found among procurement method, project type and contract size. The empirical distributions for the cost overruns were found to be non-Gaussian. Non-parametric goodness-of-fit tests were used to select the best-fit probability distribution. A

three-parameter Frechet probability function was found to provide the best overall distribution fit to calculate the probability of cost overruns. As a line of inquiry, the statistical characteristics of contract size and cost overruns were also analysed. The Cauchy (<A\$1 million), Wakeby (A\$1 to 10 million, <A\$101 million), and four-parameter Burr (A\$11 to \$50 million) were found to provide the best distribution fits and were therefore used to calculate cost overrun probabilities by contract size. It is suggested that distribution fitting of empirical distributions is necessary to produce reliable and realistic cost overrun probabilities and, as a result, improve decision making.

6.5.1 Contingency – definition

There are three basic types of contingencies in projects: tolerance in the specification, float in the schedule, and money in the budget (CIRIA, 1996). There is no standard definition for contingency as (Patrascu, 1988:115) observes, “Contingency is probably the most misunderstood, misinterpreted and misapplied word in project execution. Contingency can and does mean different things to different people”. Contingency has been defined as “the amount of money or time needed above the estimate to reduce the risk of overruns of project objectives to a level acceptable to the organisation” (PMI, 2000).

Some authors distinguish between ‘contingency’, ‘allowance’ and ‘management reserve’. Allowance is for specific, known but undefined items (Clark & Lorenzoni, 1985; Patrascu, 1988; Querns, 1989; Rad, 2002). Management reserve is a provision held by the project sponsor for possible changes in project scope and quality (Wideman, 1992). The management reserve should also be expected to cater for extraordinary, unforeseen external risks, for example currency exchange fluctuation, *force majeure* (Yeo, 1990).

6.5.2 Contingency – attributes

An analysis of the literature identifies the following key attributes of the concept of project cost contingency:

Reserve – Cost contingency is a reserve of money. A reserve is a provision in the project plan to mitigate cost risk (PMI, 2000).

Risk and uncertainty – The need and amount for contingency reflects the existence of risk and uncertainty in projects (Thompson & Perry, 1992). Contingency caters for events within the defined project scope that are unforeseen (Moselhi, 1997; Yeo, 1990), unknown (PMI, 2000), unexpected (Mak et al., 1998), unidentified (Levine, 1995), or undefined (Clark & Lorenzoni, 1985; Thompson & Perry, 1992).

Risk management – Contingency is an antidote to risk. There is a range of risk treatment strategies for managing risk in projects such as risk transfer, risk reduction, and financial treatments for retained risks, for example contingency. So contingency is used in conjunction with other risk treatment strategies.

Total commitment – Cost estimates are prepared and contingencies added in order to indicate the likely total cost of the project. The inclusion of contingencies within a budget estimate means that the estimate represents the total financial commitment for a project. Contingency should avoid the need to appropriate additional funds and reduce the impact of overrunning the cost objective.

Project outcomes – Contingency can have a major impact on project outcomes for a project sponsor. If contingency is too high it might encourage sloppy cost management, cause the project to be uneconomic and aborted, and lock up funds not available for other organisational activities; if too low it may be too rigid and set

an unrealistic financial environment, and result in unsatisfactory performance outcomes (Dey et al., 1994).

6.5.4 Contingency – coverage

Contingency caters for two categories of risk: known unknowns and unknown unknowns (PMI, 2000; Hillson, 1999). Known unknowns are risks that have been identified and analysed and it may be possible to plan for them (PMI, 2000). They are identifiable sources of uncertainty (Chapman & Ward, 2000). Unknown unknowns cannot be managed although they may be addressed by applying a general contingency based on past experience with similar projects (PMI, 2000). A contingency should be set up to allow for residual unidentified risks not revealed during the risk identification process (Hillson, 1999). Unknown unknowns cannot be anticipated and therefore are not manageable; the realisation of some of them is usually inevitable but they exclude risks like ‘the world may end tomorrow’ (Chapman & Ward, 2000).

It is not only important to understand the factors covered by contingency, but also those factors that it is not intended for: Scope changes occur when what is now expected is materially different from what was previously reasonably expected (Querns, 1989; Moselhi, 1997). Contingency does cover for cost created by scope development, i.e. scope remains constant even as the product characteristics are progressively elaborated (PMI, 2000); escalation, which is usually shown as a separate item within the project budget (Querns 1989; Moselhi 1997); unforeseeable major events such as extreme weather, earthquakes, riots, acts of war, new government regulations and economic collapse (Heinze, 1996; Moselhi, 1997).

6.5.5 Contingency – estimation

A range of estimating techniques is available for calculating project cost contingency in Table 5.

Table 5: Contingency – Estimating methods

Contingency Estimating methods	References (Examples)
1. Traditional percentage	Ahmad 1992, Moselhi 1997
2. Method of Moments	Diekmann 1983, Moselhi, 1997, Yeo 1990
3. Monte Carlo Simulation	Lorance & Wendling 2001
4. Factor Rating	Hackney 1985, Oberlander & Trost 2001
5. Individual risks – expected value	Mak, Wong & Picken 1998
6. Range Estimating	Curran 1989
7. Regression	Merrow & Schroeder 1991; Aibinu & Jagboro 2002
8. Artificial Neural Networks	Chen & Hartmann 2000; Williams 2003
9. Fuzzy Sets	Paek, Lee, & Ock, 1993
10. Controlled Interval Memory	Cooper and Chapman 1985;
11. Influence Diagrams	Diekmann & Featherman 1998
12. Theory of Constraints	Leach 2003
13. Analytical Hierarchy Process	Dey, Tabucanon & Ogunlana 1994

Adopted from Baccharini (2005)

Traditional percentage

Traditionally cost estimates are deterministic (i.e. point estimates for each cost element) based on their most likely value (Mak et al., 1998). Contingencies are often calculated as an across-the-board percentage addition on the base estimate, typically derived from intuition, past experience and historical data. The percentage addition method is based on a subjective approach and may consider project characteristics such as type of work, phase of the project, and level of scope definition (Lorance & Wendling, 2001). This calculation method is satisfactory for simple projects under stable conditions but is unsuitable for large and complex projects (Newton, 1992).

A different contingency percentage can be calculated for every major cost element, which reflects that some parts of the project may have greater uncertainty than others (Ahmad, 1992; Moselhi, 1997). Every major segment of the estimate is classified in terms of its degree of uncertainty or accuracy and then attracts its own appropriate contingency (Bent & Humphreys, 1996). This method is considered

more rational and reliable than the simple application of one overall percentage to the total cost because it encourages close examination of every cost area (Moselhi, 1997).

Traditional percentage – weakness

Thompson and Perry (1992:1) observe “all too often risk is either ignored or dealt with in an arbitrary way: simply adding a 10% ‘contingency’ onto the estimated cost of a project is typical”. This arbitrary bottom percentage may not be appropriate for the proposed project (Heinze, 1996) and it is difficult for the estimator to justify or defend (Newton, 1992; Yeo, 1990). It is an unscientific approach and a reason why so many projects are over budget (Hartman, 2000). Allocating a contingency percentage is insufficient unless linked to a confidence level, i.e. the level of probability that the final project cost will be within the estimate including contingencies (Moselhi, 1997).

There is a tendency to incorporate hidden contingency within the individual cost elements (‘padding’) as well as an additional percentage to the total cost (Mak et al., 1998). The project manager may not be aware of the padding and therefore will not be able to control this hidden contingency. A padded cost element can become a self-fulfilling prophecy as the entire amount is unnecessarily spent to justify the estimate (Hamburger, 1994).

A percentage addition results in a single-figure prediction of estimated cost, which implies a degree of certainty that is not justified (Mak et al., 1998). It does not encourage creativity in estimating practice, promoting a routine and mundane administrative approach requiring little investigation and decision making, which may propagate oversights (Yeo, 1990; Mak et al., 1998). It is claimed that contingency is often set too high for low-risk projects and too low for high-risk projects (Mok et al., 1997). There is a tendency to overestimate contingency because an underestimated contingency may attract negative comment while there

is no penalty for overestimation, and to avoid the need to seek additional funds if budgets become overspent (Mak et al., 1998).

The weaknesses of the traditional percentage addition approach for calculating contingencies has led for a search for a more robust approach as evidenced by the range of estimating methods set out in Table 5.

6.5.6 Contingency – management

Once a contingency fund has been formulated, its use must be explicitly identified and controlled. The level of contingency should be constantly monitored and reassessed throughout the project life cycle for appropriateness (CIRIA, 1996). Importantly, cost contingency must be used for its intended purpose and not incorrectly used for poor performance (Levine, 1995).

6.5.7 Contingency – a model

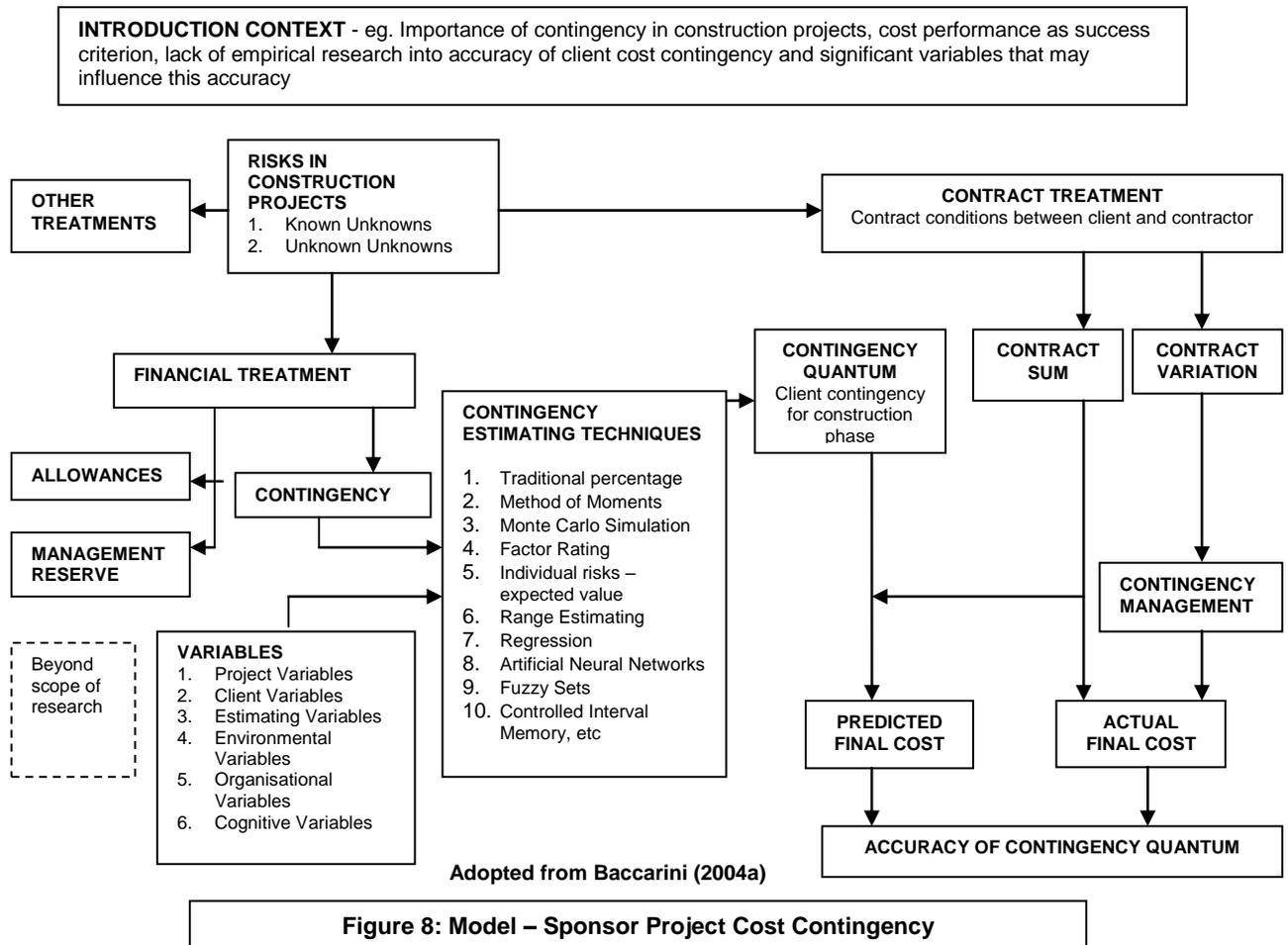


Figure 8 sets out a model for the estimating for project cost contingency. The model is for the estimating of contingency by the project sponsor just prior to the commencement of the construction phase of building projects. The sponsor has awarded a contract to a building contractor and needs an estimate of the final cost of the project for budgeting purposes. This budget is a combination of the contract sum plus contingency. The key elements of this model are:

- Contingency is a part of an overall risk management strategy. It is a financial reserve to cater for retained risks. The selection of contingency as a risk treatment strategy leads to the need to estimate the amount of contingency required.
- There are numerous estimating methods available for project cost contingency ranging from the traditional percentage approach to more sophisticated methods such as Monte Carlo simulation and artificial neural networks.
- There are several influential variables that affect the estimating process and the amount of estimated contingency (for example, cognitive bias of the estimator, organisational policies, project size and complexity, and estimator's experience).
- Contractual variations are the means for altering the contract sum and affecting the actual final cost. The final total amount of variations will be influenced by the contingency management approach; for example, a formal rigorous method that aims to minimise contractual variations is likely to limit the final total value of variations.
- Once a contingency has been estimated it is added to the contract sum to represent the predicted final cost of the project for the sponsor. The actual final cost is the sum of the contract plus contractual variations. The accuracy of the contingency can be measured by comparing the predicted final cost against the actual final cost.

6.6 Estimating project cost construction contingency – a statistical analysis

The cost performance of construction projects is a key success criterion for project sponsors. Construction projects are notorious for running over budget (Hester et al., 1991; Zeitoun & Oberlander, 1993). Cost contingency is included within a budget to represent the total financial commitment for the project sponsor; the estimation of cost contingency and its ultimate adequacy is therefore of critical importance to projects.

There is no standard definition for contingency as Patrascu (1988:115) observes, “contingency is probably the most misunderstood, misinterpreted and misapplied word in project execution. Contingency can and does mean different things to different people”. Contingency has been defined as “An amount of money or time (or other resources) added to the base estimated amount to (1) achieve a specific confidence level, or (2) allow for changes that experience shows will likely be required” (AACE, 2000) and “The amount of money or time needed above the estimate to reduce the risk of overruns of project objectives to a level acceptable to the organisation” (PMI, 2000).

6.7 Estimating cost contingency for construction projects

Perminpova et al. (2008) propose risk as an event having a negative affect on project outcomes, or opportunities, as events that beneficial impact on project performance. The above is in contrast with uncertainty perceived as an event or situation, which was not expected to happen, regardless of whether it could have been possible to consider in advance. Thus, all projects are affected by a myriad of risk and uncertainties; hence, the need for contingencies to curtail the risk of cost overruns.

Hervert (2011) holds that a contingency is an amount of money that must be added to a project baseline to account for the impact of uncertain conditions which

excludes major scope changes, *force majeure* events and escalations. Thus the essence of economic factors on the total success of infrastructural projects cannot be overemphasised. Xueqing (2005), after studying the critical success factors of infrastructural projects, held that most projects are abandoned at just 30% completion with just a few going through to completion thus meeting the stipulated contract duration and project characteristics. Park et al. (2005) posit that more than 60% of construction contractors' failure is due to economic factors. These economic factors include a myriad of cost risk that are poorly perceived and scoped at the onset of the project. A poor scope definition and scope planning results in difficulties in managing contingencies associated with the project with the possibility of cost overruns. Hartman (2000) holds that the subject of cost overruns is the result of poor contingency planning and cost management. It can be established that a sound cost base line and cost budgeting following a good risk assessment and analysis results in a coherent cost control mechanism (Hendrickson, 2008 cited in Buerthey et al., 2012). Most projects have historically experienced increases resulting from persistent cost estimation and a traditional deterministic conservative approach in estimating cost contingencies (Molenaar, 2005).

Many factors necessitate the need to include a contingency sum in a contract. Patrascu (1988) postulates that factors that may result in the need to include contingency are minor design changes, lack of experience, underestimation of cost and quantities, unanticipated price changes, corrections of some erroneous assumptions, abnormal schedule slippage, lack of scope definition and changes in scope definition, unforeseen regulations, safety requirements and other circumstances. Since a contingency is the amount of funds or budget needed above the estimate to reduce the risk of overruns of a project objective to a level acceptable to the organisation or project team, a contingency sum may or may not include a management reserve, which allows for unplanned but potentially required changes in scope and cost.

6.7.1 Conceptual framework

According to Ali (2005), most firms have adopted a rule-of-thumb, which is applied during estimation to take care of risk in relation to cost on the project. Gunhan and Arditi (2007) put forward that one of the simplest methods of estimating contingency margins for construction projects is to consider a percentage of the estimated contract value such as 10% across the entire project commissioned by the owner typically derived from intuition, past experience and historical data. One would agree with (Lhee et al. 2009 cited in Buerthey et al., 2012) that applying deterministic approaches is vague and lacks scientific basis.

Hervert (2011) declares that risk identification has revealed two categories of risk: systemic and project specific risk. Systemic risk are those risks which can be identified at the onset of the project and can be predicted to have an impact on a project which would likely result in cost overruns. Systemic risk are said to be an artefact of the project system, culture, process, technology or complexity. Systemic risks are thus measurable and predictable, even at the very earliest stage of the project definition, with cost impact stochastic in nature, thus making it very difficult for individual team members to determine impact at the earliest project stage (AACE, 2009). Hervert (2011) agrees with the AACE (2009) that systemic risk affects the artefact of the system, with systemic risk affected by the estimation approach, understanding of scope, and alignment of stakeholders, project team experience and completeness of engineering drawings. Thus systemic risks are more inclined to design factors, scope definition and factors within the direct control of the project team.

Project specific risks are factors that may affect the artefact of the project. These include: delivery delays, constructability, site conditions, terms and conditions and may be termed as factors beyond the domain of the design team (Hervert, 2011). These risk factors are associated with the construction that can neither be determined now nor be predicted in the future. Project specific risk impact is highly

unpredictable between projects within a system or industry as a whole (AACE, 2009).

Systemic risk drivers having a possible effect on cost growth include basic design, level of technology, process complexity, material quality, soil requirement, engineering design, schedule development, team experience, cost information, bidding and labour climate, and cost information available (Hollmann, 2009). During the estimation process, systemic risk results in the estimation of a definitive budget (Hervert, 2011). Unpredicted project specific risk results in additional cost growth, shifting the total cost curve outwards. The implication of the above is that systemic risk can be predicted empirically using historical data whereas project specific risk can only be predicted by simulation.

Molenaar (2007) holds that uncertainty in cost growth decreases as one travels along the project trajectory with significant risk unveiling. The distinction between known-known (quantifiable cost), known-unknown (known but non-quantifiable cost) and unknown-unknown (unrealised cost) brings to the fore the need for contingency and management allowance.

6.7.2 Estimating project cost contingency – beyond the 10% syndrome

The cost performance of construction projects is a key success criterion for project sponsors. Cost contingency is included within a budget estimate so that the budget represents the total financial commitment for the project sponsor. The estimation of cost contingency and its ultimate adequacy is of critical importance to projects. There are three basic types of contingencies in projects: tolerance in the specification, float in the schedule, and money in the budget (CIRIA, 1996). Patrascu (1988:115) observes, “Contingency is probably the most misunderstood, misinterpreted and misapplied word in project execution”. Contingency has been defined as the amount of money or time needed above the estimate to reduce the

risk of overruns of project objectives to a level acceptable to the organisation (PMI, 2004).

6.7.3 Traditional percentage

Traditional cost estimates are deterministic, i.e. point estimates for each cost element based on their most likely value (Mak et al., 1998). Contingencies are often calculated as an across-the-board percentage addition on the base estimate, typically derived from intuition, past experience and historical data. This estimating method is arbitrary and difficult to justify or defend (Thompson & Perry, 1992). It is an unscientific approach and a reason why so many projects are over budget (Hartman, 2000). A percentage addition results in a single-figure prediction of estimated cost, which implies a degree of certainty that is not justified (Mak et al., 1998). The weaknesses of the traditional percentage addition approach for calculating contingencies has led to a search for a more robust approach as evidenced by the range of estimating methods set out in Table 5.

6.7.4 Individual risks – expected value

The amount of contingency reserve can be based on the ‘expected value’ for individual risk events. Expected value is the mean of a probability distribution of a risk. For example, the Hong Kong Government’s Works Branch introduced Estimating using Risk Analysis (ERA) for construction projects for determining contingencies using expected value (Mak et al., 1998; Mak & Picken, 2000).

Firstly, a risk-free estimate of known scope is produced, then risk events are identified and costed in terms of an average, and maximum risk allowance is calculated. The accuracy of contingencies was tested for completed ERA and non-ERA projects (i.e. using traditional percentage addition). It was found that the ERA-derived contingency was significantly more accurate (Mak et al., 1998; Mak & Picken, 2000).

6.7.5 Method of moments

Every cost item in an estimate is expressed by a probability distribution, reflecting the risk within the cost item. Each cost item distribution has its expected value and variance. The expected values and variances for all cost items are added to arrive at the expected value and standard deviation for the total project cost. Total project cost can be assumed to follow a normal distribution based on the central limit theorem, but only if the cost items are independent. Then, using probability tables (z-scores) for a normal distribution, a contingency can be derived from the probability distribution based on a desired confidence level, i.e. level of probability of total project cost not being exceeded. For example, refer to (Table 6 below) if a sponsor wants a baseline budget set at the EV of R116.67 and then adds contingency that will have a 90% probability of not being exceeded, then the contingency will need to be R67.61.

Table 6: Method of Moments

Variable (Cost)	Distribution	a Mn. (R)	b Most Likely (R)	c Max (R)	EV	V	SD
Foundation	triangula	25	30	65	40.00	1415.00	
Walls	triangula	40	60	80	60.00	1200.00	
Roof	triangula	10	15	25	16.67	175.00	
Total project cost	Normal (CLT)				R116.67	R2790.00	R52.82

$$EV = (a+b+c)/3; \quad V = (a^2 + b^2 + c^2 - ab - ac - bc)/18; \quad SD = \sqrt{V}$$

Adopted from Baccarini (2004b)

6.7.6 Monte Carlo simulation (MCS)

MCS allows examination of what would happen if we undertook many trials of a project. MCS is a quantitative technique for analysing risk and provides a

structured way of setting the contingency value in a project cost estimate (Clark, 2001). The output of MCS is a probability distribution for total cost of the project. An example of its application is provided by Honeywell Performance Polymers and Chemical, which used MCS in 47 projects ranging from US\$1.4m to US\$505m (Clark, 2001). Contingency is to be set at 50% probability level (median), based on the rationale that many projects make up the total annual budget, so cost variations on one may be offset by another project. This approach often yields a recommended contingency value of less than 5%, or zero for a well-defined project (Clark, 2001). However, for very large or strategic projects, an 80% or 90% probability level is chosen for contingency; and at a preliminary stage of a project, 95% is usually required.

Many authors, such as Lorange and Wendling (1999), advocate assigning contingency so that the Base Estimate + Contingency = 50/50 point (median) because this establishes a target for the project team where they have an equal chance of underrunning or overrunning the estimate. The US Federal Aviation Administration (FAA) uses the median (50/50) point as its budget baseline, and contingency is the difference between the 50% and 80% confidence level (Fenton et al., 1999).

6.7.7 Estimate quality

Oberlander and Trost (2001) developed a quantitative model to predict the amount of cost contingency required based the quality of the project cost estimate and historical cost data. The accuracy of an estimate depends on four determinants: who is involved in the estimate (16% influence); how the estimate is prepared (23%); what is known about the project (39%); and other factors considered whilst preparing the estimate (22%). These four determinants were decomposed into 45 elements used to measure the quality of an estimate. The model was based on detailed analysis of 67 completed capital projects (US\$5.6bn) in the process industry. For the estimate, each element is rated from 1 (best) to 5 (worst).

Examples of these elements are relevant experience of estimating team; time allowed for preparing estimate; what is known about technology.

The score for each element is entered into the model and an overall score for estimate quality is automatically derived. An ordinary least-square (OLS) fit through the data of the 67 projects provides the basis for predicting the accuracy of an estimate. The prediction model is $y = mx + b$, where y represents the percentage contingency and x represents the estimate score, m is the slope and b is the intercept. This score then predicts the accuracy of the estimate; the higher the score, the greater the inaccuracy and therefore the need for more contingency for a chosen confidence level. For example, a score of 41.8 has a 90% chance of underrunning, if 34.9% contingency is added to the base estimate. This information can be used to check the amount of contingency determined by other methods, as well as a method of predicting its own contingency.

6.7.8 Regression analysis

Regression models have been used since the 1970s for estimating cost (Kim et al., 2004). The purpose of linear regression is to use the linear relationship between a dependent variable (for example estimated final cost) and independent variables (for example location, size) to predict or explain the behaviour of the dependent variable. Multiple regression analysis is generally represented in the form: $y = a + b_1x_1 + b_2x_2 + \dots + b_nx_n$, where y is the total estimated cost; x_1, x_2, \dots etc. are the measures of variables that may help estimate y ; and b_1, b_2, \dots etc. are the coefficients estimated by regression analysis. The regression equation can then be used to predict the value of a dependent variable once the values of the independent variables are inserted. For example, (Merrow and Yarossi, 1990) have y as the estimated cost/actual cost and x variables such as level of scope definition, and level of unproven technology.

6.7.9 Artificial Neural Networks (ANNs)

ANNs are an information processing technique that simulates the biological brain and its interconnected neurons (Chen & Hartman, 2000). The structure of ANNs mimics the nervous system by allowing signals to travel through a network of simple processing elements (akin to neurons) by means of interconnections among these elements. These processing elements are organised in a sequence of layers consisting of an input layer, followed by one or more hidden layers and culminating in an output layer. The input processors accept the data into the ANN (for example, variables that have a relationship to the amount of cost overrun in projects), the hidden processors represent relationships in the data and the output layer produces the required result (for example predicted amount of cost overrun). ANNs employ a mechanism to learn and acquire problem-solving capabilities from 'training' examples by detecting hidden relationships among data and generalising solutions to new problems. ANNs are suitable for non-linear modelling of data, which contrasts with the linear approaches using regression

Over the past decade, the use of ANNs for cost estimating has grown. ANN can be used to predict project cost overruns and thereby assist management in developing an appropriate contingency (Chen & Hartman, 2000). Examples of the application of ANNs to predict the level of cost overrun/underrun include:

Chen and Hartman (2000) used ANN to predict the final cost of completed oil and gas projects from one organisation using 19 risk factors as the input data. It was found that 75% of the predicted final cost aligned with the actual variance, i.e. where the ANN model predicted an overrun/underrun, an overrun/underrun actually occurred. The prediction accuracy of ANN outperformed multiple linear regression.

Chau et al. (1997) used eight key project management factors to predict the final cost of construction projects. It was found that more than 90% of the examples did not differ by more than one degree of deviation from the expected. Gunaydin and

Dogan (2004) used eight design parameters to estimate the square metre cost of reinforced concrete structure systems in low-rise residential buildings and found that the ANN provided an average cost estimation accuracy of 93%.

6.8 Summary

Traditionally, contingencies are often calculated as an across-the-board percentage addition on the base estimate, typically derived from intuition, past experience and historical data. This estimating method has serious flaws. It is usually illogically arrived at and may not be appropriate for the proposed project. This judgmental and arbitrary method of contingency calculation is difficult for the estimator to justify or defend. A percentage addition results in a single-figure prediction of estimated cost, which implies a degree of certainty that is simply not justified. It does not encourage creativity in estimating practice, promoting a routine and mundane administrative approach requiring little investigation and decision making.

6.9 Conclusion

There are a number of methods used to calculate contingency for risks in construction project environments. If these contingencies are unplanned for and risk associated events occur, it may lead to cost overruns which in turn damage the project lifecycle. Accurate estimating for project cost contingency, especially in the early phases of the project lifecycle, is crucial as these estimates will be used as a cost baseline for the duration of the project. These contingencies are allocated either on an item-by-item basis or applied as a percentage of the total cost.

Cost overruns and their effects on project performance are examined in the next chapter as well as other factors that can delay project schedules.

CHAPTER 7

COST OVERRUNS AND PERFORMANCE

7.1 Introduction

Cost overruns and delays in project schedules are problems often experienced in construction projects. While there is no clear way of avoiding cost overruns, proper planning can decrease the chances of these overruns occurring, thereby contributing to project stability. As with risk, there is an element of probability in the occurrence of cost overruns. Delays in projects cause time overrun and these can affect not only current projects, but future projects as well, as time constraints and adjusted deadlines affect their implementation. This is particularly true for large construction projects with possibilities of risk-based events occurring, including overruns.

7.2 Construction time performance

Walker (1995) indicated that construction time performance, cost and quality have been identified as three crucial success factors for a construction project. A review of the literature established that construction time performance is determined by numerous factors. Much of the literature concentrated on project scope as a useful predictor of construction time. Bromilow's seminal work (Bromilow et al., 1980; Bromilow & Henderson, 1976), is widely cited and his ideas have been developed and extended by those developing construction time prediction models.

While previous models have explained construction time by project scope measured by construction cost or gross floor area and number of floors (Ireland, 1983; Nahapiet & Nahapiet, 1985), there is widespread acceptance that other factors must also be considered.

The principal criticism of purely scope-based models is that the management process is too complex to be relegated to the value of a constant conveniently described in a formula, regardless of the correctness of the statistical methodology used.

A number of researchers have linked non-scope factors to construction time performance. Ireland (1983) investigated the impact of managerial action on cost, time and quality performance in building, and Sidwell (1982) investigated the impact of client decision making on the construction process and project success. Both identified influences on project time performance from inception to completion and concluded that client experience, form of building procurement and project organisational structure are elements of a complex causal model of project time performance. Sidwell (1982) states, "when the building team and project procedures are appropriate to client and project procedures, higher levels of success will be attained" (1982). He also identifies managerial control as a key element of achieving project success, linking this to project complexity. Ireland's work (1983) supports Sidwell's conclusions and indicates that non-traditional procurement methods are likely to lead to better construction performance than traditional ones. In reporting results from a study of 69 projects, Naoum (1991) concludes that "the major factors that affect cost and time overruns are the procurement method adopted and the designer's experience..." (1991). However, Bresnen et al. (1990) in a study of 138 projects, conclude that there was only a slight association between type of client and type of project and construction time performance. An insignificant association was found between contract type and construction time performance. They also found that new work was built more quickly than refurbishment projects. Chauchau and Chiang (1988) undertook a survey of 100 building and civil engineering projects in Hong Kong, India, Korea, Singapore, Taiwan and Thailand. Their survey results led them to believe that the performance of a construction management team is influenced by internal and external factors that they classify as: project, environment and management related.

7.2.1 Importance of timeous completion of projects

A project is said to be successful when it is completed within budget cost, specified quality and stipulated time and delivered safely, according to Mbamali et al. (2005). There has been much dispute and conflict occurring from these projects not being completed within the specified time span. Delays occur due to detrimental actions of parties in a contract. Contributions to delays emanating from the client may include late decision making, late release of funds and changing of the scope. Factors contributed by consultants include late instructions, poor dimensional co-ordination, late approval of work, late preparations of interim valuations and certificates for the contractor, and late inspection and approval of work. Under-performance of the contractor, lack of material and skilled human resources, poor construction, techniques, weather influences and labour strikes are capable sources of delay. The possible circumstances and consequences of all these actions are greater for project cost, late delivery of projects and, sometimes, termination or cancellation of contract. Having said that, every effort should be made to ensure that parties do not unnecessarily hamper the on-time execution of projects.

7.2.2 Issuing of revised drawings

According to Yakubu and Sun (2009), design changes are the most encouraging factor inhabiting the delivery of projects on time in the United Kingdom construction industry from the perspective of the contractor and consultants. Walker and Shen (2002) announced that a delay in design documentation was ranked the second most influencing factor that adversely affects project delivery. Time should not be taken for granted in this process of issuing revised drawings. The Joint Contract Tribunal (JCT, 1980) clearly specifies that revision of drawings should not exceed more than three days, after which the contractor can claim for extension of time. This could elevate the final project cost to the disadvantage of the client, which the

client might not want to incur. Revisions of design should be done promptly and accurately.

7.2.3 Missing information

Andi and Minato (2003) articulate that poor design and documentation quality negatively affects the construction process. Moreover, Alaghbari et al. (2007) identify incomplete documents as one of the ten factors causing setbacks in the delivery of projects in the Malaysian construction industry. Missing information interrupts or comes between the smooth operations of work. Contractors are employed to build in such a way that they adhere to design and specification. Assumptions should not be made while constructing; therefore missing information, should be brought to the notice of the designer and a quick response should be given to address this.

7.3 Construction delays – classification

There is a plethora of literature pertaining to the subject of delay in the delivery of projects: Aibinu and Jagboro (2002) in Nigeria; Belout and Gauvreau (2004) in Canada; Koushki and Kartam (2004), Assaf and Al-Heijji (2006) and Faridi and El-Sayegh (2006) in Saudi Arabia; Frimpong, et al. (2003) in Ghana; Bryde and Robinson (2005) in the UK and Toor and Ogunlana (2008) in Thailand.

Based on the survey of the literature, 76 potential factors that could influence project delivery time were identified and classified into 12 categories. These classifications and the factors that constitute each classification are:

- **Client understanding of the design, procurement and construction process**

Lim and Ling (2002) identify the following as factors that lead to this problem: clients' understanding of the project constraints; the ability to effectively brief the

design team; the ability to contribute ideas to the design and construction processes; the ability to make authoritative decisions quickly and the stability of these decisions.

- **Quality of management during design**

Project success depends, inter alia, on the performance of the design team. Defective designs have an adverse influence on project performance and the participants are responsible for many construction failures (Andi & Minato, 2003:297). Failure at the conceptual planning and design stages may lead to significant problems in successive stages of the project. Oyedele and Tham (2007) provide a listing of clients' ranking of designers; performance criteria among which were those that relate to quality, to design co-ordination, smooth flow of work vis-à-vis conflicting design information, time spent on issuing of revised drawings, missing information, dimensional inaccuracies and the delay of release of shop drawings.

- **Quality of management during construction**

Dainty et al. (2003) cite Cooke-Davis (2001) who declares that project management competence represents only one of many criteria on which project performance is contingent. According to Ponpeng and Liston (2003:281), problems such as schedule delays, budget overruns, non-achievement of quality extent, and from not selecting the best contractor to construct the facility. Quality of management during construction concerns the steps taken to ensure that products are in accordance with the quality standards and measure the effectiveness or competency of consultants and contractors. The factors that contribute to quality of management during construction are: forecast planning data such as analysis of construction methods; analysis of resource movement to and within site; analysis of work sequencing to achieve and maintain workflow; monitoring and updating of plans to appropriately reflect work status; responding to, and recovering from problems or advantage of opportunities presented; effective co-ordination of

resources, and the development of appropriate organisational structure to maintain workflow.

- **Motivation of staff**

Productivity in the construction industry has been steadily declining. Labour efficiency has been cited as poor, resulting in delays. Several techniques may be used to positively influence workers' behaviour. Two of these techniques are the behavioural and economic approaches. The former views motivation from the perspective of workers' psychological requirements, and the second views it from the economic approach, placing emphasis on monetary rewards (Andawei, 2002:2).

Motivation variables that could impact on construction time are: pay and allowances; job security; a sense of belonging and identification with the project team; recognition of contribution made; opportunity to extend skills and experience through learning; equitable rewards relative to others' input into the project; and the exercise of power and opportunity for career advancement for future benefit.

- **Site ground conditions**

The inherent site conditions of a project affect the speed of delivery (Frimpong et al., 2003). This is often due to a lack or poor investigation of site ground conditions to obtain data regarding site soil conditions. The research of Frimpong et al., (2003) found that ground problems and unexpected geological conditions contribute to delays. Other ground factors that impact on the speed of construction include the nature of demolition work; the nature of restoration work; the structural stability of ground; the extent of ground contamination; the extent of archaeological funds; the impact of the water table; the impact of underground services and the impact of underpinning existing structures.

- **Site access**

The condition of site access to a project will determine the rate of flow of materials, machines and people to the project site (Griffith & Watson, 2004). Where there is difficulty in getting to the site, in the form of bad road surfacing, narrowness of the road or a long distance between storage space and entry point, these factors will negatively affect construction speed. According to Toor and Ogunlana (2008), these cause delays in construction.

- **Constructability of design**

Mbamali et al., (2005) define the extent to which a building design facilitates the ease of construction as *buildability*, the British term, or *constructability*, the American term, which is defined as the grouping of similar work components and the use of modular dimensions in design to reduce construction cost and time. Oyedele and Tham (2007) provide a list of factors that could be used to assess constructability, inter alia, flexibility of design to changes; dimensional co-ordination of elements; knowledge of performance of materials and components; effective constructability review of design; effective participation in site inspection and control; the scope of off-site fabrication; complexity of off-site fabrication; components; appropriateness of design tolerances; appropriateness of working space; implication upon trade co-ordination; impact of material storage and movement; and impact of smooth activity workflow and activity sequencing,

- **Management style**

People undertake complex work, and they have varying personality traits and characteristics. Supervision is required to enable workers to meet scheduled targets. The following factors could be used in assessing the management style of those in positions of authority: setting specific goals employees are to accomplish; organising the work environment for people; setting timeliness; providing specific direction; conducting regular updates on progress; providing support and

encouragement; involving team members through discussion of work; and seeking people's opinions and concerns.

- **Management techniques used for planning and control**

Project-controlling techniques indicate the direction of the project at each stage and real progress. According to Burke (2006) there are various types of planning tools, namely the Gantt (bar) chart, network diagrams and the CPM as well as the Program Evaluation and Review Technique (PERT). Others include line of balance, horse blanket and S-curves.

- **Physical environmental conditions**

These are factors that no party to a contract can control (Faridi & El-Sayegh, 2006). Mbachu and Nkado (2006) contend that socio-cultural issues and unforeseen circumstances constitute these factors and constrain successful construction project delivery in South Africa. They include the impact of natural hazards such as fire and floods; adverse local weather conditions such as rainfall and high temperatures; ambient noise beyond tolerance level; and either the lack or intenseness of lighting conditions.

- **Economic policy**

This refers to the level of general economic activity and resources available to carry out construction work. Koushki and Kartam (2004) identify 25 such factors that could influence construction time. Those applicable to this study include the availability of materials; the availability of equipment; the availability of trades/operatives; the availability of supervision/management staff; and the indirect impact of interest rates/inflation, insolvency and bankruptcy.

- **Socio-political conditions**

The socio-political environment concerns projects or individuals while the political environment is concerned with government policy and the effect of political

decisions on projects. Political sociology is defined as the study of power and the intersection of personality, social structure and politics. These factors include civil strife or riots, the influence of civil action groups, and disruptions due to environmental concerns.

7.4 Construction delays

The major customer of the construction industry in most countries is the government (Okpala & Aiekwu, 1988). To the dislike of owners, contractors and consultants, many government projects experience extensive delays and therefore exceed the initial time and cost estimates (Odeh & Battaineh, 2002). This problem is more evident in the traditional type of contracts in which the contract is awarded to the lowest bidder. The majority of government projects in developing countries adopts the procurement strategy. The Latham Report (Latham, 1994) suggested that ensuring on-time timely delivery of projects is one of the most important needs of clients of the construction industry. Severe criticisms of the industry arise if it takes much longer than the stipulated project time (Bennett et al., 1979; Flanagan et al., 1986). Completing projects on time is an indicator of an efficient construction industry (NEDO, 1985). Contractors are primarily concerned with quality, time and cost and yet the majority of construction projects are procured based on only two of these parameters, namely time and cost (Bennett & Grice, 1990). The literature emphasises time as an indicator of project success.

The construction process can be divided into three important phases, i.e. project conception, project design and project construction. Usually, the vast majority of project delays occur during the construction phase, where many unforeseen factors are always involved (Chan & Kumaraswamy, 1997). In construction, delay could be defined as time overruns either beyond the completion date specified in a contract, or beyond the date that the parties agreed on for the delivery of a project. It is a project slipping over its planned schedule and this is a common problem in construction projects. To the owner, delay means loss of revenue through non-

availability of production facilities and rentable space or a dependence on present facilities. In some cases, delay causes higher overhead costs to the contractor because of a longer work period, higher material costs through inflation, and labour cost increases. Completing projects on time is an indicator of efficiency, but the construction process is subject to many variables and unpredictable factors, which result from many sources. The sources are the performance of parties, resources availability, environmental conditions, involvement of other parties and contractual relations, and the completion of a project within the specified time is rare (Assaf and Al-Heijji, 2006).

Cost and schedule overruns occur due to a wide range of factors. If project costs or schedules exceed their planned targets, client satisfaction is compromised. The funding profile no longer matches the budget requirement and further slippage in the schedule could result (Kaliba et al., 2009). According to Ahmed et al. (2002), delays on construction projects are a universal phenomenon and road construction projects are no exception. Delays are usually accompanied by cost overruns. These have a debilitating effect on contractors and consultants in terms of growth in adversarial relationships, mistrust, litigation, arbitration, cash-flow problems and a general feeling of trepidation towards other stakeholders (Ahmed et al., 2002). This problem is not unique to developed countries and is experienced in most of the developing economies.

When projects are delayed, they are either extended or accelerated and therefore incur additional cost. Normal practices usually allow a percentage of the project cost as a contingency allowance in the contract price and this allowance is usually based on judgment (Akinsola, 1996). Although the contract parties agree on the extra time and cost associated with delay, in many cases there are problems between the owner and contractor as to whether the contractor is entitled to claim the extra cost. Such situations result in questioning facts, causal factors and contract interpretations (Alkass et al., 1996). Therefore, delays in construction projects cause dissatisfaction to all parties involved and the main role of the project

manager is to make sure that projects are completed within the budgeted time and cost. Several studies have been undertaken on factors causing delays and cost overruns, and affecting quality, safety, productivity and specific problems in special types of projects. These studies usually focus on specific aspects of project performance. Practitioners need to develop the capacity to foresee potential problems likely to confront their current and future projects. Identification of the common problems experienced on past projects in their construction business environment is a good option (Long et al., 2004).

Frimpong et al. (2003) show that project management tools and techniques play an important role in the effective management of a project. PMBOK defines project management as the application of knowledge, skills, tools and techniques to project activities to meet the project requirements (PMI, 2008). Project management involves managing the resources, workers, machines, money, materials and methods used (Giridhar & Ramesh, 1998). Some projects are effectively and efficiently managed while others are mismanaged, incurring much delay and many cost overruns. Any construction project comprises two distinct phases: the preconstruction phase (the period between the initial conceptions of the project and awarding the contract) and the construction phase (period from awarding the contract to when the actual construction is completed). Delays and cost overruns occur in both phases. However, the major instances of project overruns usually take place in the construction phase (Frimpong et al., 2003).

Unfortunately, for various reasons, project successes are not common in the construction industry, especially in developing countries. From several studies and empirical evidence it is clear that project overruns comprising delays and cost overruns occur during the construction phase. Therefore, professionals and scholars have been motivated to take steps to meet this challenge.

7.4.1 Review of construction delays across the world

Realistic 'construction time' has become increasingly important because it often serves as a crucial benchmark for assessing the performance of a project and the efficiency of the contractor (Chan and Kumaraswamy, 2002). This study aims to identify the uncertainties and to foresee potential problems likely to confront current and future projects, helping project teams to be proactive in managing their projects in which potential problems are fully anticipated (Long et al., 2004).

Research literature from across the world was collated and consolidated for a better understanding and to conceive the overall picture of these issues. This critical review is presented in five sections: firstly, identification of factors and categories; secondly, the research methodology adopted in earlier studies (reorganising and tabulating the data from literature); thirdly, analysis of data; fourthly, results and discussions; and fifthly, conclusions.

7.5 Cost overruns

The greatest challenge facing the construction industry in developing countries like South Africa is the chronic and long-lasting problem of cost overruns. Under certain circumstances a whole set of drawings and specifications should be made available to the quantity surveyor, who would accurately prepare the entire bill of quantities for tendering purposes according to Koushki, et al. (2005). However, this will limit changes during the construction stage because the constructor will have all the needed documents/information to base his price on. As has been mentioned, this is not always the case according to Aibinu and Jagboro (2002), since the contract sum cannot always be regarded as a firm price. Even where the work is ordered on 'a fixed price contract' basis, there are still re-measurements of provisional works, an accurate prime cost, provisional sums and variation orders to contend with.

According to Kaming et al. (1997) and Cox et al. (1999), much research has been conducted on cost and time overruns. These research findings have one thing in common. It has been discovered that there were more cases of cost overruns than time overruns. This makes the dilemma of cost overruns of great significance. Most previous studies put their focus on a few factors that influence time and cost overruns such as design changes, which have been reported to account for 5-8% of the total project cost according to Cox, et al. (1999). This specific approach leaves many factors that one encounters in the final account reports. The best approach should be to investigate most of them and rank them accordingly. Although certain factors may seem meaningless or not vital in one project, they may prove to be significant in another project as the condition of the project is not always the same. It appears that there has always been a necessity for debate and further research because of the chronic problem of construction cost overruns. As one arbitrator once observed, it is hard to imagine a building contract that proceeds to completion without delay or variation whatsoever – that is according to Koleola and Henry (2008) and Nwachukwu and Emoh (2010). Having said that, it does not mean that there are no building projects that have been completed within budget. Conditions or rather situations like this are rare (Chan, 2001). Chan and Kumaraswamy (1996) found that there are more building projects that have cost overruns than those that are completed within budget. The scenario of cost overruns has been blamed on the many factors that influence construction cost overruns (Kaming, et al., 1997).

7.5.1 The factors that influence cost overruns

Many researchers have found reasons for the disparity between the tender sum and the final cost of a construction project; these include design change, inadequate planning, unpredictable weather conditions and fluctuation in construction materials (Morris, 1990; Kaming et al., 1997; Mansfield et al. 1994).

1. List of critical factors that cause cost overruns:

- a. Incomplete design at the time of tender
- b. Additional work at owner's request
- c. Changes in owner brief
- d. Lack of cost planning/monitoring during pre- and post-contract stage
- e. Site/poor soil conditions
- f. Adjustment of prime cost and provision sums
- g. Re-measurement of provisional works
- h. Logistics due to site location
- i. Lack of cost reports during construction stage

2. List of other factors that are usually ignored:

- a. Delay in issuing information to the contractor on construction delays
- b. Technical omissions at design stage
- c. Contractual claims, such as extension of time with cost claims
- d. Improvement to standard drawing during construction stage
- e. Wrong decision by the supervising team in dealing with the contractor's queries about delays
- f. Delays in costing variations and additional works
- g. Omissions and errors in the bill of quantities
- h. Ignoring items with abnormal rate during tender evaluations, especially items with provisional qualities
- i. Some tendering manoeuvres by contractors such as front-loading of rate.

The most crucial variables of cost overruns have been classified as: unpredictable weather, inflationary material cost, inaccurate materials estimated, complexity of project, contractor's lack of geographical experience, contractor's lack of project type experience, and non-familiarity with local regulations (Kaming et al., 1997). Morris (1990) conducted a study on the factors that influence cost overruns that were prepared with current prices obtained as at the time of tender, and as a result of delays from both parties and the unstable market resulting in cost escalation.

7.5.2 Determining the probability of project cost overruns

The ability to make accurate cost predictions is crucial to successful project delivery. Although many techniques have been devised and applied, cost overruns in projects remain a problem and these estimation problems are attributed to two main phenomena in drawing up the project budget: optimism bias and strategic misrepresentation. Optimism bias refers to the unintentional human tendency to exaggerate one's own ability and underestimate potential difficulties (Flyvbjerg et al 2005a; Lovallo & Kahneman, 2003), while strategic misrepresentation is the planned systematic distortion of fact (Jones & Euske, 1991).

Although these are primary contributors to cost overruns, they neglect the underlying complexity of the design and construction process (Love et al., 2012). The budget is modified as more information about a project's requirements becomes available during the design process. The establishment of a reliable reference point for cost overruns at contract award is important. Factors that contribute to overruns from this point include labour and material shortage, price inflation, rework, change orders, site access, unexpected site conditions and unforeseen events (Ariditi et al., 1985; Semple et al., 1994; Chang, 2002; Knight & Fayak, 2002; Gkritza & Labi, 2008; Love et al., 2012). These may not have been considered at contract award and arise during construction. However, with sufficient data of projects, the probability of cost overruns can be determined early (Jahren & Ashe, 1990; Birnie & Yates; 1991, Gkritza & Labi, 2008). Cost overruns are defined as random continuous variables because they can take on an infinite range of variables. The probability density function of normal distribution has been used to determine project overruns; however, a normal distribution is symmetric about its mean value and therefore cannot be used to accurately model left or right skewed data. Fitting empirical distribution of data can be difficult as there is a wide array of statistical distribution choices available and the selection of inappropriate statistical distribution may produce incorrect probabilities, which in turn will adversely affect decision making and lead to negative outcomes.

7.5.3 Cost overruns

Cost overruns are budget increases, cost increases or cost growths. Actual construction costs are defined as the costs accounted at the time of project completion. Table 7 provides a summary of studies that have examined cost overruns in construction and engineering projects. Issues related to project types and their influence on cost overruns has been examined and is the subject of ongoing debate. Flyvbjerg et al. (2005 a,b). reveal that there was a significant difference between the mean cost overruns for different project types but not for geographical location. Odeck (2004), however, determined that project type did not influence the level of cost overrun incurred.

Table 7: Descriptive Statistics for Cost Overruns

Statistic	Value
Sample size	276
Range	328.35
Mean	12.22%
Variance	426.54
Standard deviation	20.65
Coefficient of variation	1.689
Standard error	1.243
Skewness	5.549
Excess kurtosis	60.25

Adopted from Love et al. (2013)

7.5.4 Cost overrun determination

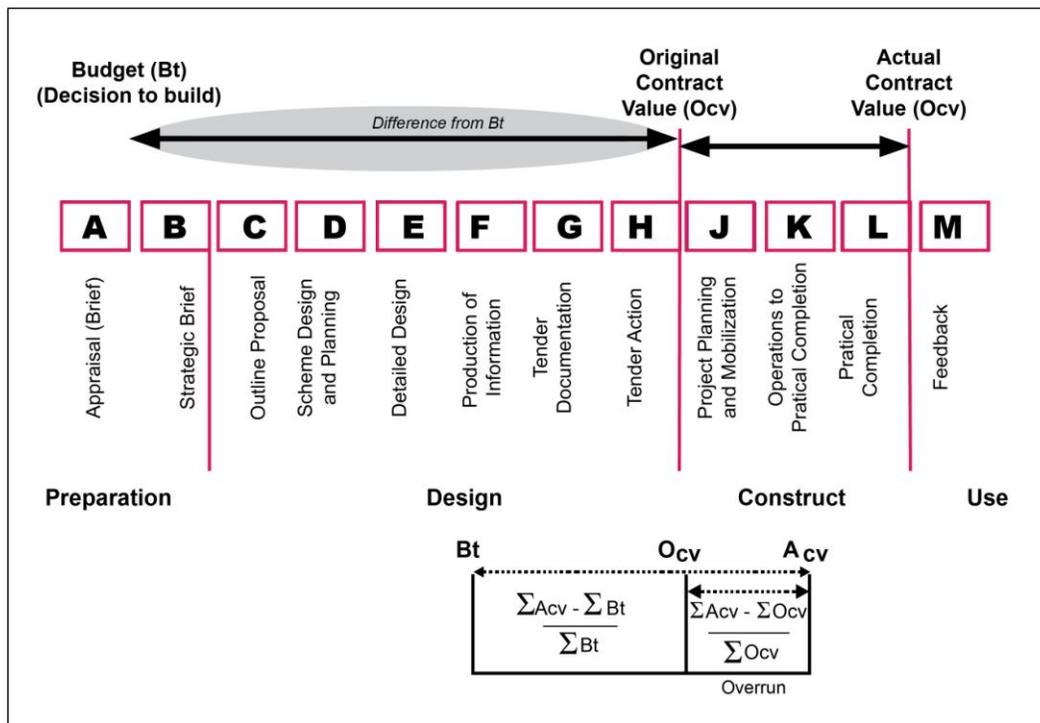


Figure 9: Project development process: determination of cost overrun
Adopted from Love et al (2013)

Figure 9 (above) presents the project development process along with reference points that determine project cost overrun. Project costs increase either by changing their character or by changing the economic and institutional environment in which they develop. Distinguishing between the factors that increase project costs and those that affect the accuracy of estimation is central to determining an accurate cost overrun probability. The percentage increase from the estimate, from time of contract award to decision to build, needs to be separated from the cost overrun analysis so that an appropriate contingency can be determined at the decision to build and be used to obtain a higher degree of estimation certainty. When large infrastructure projects and their costs are announced by governments, the general public opinion is that those costs will rise - which is usually the case, considering how long some of these projects take to complete. Depending on the size and complexity of the project, the physical construction may take years. A prime example is the Fiona Stanley Hospital in Perth, Western Australia. In 2004 it

was budgeted at AU\$420 million and after four years of planning and design, this figure rose to AU\$1.76 billion. Before construction had even begun, the project faced a cost overrun of 320%. The revised budget did not include the fittings required to run a working hospital. Construction and building works, however, only accounted for AU\$755 million of the revised 2008 budget. The current Perth Arena project has also been susceptible to massive cost overruns with an original budget of AU\$160 million in 2005, expected to be completed and operational in 2009. This is now expected to exceed AU\$500 million as a result of poor governance and significant changes in scope. Flyvbjerg and Cowi (2004) regard inaccurate budgets of this nature as optimism bias and reference class forecasting was developed to mitigate the risk of optimism bias, Love et al, (2013).

In the cases of the Fiona Stanley Hospital and the Perth Arena, the initial estimates were unrealistic because their scope had not been well defined and understood. During the design phase of the hospital, its size increased by 44% as a result of additional construction demands. Similarly, the Perth Arena faced design changes of AU\$7 million, changes to building design AU\$55 million, inclusion of outfitting and transition to operation AU\$42 million and an underground car parking facility AU\$34 million. This is a prime example of the importance of defining the project scope before drawing up the budget, Love et al, (2013).

Costs and project size

Research suggests that the likelihood of cost overruns increases with contract size and complexity as well as the number of change orders (Rowland, 1981; Hinze et al., 1992). Jähren and Ashe (1990) define change order rate as the ratio between the dollar amount change to change orders and the award amount. Rowland (1981) found that as the change order rate increased, the contract size increased, whereas Randolph et al. (1987) found that as the change order rate decreased, the contract size increased. Jähren and Ashe's (1990) examination of 1 576 construction projects found that a cost overrun rate of 1 to 11% is more likely to occur on large infrastructure projects than smaller ones as managers have longer

time to rectify cost-related issues. Odeck's (2004) research shows that larger overruns were experienced in smaller projects as larger projects are better managed and have longer completion times, allowing for adjustments to be made to facilitate cost control. To generally improve cost control, strategies are needed to prevent factors that cause cost overruns from occurring.

According to Liu and Zhu (2007), a typical construction project has five stages: conceptual or strategic stage; conceptual design stage; tender or detailed stage; preconstruction stage; and the build stage, with a cost estimate for every stage. The estimate accuracy, as well as the level of organisational resources committed to cost estimation, increases as the project progresses. A typical project cost estimate includes a base estimate (physical material and labour quantities) and risk contingency (quantifies the level of uncertainty or risk associated with the estimate). The base estimate is calculated from multiplying the rates and quantities of the project components. Risk contingency is expected to be expended and is the amount added to an estimate to allow for items, conditions or events for which the state, occurrence or effect is uncertain and will likely result in additional costs. Methods used to quantify the risk contingency include reference class forecasting, the conventional contingency approach and risk-based estimating. The cost estimates produced at different stages of a project have different levels of risk or uncertainty and therefore different estimation accuracies. With progress, more information becomes available about the scope, design and specifications which allow for more accurate estimation by the estimation team. Because of this, more risk contingency is applied at early stages of a project than at the later stages. Studies by Ashworth and Skitmore (1982) show that the typical estimation accuracy is around 30-50% at conceptual stage; 20% around the design stage (Morrison, 1984); 10% at the tendering stage (Flanagan & Norman, 1983) and 5% during pre-construction (Ferry & Brandon, 1991). Most of these studies compared the estimation at the tender stage to the actual cost when examining the estimation accuracy. Preconstruction cost estimates are primarily used for cost control and not estimation accuracy, as they are generally prepared after tendering.

Project cost performance and causal factors for cost overruns

Collective studies on infrastructure projects indicate that attempts to curb delays and large cost overruns are futile on large projects (Flyvbjerg et al., 2002; Pickrell, 1990; Merewitz, 1973) and this phenomenon is not limited to any geographical location. Australian studies were conducted on 21 infrastructure projects in Australia and the UK with a total value of AU\$7.66 billion. Of these, six were public sector and fifteen were private sector. The study found that 50% of projects executed by government entities exceeded their costs by 20% as opposed to 60% of the private sector projects that had actual costs within 5% of estimates.

Table 8: Project Cost Performance Findings

Author & Year	Sample Size	Type of Project	Mean	SD
Odeck, 2004	610	Road Infrastructure	7.88%	29.20%
Odeck & Skjeseth, 1995	12	Toll Roads	5%	-
Bertisen & Davis, 2008	63	Mining and Smelting Projects	25%	30%
Thomas, 2001	21	Mining	17%	-
Flyvbjerg, Holm & Buhl, 2005	58	Rail	45%	38%
Flyvberg, Holm, & Buhl, 2005	33	Bridges and Tunnels	34%	62%
Flyvberg, Holm & Buhl, 2005	167	Roads	20%	30%
Pohl & Mihaljek, 1992	1015	World Bank Projects	22%	-
Pickrell, 1990	8	Rail	60%	-
AGS, 1994	8	Road	86%	-
AGS, 1994	7	Rail	17%	-
Fourarcre, Allport & Thomson, 1990	21	Metro Projects	45%	-
Merrow, 1988	47	Various	88%	-
Gypton, 2002	60	Mining	22%	-
Castle, 1985	17	Mining	35%	-
Bennett, 1997	16	Mining	27%	-
Average			34.7%	37.8%

Adopted from Love and Li, (2000)

Data in Table 8 (above) shows that of 2 221 projects investigated, the average overrun ranges from 5% to 88% with a mean of 34.7% while the standard deviation ranges from 29.2% to 62% with a mean of 37.8%. This indicates that cost overruns

for infrastructure projects are substantial and the estimates completely unsatisfactory.

Various factors have been identified that contribute to persistent cost overruns such as poorly defined scope or significant changes in the scope (Pickrell 1990; Bertisen & Davis, 2008) and incorrect quantities or unit rates for material and labour quantities that lead to inadequate base estimates (Odeck & Skjeseth, 1995; Pohl & Mihaljek, 1992). In contrast, some argue that the cost estimates are so complex and unique that the ability to learn from past projects is limited (McMillan, 1992) and that the time taken from estimation to completion leads to price fluctuations and construction costs that are very difficult to estimate. Others argue that scope changes and preparing estimates should not lead to persistent cost overruns; instead, the estimating errors derived from scope and preparation errors should be random and unsystematic and should not result in systematic bias in the long run (Flyvbjerg et al., 2005b; Odeck, 2004; Bertisen & Davis, 2008). Errors are also a result of imperfect techniques, inadequate data, honest mistakes, modelling errors and lack of experience (Bruzelius et al., 2002; Morris & Hough, 1987; Wachs, 1990).

Optimism bias coined by Kahneman (1994) refers to the unintentional human tendency to exaggerate one's own ability and underestimate potential difficulties (Flyvbjerg, 2006; Kahneman & Lovallo, 1993; Mackie & Preston, 1998). The preliminary plan of the project puts it into a positive light and this view is skewed as the project progresses and is exacerbated by suppression of pessimistic views during estimation and planning (Lovallo & Kahneman, 2003). Strategic misrepresentation refers to the intentional deception by project promoters to gain a favourable outcome and has been identified as a major contributor to cost overruns (such as giving a low bidding price and raising variation prices during the construction phase). Trujillo et al., (2002), concludes that politicians have incentive to back large infrastructure projects owing to the greater gain from their announcement compared to losses (such as tax money) later. A prime example is

the Sydney Opera House that had an actual cost fifteen times greater than the original estimate because of promoters giving underestimates that they knew would be approved (Flyvbjerg, 2006).

Accuracy of hybrid estimating approaches

Cost overruns of large infrastructure projects have remained unchanged over the past 70 years (Bruzelius et al., 2002). Studies report that inaccuracy in cost estimation ranges from 20.4% to 44.7% depending on the type of project. Overruns of 50-100% in fixed prices are common for major infrastructure projects and overruns above 100% are not uncommon (Flyvbjerg et al., 2003; Flyvbjerg et al., 2002; Flyvbjerg et al., 2005a). The two main factors leading to inaccurate cost forecast for infrastructure projects are optimism bias and strategic misrepresentation (Bruzelius et al., 2002; Flyvbjerg, 2006). Optimism bias is the over optimism of people in overestimating benefits and underestimating costs (Lovallo & Kahneman, 2003), while strategic misrepresentation refers to deliberately underestimating project costs and risks for political, economic, and/or other gains (Flyvbjerg, 2006).

The main consequence of both optimism bias and strategic misrepresentation in cost estimation is the failure to account fully for risks/uncertainties in the estimates. Consequently, flawed planning, breakdown in the relationship between the client and contractors, and difficulties in delivering the project, result in both project delays and cost overruns. Kahneman and Lovallo (1993) conclude that the only way to mitigate optimism bias and strategic misrepresentation is to take the 'outside view' when making decisions. Reference Class Forecasting (RCF) was recently introduced as a technique to mitigate optimism bias and strategic misrepresentation. It uses a database of actual performance of comparable past projects within a given reference class to provide an objective reference point for the cost forecast of a current project (Flyvbjerg et al., 2005a). A percentage 'uplift' is determined and added to the base estimate as risk contingency (Flyvbjerg et al., 2002). The main challenge for applying the RCF method is the accumulation of a

large sample size of similar projects with accurate cost information (Napier & Liu, 2008).

Little empirical evidence exists on the accuracy of RCF and its comparison to other dominant cost estimation methods. Organisations tend to tailor generic estimating approaches to their unique operating environments by developing hybrid approaches, blending RCF with other approaches such as the conventional fixed contingency approach. For practitioners, such evidence will help in choosing and adopting the best project cost estimation method. This study finds that the average accuracy of this sample using the hybrid approach compares favourably with historical results, which typically use the fixed contingency approach. This finding is further supported through the comparison with a sample of conventional construction projects using fixed contingency approach that shows hybrid samples tend to produce estimates that are more likely to lead to under-budget rather than over-budget with similar dispersion around the mean estimation error. The results suggest that RBE is more accurate than the hybrid approach and the findings have important implications for both practice and future research.

Studies have identified a number of factors contributing to persistent cost overrun such as a poorly defined scope or significant changes in scope that were not counted in the base estimate could lead to significant overruns (Pickrell, 1990; Bertisen & Davis, 2008). Similarly, incorrect quantities or unit rates for material and labour quantities could produce inadequate base estimates and subsequently lead to overruns (Odeck & Skjeseth, 1995; Pohl & Mihaljek, 1992).

Some scholars have argued that the cost estimates of projects are sometimes so complex and unique that the ability to learn from past mistakes is limited (McMillan, 1992). Touran and Lopez (2006) contend that, given the length of time between estimation and project completion, price fluctuation in construction costs tend to increase the difficulty of estimating and drives estimates to become very unreliable. While acknowledging that both poor scope definition and mistakes within the

preparation of the base estimate do lead to error, a number of scholars (Odeck, 2004; Flyvbjerg et al., 2005b; Bertisen and Davis, 2008) argue strongly that the scope changes and errors in preparing the estimates should not lead to persistent cost overruns. Instead, they argue that the estimating errors derived from scope changes and preparation errors should be random and unsystematic, thus in the long term should not result in a systematic bias. The errors could also come from imperfect techniques, inadequate data, honest mistakes, modelling errors and lack of experience (Bruzelius et al., 2002; Morris & Hough, 1987; Wachs, 1990). People tend to be optimistic about what they can achieve and this optimism can lead to 'planning fallacy' (Lovallo & Kahneman, 2003). A project usually starts with a preliminary plan that typically puts the project in a positive light. The subsequent analysis of the project is anchored on the preliminary plan and is effectively skewed towards over-optimism (Lovallo & Kahneman, 2003). The problem becomes particularly acute when pessimistic views are suppressed and optimistic opinions rewarded and, as a result, people lose the ability to think critically (Lovallo & Kahneman, 2003).

Finally, strategic misrepresentation, which refers to the intentional deception designed to secure a favourable outcome for the project promoters (Flyvbjerg et al., 2002) was identified as a major contributor to persistent project cost overruns. Trujillo et al. (2002) conclude that politicians have an incentive to embark on large infrastructure construction projects because they enjoy a greater gain from such announcements compared to the losses incurred by having to raise taxes later. The Sydney Opera House is an example of strategic misrepresentation. With an actual cost fifteen times the original, promoters knew that such an expenditure would be seen as unfavourable in the public eye and had strategically underestimated the costs to ensure that prompt approval for construction was granted (Flyvbjerg et al., 2005a,b).

7.6 Conclusion

A number of factors contribute to cost overruns and delays in projects, some within the control of the project team, most of them not. These cost overruns and delays lead to additional costs and loss of productivity on work sites owing to lost time. These factors are also not limited to certain regions, but occur in similar projects across the globe. Optimism bias and strategic misrepresentation are identified as the main causes of cost overruns in construction project estimates and costs. While the estimation process for this type of project is very complicated, certain techniques have been developed to assess risk and plan for contingency for these types of problems.

The next chapter examines the procurement process in construction projects as well as the ethical issues surrounding procurement practices.

CHAPTER 8

PROCUREMENT

8.1 Introduction

The procurement process is the process by which a project is adjudicated to a contractor. By the nature of this process, a number of ethical questions and practices arise in its implementation. These issues may stem either from the client's side, the contractor's side or both. When unethical decisions are made, the outcomes adversely affect the quality of the project and the concept of ethics on the procurement side of project management has been widely debated. Policy of procurement procedures plays a major role in how construction projects are awarded in the tendering process and proper policy management and implementation is necessary to regulate the procurement process, especially for large construction projects or projects that are conducted for government.

8.2 Ethics in procurement

8.2.1 Factors contributing to ethical issues

Even though there are guidelines and acts to guide the procurement process, there are still ethical issues that arise in project procurement that eventually lead to a lower quality outcome for the project. In Malaysia, a number of public sector projects are facing this problem: the headquarters of Malaysian External Trade Development Corporation; the delay in completion of school buildings; school computer laboratories; cracks in 31 pillars of Middle Road Ring Two (MRR2) projects; and the most recent, the collapsed roof of Sultan Mizan Zainal Abidin's stadium in Terengganu (Boards of Architects Malaysia, 2008, cited in Hassim et al).

These problems should be the responsibility of all parties involved in the project, including the client as the project sponsor. Morality is synonymous with ethical

issues. According to the Works Ministry of Malaysia, YB Dato' Shaziman bin Abu Mansor in his speech during the opening of the Construction Industry Integrity Seminar 2009, ethical issues will normally occur especially during the economic downturn. Those contractors and clients who are in the construction industry will try to get projects using whatever methods, including unethical behaviour, that ignore morality and integrity. This is because they are willing to do anything to survive during the economic downturn. Owing to this unethical behaviour by the construction industry parties, there is a great impact on the quality of the project (Rahman et al., 2007). One of the key challenges of the construction industry in Malaysia is to focus on continuous quality improvement. Donaldson (2008) states that ethical practices that promote economic efficiency include respect for intellectual property, engaging in fairer competition, avoiding monopolies, avoiding nepotism and crony capitalism, not abusing government relationships, providing accurate information to the market, avoiding bribery, respect for the environment and honouring contracts, promises and other commitments. Ethical issues in project procurement are not only about bribery or corruption but also about conflicts of interests and collusive tendering. Transparency International has shown how corruption can add up to 25% to the cost of public contracting, generating waste of public resources, missed development opportunities and an unstable environment for businesses. These statistics indicate that the scale of corruption is higher in construction than any other sector of the economy.

Ethical issues not only occur among the contractors and suppliers but also with the client. The ethical issues in procurement practices have not considered the role of clients seriously. From an extensive literature review, there are a few studies carried out researching the role of clients, including the government client, in relation to ethical practices in the project procurement. Project implementation begins with the client, sponsor of the construction process, who provides the most important perspective on project performance and whose needs must be met by the project team (Masterman, 2002; Rowlinson, 1999; Masterman, 2002; Newcombe, 1994). Most of the previous research conducted concerns the ethical

issues in the tendering or contract award phases of project procurement. However, it is also important to study the plan procurement or the pre-award phase of project procurement. This is because plan procurement is the key function that sets the stage for the procurement process. According to PMI (2008), plan procurement involves determining whether to acquire outside support; if so, what to acquire; how to acquire it; how much is needed; and when to acquire it. This process also includes consideration of potential sellers, mainly if the buyer wishes to implement some measure of influence or control over acquisition decisions. As a key project activity, the need for planning emerges as being underemphasised at the initial stages of procurement projects.

Procurement may be defined as an amalgam of activities undertaken by a client to obtain a new building (Rowlinson, 1999). The Office of Government and Commerce (OGC, 2003) defined procurement as the means of achieving project objectives and value for money by taking into account the risks and constraints, leading to decisions about the funding mechanism and asset ownership for the project. Project procurement is one of the important areas in project management. It includes the broad management functions of planning, organising and leadership, staffing, controlling and communicating procurement processes and activities across the spectrum of the 'upstream' supply chain activities of both public and private organisations. According to PMBOK (2004), project procurement includes all the processes necessary to purchase or acquire the products, services or results needed from outside the project team to perform the work.

The decisions made in plan procurement will influence the project schedule and are integrated with developing the schedules in the future. According to PMBOK (2006), Government Extension, government procurement decisions have many challenges to maintain public trust, fully used government resources and to ensure open and fair competition among prospective government contractors.

Practitioners and researchers have widely discussed and debated ethics in project management and one of the areas that they focus on is project procurement. This area has been identified as one of the major areas in project management that has contributed to ethical issues during the implementation of projects. Based on an extensive literature review by other scholars, researchers and writers conclude there has been a lack of focus on ethical issues in public sector project procurement particularly in the pre-stage of project procurement. Owing to the huge amount of money and a large number of companies involved with the procurement process for big contracts, potential exists for unethical business practices in each of the steps in the procurement process. Ethics is not only about behaviour but includes thoughts, language, reasoning, processes and judgement that informs the choices people make in their daily lives that affect their own well-being and that of others (Wasserman, 2000). There is a tremendous impact of organisational culture on the ethical behaviour of people within the organisation and can indirectly manipulate the ethical behaviour of people involved in the plan procurement. According to Bowen (2004), all of these dimensions have an effect on ethical decision making through factors such as the level of autonomy for communication in issue decision making, the relationship of the top communicator to the dominant coalition and how the moral analyses of individuals were communicated in issues management meetings.

Besides personality, position or status will also affect the ethical decision making. This is due to the amount of responsibility and power held by an individual. Demographics have been used to predict moral reasoning in a number of studies. Demographics include age, gender, education level and background. Some variables are also related to the confidence and personal beliefs of the individual decision maker. Ego strength is related to strength of conviction or self-regulatory skills (McDevitt et al., 2007). According to Guth (2009) there are a few ethical issues related to the project procurement processes, that may occur:

Issues of influence – behaviours or actions that may negatively influence or appear to influence, procurement decisions (such as seller gifts, entertainment or outright bribes)

Perceived impropriety –the intent and appearance of unethical or compromising conduct in relationships, actions and communications

Conflict of interest – personal, business or other activities that conflict with the lawful interests of the employer

Confidential and propriety information – violations of confidentiality, non-disclosure and proprietary rights

Reciprocity – improper reciprocal agreements

Applicable laws, regulations and trade agreements – violations of law.

A conflict of interest exists when an individual has the opportunity to take a decision that advances his or her own interest rather than that of the organisation (Walker and Rowlinson., 2008). However, bribes, gifts or personal payments have different meanings in different countries. In western countries, all of these are considered a potential conflict of interest. In China, the term, 'guanxi', which means to establish rapport and trust with business partners is considered different from bribery. In Chinese culture, gift giving is a natural dynamic of any relationship. It shows that a relationship is valued and is a means of expressing respect and honour for the other person (Tian, 2008). Honesty and fairness is needed in business ethics and so with project procurement. In Malaysia, bribery and corruption are considered unethical behaviour and those who are caught giving or accepting bribes will be penalised under the Malaysian *Anti-Corruption Act* of 2009. However, many factors cause people to be involved in ethical issues in project procurement. In Malaysia, research was conducted to show the effect of unethical behaviour on the construction quality (Rahman et al., 2007). Most of these unethical conducts occur in the project procurement process; 74.2% of the respondents gave the same feedback regarding the Malaysian construction industry whereby this industry is tainted with unethical conducts among the construction players, including the public sectors as the main clients of the

construction industry. According to Bowen (2004), all of these dimensions had an effect on ethical decision making through factors such as the level of autonomy for communication in issue decision making, the relationship of the top communicator to the dominant coalition and how the moral analyses of individuals were communicated in issues management meetings.

More than half of the respondents of the research conducted by Rahman et al. (2007) felt that leadership is needed as a role model to improve professionalism. Leaders must show an effective leadership style as they are the role model of their employees. Their conduct or behaviour will influence the organisation's norms and values. The people within the organisation will normally follow the norms that are being practised within that organisation (Gupta & Sulaiman, 1996; Zabid & Alsagof, 1993). The behaviour of top management and the immediate superior is a guidepost for acceptability of ethical or unethical behaviour in an organisation. They are the role models of their staff to show that integrity is well implemented in the organisation. The Integrity Institute of Malaysia (IIM) was therefore established in 2004 to inculcate ethical values and behaviour among the public and private sectors. One of the main reasons that ethical issues occur in plan procurement is the non-transparent selection process. This has led to allegations of corruption whereby the Public Works Department of Malaysia is under siege for the multi-billion ringgit fiascos involving MRR2, the Matrade Building and the Navy Recruit Training Centre (Beh, 2007). Today, the Matrade projects have not yet been completed and the MRR2 project is facing a problem with the cracks that were found at the piling.

It is crucial that the issue of transparency and accountability is to be focused on especially when it comes to public expenditure. Problems of accountability arise when governments ignore ethics and constitutional and legal provisions in spending public money and conducting affairs. This also includes the disregard of the administrative systems, tasks that are so complex that it is difficult to identify who is responsible for what and activities that are underfunded. Failure to control

the bidding exercise may also cause unethical behaviour. It will end up with under-bidding by contractors and this will affect the project implementation and project delivery to the end user (Rahman et al., 2007). It is important to control the bidding exercises to ensure that the public sectors are getting the most qualified contractor to perform the project based on the specific requirements. If this is not controlled it may cause low project quality or, even worse, the project could not be completed within the stipulated time frame due to the bidding exercises that are not controlled by a specific body or department.

Mullins (2003) argues that procurement planning is the process of determining the procurement needs of an entity and the timing of its acquisition and its funding such that the entity's operations are met as required in an efficient way. But, if there are ethical issues in the plan procurement, it is difficult to meet all the requirements and the objective of project procurement. The plan procurement process of public sectors needs to be transparent to be able to deal with questions and to prevent any ethical issues from arising.

The importance of accountability has become an important agenda especially in the public sectors. This mechanism of accountability is indispensable for promoting a high standard of ethical conduct in order to move towards a developed nation (Beh, 2007). Public projects in Malaysia should be evaluated closely to ensure that the public expenditure is used wisely for projects, as in the Ninth Malaysian Plan (EPU, 2008). The Public Accounts Committee needs to have a balanced composition to act in a non-partisan manner on public expenditure issues. The open tender process is one of the ways to mitigate the possible conflicts of interest and to promote cost efficiency in project procurement. Currently, all public sectors have been directed to comply with the current procurement policies with the improvement of the open tender system to ensure transparency and accountability in the project procurement among the public sectors.

Every professional body or organisation has its own professional code of conduct and policies to guide the ethical behaviour among its members. Failure on the part of professional personnel to exercise the degree of care considered reasonable under the circumstances can cause ethical issues to emerge in project procurement. This is because most of the codes of ethics do not address the specific kinds of situations that professionals encounter (Loo, 2002). Even though Malaysian public sectors have many policies to guard against unethical behaviour, they are not being enforced properly. Accountability mechanisms need to be strengthened to address the irregularity in project procurement and greater demands have been placed on the public sectors for improving the project procurement process to be more transparent. According to London and Everingham (2006), although codes may seem to work in theory, they do not necessarily work in practice and perhaps this is one of the perennial dilemmas of the construction industry, including procurement. In Malaysia, even though 70% of Malaysian managers knew the existence of formal written codes of ethics in their organisations, a large percentage of them are not familiar with or 'do not know' of the existence of the written codes of ethics (Gupta & Sulaiman, 1996). Codes of ethics are also not enforced in a proper and consistent manner in the Malaysian context, leading to a low degree of seriousness of implementation (Gupta & Sulaiman, 1996). To overcome the ethical issues in procurement, an organisation should not only have a professional code of conduct but also enforce and be willing to commit to the code of ethics throughout the organisation (Karande et al., 2000). When there is no awareness and commitment among the people within the organisation, ethical issues cannot be resolved.

8.3 Procurement selection

Experienced clients can select a procurement approach that has previously worked well for them, or that they deem to be suitable, when considering their prioritised objectives and attitude to risk (Mortledge et al., 2006). Inexperienced clients, on the other hand, will need to seek professional advice to assist them through the

process (Love et al., 1998). Mortledge et al. (2006) state that the selection of an appropriate procurement strategy has two components:

1. Analysis: Assessing and establishing priorities for the project objectives and client attitude to risk.
2. Choice: Considering possible options, evaluating them and selecting the most appropriate.

The efficient procurement of a building project through the choice of the most appropriate procurement strategy has long been recognised as a major determinant of project success (Bennett & Grice, 1990). Indeed, failure to select an appropriate procurement approach is widely cited as being the primary cause of project dissatisfaction (Masterman, 1992). The selection of a procurement method is more than simply establishing a contractual relationship. It involves creating a unique set of social relationships whereby forms of power within a coalition of competing or cooperative interest groups are established (Liu, 1994). Differing goals and objectives and varying degrees of power within a project team are often the underlying conditions for triggering adversarial relations (Love et al., 2004).

In an attempt to overcome the adversarial nature of construction and improve project outcomes, both private and public clients have used relationship contracting (such as alliances) (Li et al., 2000; Hampson et al., 2001). In Australia, the use of relationship-based contracting, particularly partnering, has had a lengthy and somewhat chequered history, principally due to a number of parties attempting to exploit the concept in a rather cynical way (Morledge et al., 2006). Partnering, for example, is often used as an 'add-on' to pre-existing construction contract forms and the fundamental transactional nature of the contract remains the same (Howell et al., 1996). In most cases the partnering agreement is separate from the legal contract and the partnering charter that is established is little more than an informal statement of intent to co-operate. While partnering partially fills a gap in current practice, it can be perceived as being a programmatic Band-Aid (Howell et al., 1996) unless embedded within the procurement strategy. If public clients use

partnering, then formal relational-based contracts must be used and address issues such as cost reimbursement, performance-based fees and incentives.

8.3.1 Determination of selection criteria

The National Economic Department Organisation (NEDO, 1985) identified nine criteria that clients could use to select their priorities for projects. These are:

- Time. Is early completion required?
- Certainty of time. Is time of completion of project important?
- Certainty of cost. Is a firm price needed before any commitment to construction is given?
- Price competition. Is the selection of the construction team by price competition important?
- Flexibility. Are variations necessary after work has begun on site?
- Complexity. Does the building need to be highly specialised, technologically advanced or highly serviced?
- Quality. Is high quality of the product, in terms of material, workmanship and design concept important?
- Responsibility. Is the single point of responsibility the client's after the briefing stage or is a direct responsibility to the client desired from the designers and cost consultants?
- Risk. Is the transfer of the risk of cost and time slippage from the client important?

Several studies, such as those identified in Love et al. (1998), have used modified versions of the NEDO criteria in an attempt to develop a procurement selection framework. Luu et al. (2003:a,b) state that the use of a limited number of factors such as those identified by NEDO (1985) may give rise to the selection of a sub-optimal procurement system. Since the selection of the procurement system is influenced by client characteristics (Moshini & Botros, 1990), project characteristics

(Ambrose & Tucker, 2000) and the external constraints imposed on the project should be considered before a decision is made.

The major challenge for clients when selecting a procurement method is identifying the criteria for the project, but the question is that if projects are different in nature and clients' needs are constantly changing due to internal and external demands, would the same criteria be applicable for all projects? The weighting for criteria would invariably change, as would the criteria type.

8.3.2 Importance of control over expenditure

The traditional system of building any structure was first designing the project, then producing the bill of quantities, obtaining tenders and awarding the contract to the lowest bidder. Managing risk, avoiding unpleasant surprises, maintaining value for money and still keeping the overall project delivery time are of the utmost importance for service delivery and clients.

In recent times, as stated by Flanagan and Tate (1997:4), procurement systems that overlap with the design and construction phase are the order of the day for larger projects. Benjamin Franklin (1748) said "Remember that time is money" (Flanagan & Tate, 1997), as it is today. The most critical issue, as stated by Ramabodu and Verster (2010), is that projects fail owing to the fact that they go on tender when they are only half or three-quarter way designed. They state that this is caused by pressure from project owners to get to the construction phase as quickly as possible. Therefore, the traditional approach is more appropriate. The design consultants produce a completed or almost completed design before commencement on site. This approach not only gives the design stage a lengthy time, but also serves to control costs (Flanagan & Tate, 1997).

According to Flanagan and Tate (1997), whether in the commercial or non-commercial world, time is of the essence to clients. When design is separate from

the production stage tenders, clients or project owners will not tolerate any delays caused by redesigning structures. They state that a technique is needed for producing structures or buildings that can be built within the expenditure limits.

Holm et al. (2005:20) explain that when estimations and forecasting are conducted, all sources of risk factors must be included, for example, complexity of the project, weather, labour and material cost, inflation, etc. According to Flanagan and Tate (1997), the principle of cost control at the design stage is that the first estimate is often the figure that clients remember most and sets the budget.

Flanagan and Tate (1997) state two stages of the principle of a cost control system:

- Establishing a realistic first estimate.
- Planning how this estimate should be spent among the elements or part of the building.

8.3.3 Government procurement as a policy tool in South Africa

The size and volume of government procurement contracts determine decisions on when and with whom it contracts. Aside from government procurement being 'business,' it also has broader social, economic and political implications (Labuschagne, 1985; Morris, 1998; Turpin, 1989). Government procurement has often been used to promote aims secondary to the primary aim of procurement such as to promote social, industrial or environmental policies (Arrowsmith et al., 2000; Cane, 2004; Turpin, 1989). Because of the historical political situation in the country, a number of groups in South Africa were prevented from accessing government contracts. Prior to 1994, the government procurement system was geared towards large and established contractors and new contractors found it very difficult to participate in government procurement procedures (Minister of Finance, 1997).

8.3.4 Overview of policy objectives

Using procurement as a policy tool can also be referred to as “wealth redistribution” or using procurement to channel funds to discrete categories of economic stakeholders. This freedom of government to use procurement as a policy tool has been restrained in recent years due to the implementation of measures aimed at achieving free trade in public markets such as the World Trade Organisation Government Procurement Agreement (WTO GPA) and the trade restrictions in place under European community law. A study undertaken for the European Community in 1995 (Watermeyer, 2000) indicates that procurement had been used by governments to stimulate economic activity; protect national industry against foreign competition; improve the competitiveness of certain industrial sectors; and remedy regional disparities. It has also been used to achieve certain more direct social policy objectives, such as to foster the creation of jobs; promote fair labour conditions; promote the use of local labour as a means to prevent discrimination against minority groups; protect the environment; encourage equality of opportunity between men and women; and promote the increased utilisation of the disabled in employment.

There are numerous arguments in favour of using procurement as a policy tool, such as “where properly employed, procurement may prove a useful and effective instrument” (Arrowsmith, 1995) and “a valid and valuable tool for the implementation of social policies; and one which should not be denied to government without convincing justification” (Arrowsmith, 1995, pp.247-248). Provided that the use of procurement as a policy tool has measurable targets; the processes used are verifiable, auditable, and transparent; and the use of procurement as a policy tool takes place within a competitive environment, to a large extent procurement can contribute to the development of growing enterprises that are able to participate equitably in the global economy (Shezi, 1998; Watermeyer, 2000). Contracts made by organs of state should “not be viewed solely as commercial bargains”. The very power to grant contracts should be able

to be used to advance socially desirable objectives, precisely because “organs of state cannot be and should not be politically neutral towards such matters” (Craig, 2003).

According to Martin and Stehmann (1991), preferential procurement policies can also offer advantages over more direct methods of assistance because it does not raise public spending directly and is more efficient than tax-financed State aid. Procurement can be used to achieve anti-discrimination objectives in workplaces and contracts can be denied to employers who make use of discriminatory practices. As far as labour is concerned, we are bound by various statutes: the *Labour Relations Act* (No. 66 of 1995), the *Basic Conditions of Employment Act* (No. 75 of 1997), the *Employment Equity Act* (No. 55 of 1998) – hereafter the EEA and the *Occupational Health and Safety Act* (No. 85 of 1996). Non-compliance with statutes, usually to maximise profits, inevitably gives rise to unfair competitive advantages in the tendering process. It is important to ensure that those who participate in public sector procurement adhere to labour standards. Section 53(1) of the EEA aims to ensure this and states that “every employer that makes an offer to conclude an agreement with an organ of state for the furnishing of supplies or services to that organ of state or for the hiring or letting of anything (a) must (i) if it is a designated employer, comply with [the chapters on the prohibition against unfair discrimination and affirmative action in the Act]; or (ii) if it is not a designated employer, comply with [the chapter on the prohibition against unfair discrimination].”

Failure by an employer to comply with the relevant chapters may, in terms of section 53(4) of the EEA, serve as grounds for the rejection of its offer or the cancellation of the agreement. Purchasing policies pursued by public authorities should be open to modification in view of pressing social or economic problems “not to be guided exclusively by commercial criteria” (Morris 1998, pp.87-88).

8.3.5 Policy promotion and cost-effectiveness

Section 217(1) of the Constitution requires that, when organs of state contract for goods or services, they must do so in accordance with a system that is 'cost-effective' so the aim is to procure goods or services from a contractor on the best possible terms. The question that arises is, "how and to what extent does policy promotion impact on the principle of cost-effectiveness?" There are costs involved in using procurement as a policy tool and these costs may flow from the following: longer tendering periods to secure participation by the relevant groups; the training of emerging businesses; and the administrative costs associated with the enforcement of policies (Watermeyer, 2000). It is, however, often difficult to accurately estimate the costs involved in policy promotion and the benefits that may be achieved from this (Arrowsmith, 1995). Studies have shown that the current lack of data collection and records by organs of state prevents the effective monitoring of targeted procurement. This not only prevents assessment of the degree to which 'small businesses' are being targeted successfully, but also impacts negatively on the transparency of the tendering process (Sharp et al., 1999). The extent to which procurement can be used to implement national policies is difficult to determine. The question also arises as to who should bear the costs of implementing and enforcing procurement policy?

Studies have confirmed that progress has been made since the implementation of affirmative procurement in South Africa. Gounden's (2000) findings show that the financial premiums borne by the state in adopting affirmative procurement policy in the construction industry have proved to be nominal compared with the initial projected outcomes and the overall benefits. Watermeyer also points out 'major changes' that have taken place in South Africa since the implementation of affirmative procurement policies. According to him, targeted procurement has been effectively used to direct capital flows into underdeveloped and disadvantaged rural communities by means of conventional construction projects such as the Malmesbury Prison Complex which, Watermeyer (2000) points out, is "the project

which gave birth to Targeted Procurement in South Africa in 1996”. Sodurland and Schutte’s review of the Malmesbury Prison Complex and Associated Housing Estate prepared for the National Department of Public Works in September 1998 also shows that the Malmesbury Prison Contract “proved to be more efficient at channelling money into communities than some focused poverty alleviation programmes in South Africa involving the construction of community buildings” (Watermeyer, 2000).

Even though there may be time and cost premiums attached to the use of procurement as a policy tool, this premium should be regarded as an integral part of a country’s growth and transformation. Increasing the participation of small, medium and micro enterprises (SMMEs) in the government procurement system, in particular, has many advantages:

SMMEs tend to be more labour intensive and by definition less reliant on large amounts of capital and highly advanced technology and equipment. Being more flexible and less constrained by capital and technology-driven intensive factors of production, they can increase output, and hence employment, at faster rates than the formal, capital-intensive firms. A fast growing SMME sector accordingly has enormous potential to reduce unemployment, increase average household incomes, reduce the poverty gap and increase the tax base of the economy, which in turn provides the basis for further, sustainable long-term growth in the economy (Mkhize, 2004). In the case of South Africa, the question is not whether it can afford to use procurement as a policy tool, but rather whether it can afford not to.

8.3.6 Constitutional framework of preferential procurement

Prior to 1994, price was the overriding criterion for the procurement of goods and services by the government. Tenders were awarded strictly based on price and the tenderer who submitted the lowest tender (in terms of price) was only overlooked “when there was clear evidence that he did not have the necessary experience or

capacity to undertake the work or was financially unsound” (Minister of Finance and Public Works). With the effect of the 1993 and 1996 Constitutions, the practice of awarding tenders strictly based on price has changed. Even though price is still a very important criterion for the procurement of goods and services, it is no longer the decisive criterion. The specification of unnecessarily high standards in tender advertisements for goods or services is also recognised at local government as possibly having the effect of discouraging or excluding small firms from tendering [Regulation 27(2)(e) of the *Local Government Municipal Finance Management Act* of 2003; Municipal Supply Chain Management Regulations, *Government Gazette* No. 27636, 30 May 2005]. Government procurement has been recognised as a tool to correct South Africa’s history of unfair discriminatory policies and practices. A contractor’s ranking in its achievement of socio-economic objectives therefore plays a significant role in the selection process.

Section 217

Even though both the 1993 Constitution (in section 187) and the 1996 Constitution (in section 217) recognise government procurement as a constitutional principle, it is only the 1996 Constitution that makes express provision for the use of procurement as a policy tool which is not common practice. The fact that it has been done in South Africa’s Constitution serves to illustrate the importance attached to the use of procurement as a tool to correct past imbalances and to uplift vulnerable groups in society. The most important provision in the Constitution that deals with government procurement, and specifically its use as a policy tool, is section 217. Subsection (1) provides that when organs of state contract for goods or services, they must do so in accordance with a system which is fair, equitable, transparent, competitive and cost-effective. Subsection (2) provides that “subsection (1) does not prevent organs of state from implementing a procurement policy providing for (a) categories of preference in the allocation of contracts; and (b) the protection or advancement of persons, or categories of persons, disadvantaged by unfair discrimination”. Subsection (3) then provides that “national legislation must prescribe a framework within which the policy referred to in

subsection (2) must be implemented”. Section 217 therefore makes provision for the use of procurement as a policy tool.

8.3.7 Obligation to use procurement as a policy tool

Section 217(2) of the Constitution does not place organs of state under an obligation to implement a preferential procurement policy. Section 217(2) simply provides that organs of state are not ‘prevented’ from using procurement as a policy tool but as a means to address past discriminatory policies and practices. The use of procurement is an interim measure and after the recent amendment of section 217(3), organs of state who implement a preferential procurement policy are also obliged to do so in accordance with the national legislation referred to in section 217(3), i.e. the *Procurement Act*. This is because section 217(3) was amended by the *Constitution of the Republic of South Africa Second Amendment Act* (61 of 2001) and the word ‘must’ has been substituted for the word ‘may’.

8.3.8 Procurement Act and regulations

The purpose of the *Procurement Act* is “to give effect to section 217(3) of the Constitution by providing a framework for the implementation of the procurement policy contemplated in section 217(2) of the Constitution, and to provide for matters connected therewith”. The aim of the Act is to enhance the participation of HDIs and SMMEs in the public sector procurement system. Section 5(1) of the Act further provides that “the Minister of Finance may make regulations regarding any matter that may be necessary or expedient to prescribe in order to achieve the objects of this Act”. The Regulations to the *Procurement Act* were promulgated though they are in the process of being redrafted. The aim is to bring the Regulations more in line with the BBBEEA.

8.3.9 Implementation of preferential procurement policies – obligatory or discretionary

Section 2(1) of the *Procurement Act* makes it obligatory for organs of state to implement a preferential procurement policy – “an organ of state must determine its preferential procurement policy and implement it within the framework provided for in the Act”. The compulsory nature of section 2(1) can be commended. True reform of the South African government procurement system can only take place if organs of state have little (if any) discretion on whether or not to implement a preferential procurement policy. The EEA (in Chapter III) also makes it compulsory for organs of state as “designated employers” to implement affirmative action measures in their workplaces. Recent constitutional jurisprudence dealing with affirmative action measures further serves to illustrate that the implementation of preferential procurement policies should not be left to the discretion of organs of state [*Bato Star Fishing (Pty) Ltd v The Minister of Environmental Affairs and Others* 2004 (4) SA 490 (CC) para 74].

Based on constitutional jurisprudence, the use of the word ‘must’ in section 2(1) of the *Procurement Act*, and in view of Chapter III of the EEA which obliges organs of state (as employers) to implement affirmative action measures, all organs of state (as contracting entities) should be and are correctly obligated to use procurement as a policy tool.

8.3.10 Preference Point System

To address past discriminatory policies and practices, the *Procurement Act* establishes a preference point system for the award of contracts. Since price is and always will be an important criterion in the selection of contractors, the point system created by the Act is ‘dual-scale’ depending on the value of a specific contract. The total number of points that may be awarded to contractors is 100, and to ensure that organs of state still obtain the best price for goods and services, more preference points are awarded for lower value contracts and fewer

preference points for higher value contracts. For contracts between R30 000 and R500 000, a maximum of 20 preference points may be awarded for the achievement of 'specific goals'. Thus, 80 points must be awarded for price and a maximum of 20 points may be awarded for the achievement of 'specific goals' (Regulation 5). For contracts above R500 000, only a maximum of 10 preference points may be awarded for the achievement of 'specific goals'. Thus, 90 points must be awarded for price and a maximum of 10 points may be awarded for the achievement of 'specific goals' [Regulation 4 and section 2(l)(a) read with section 2(1)(b) of the *Procurement Act*].

The 80/20 Point System

Regulation 3(1) provides a formula that must be used to calculate the points to be awarded for price out of 80. The points awarded for price must then be added to the points awarded out of 20 to a tenderer "for being an HDI and/or subcontracting with an HDI and/or achieving any of the specified goals stipulated in regulation 17" [Regulation 3(2) read with Regulation 3(3)]. The formula for the 80/20 preference point system is as follows:

$$P_s = 80 [1 - (P_t - P_{mm}) \div P_{mm}]$$

Where:

P_s = the points scored for price for the tender under consideration,

P_t the Rand value of the tender under consideration, and

P_{mm} = the rand value of the lowest acceptable tender.

The 90/10 Point System

Regulation 4(1) provides that the formula that must be used for contracts above R500 000: 90 points must be awarded for price and a maximum of 10 points may be awarded to a tenderer "for being an HDI and/or subcontracting with an HDI and/or achieving any of the specified goals stipulated in regulation 17" [Regulation 4(2)]. Aside from the fact that only a maximum of 10 preference points may be awarded to a tenderer, the application of the 90/10 preference point system is principally the same as the application of the 80/20 preference point system.

Attainment of 'specific goals'

Section 2(1)(d) of the *Procurement Act* provides that an organ of state may, in its procurement policy, aim for specific goals which may include:

- contracting with persons, or categories of persons, historically disadvantaged by unfair discrimination on the basis of race, gender or disability; and
- implementing the programmes of the Reconstruction and Development Programme (RDP) as published in *Government Gazette* No. 16085 dated 23 November 1994.

A 'historically disadvantaged individual' (HDI) is defined in Regulation 1(h) as a South African citizen "(1) who, due to the apartheid policy that had been in place, had no franchise in national elections prior to the introduction of the *Constitution of the Republic of South Africa*, 1983 (Act No. 110 of 1983) or the *Constitution of the Republic of South Africa*, 1993 (Act No. 200 of 1993) ('the Interim Constitution'); and/or (2) who is a female; and/or (3) who has a disability, provided that a person who obtained South African citizenship on or after the coming into effect of the Interim Constitution, is deemed not to be an HDI."

8.4 Procurement assessment

A ubiquitous issue within the construction industry relates to clients' satisfaction and the means by which projects have been procured (Love et al., 1998). Consequently, it is important to evaluate the clients' criteria and their perceived importance and then seek performance to match those identified criteria (RICS, 1998). Traditionally, most clients have required projects to be completed on time, within budget and to the highest quality, even though in recent years environmental (for example, carbon footprint) and legislative (for example, health and safety) requirements have risen to prominence. While the use of such criteria can be used as a guide to assist decision makers with an initial understanding of the basic attributes of a particular procurement system, they should not be used as a basis

for selecting the procurement method (Luu et al., 2003a). This is because of the underlying complexity associated with matching client needs and priorities with a particular method (Kumaraswamy & Dissanayka, 1998). The New South Wales (NSW) Department of Commerce (2006), for example, states that an appropriate procurement method for a project will depend on the characteristics of the project, the factors that influence its delivery and the desired risk allocation and as a result the appropriate selection will provide value for money, manage risk and meet project objectives.

8.4.1 Tools and techniques for procurement selection

The approaches developed for procurement selection range from simple (Franks, 1990) to highly complex (Luu et al., 2005). It is important, however, that selection is undertaken logically, systematically and in a well-organised manner by the clients' principal adviser (Love, 1996).

Each of the methods presented attempts to cross-reference project variables with existing procurement systems. As a result, Sidwell et al. (2001:24) state that this "shoehorns one-off projects and their particular parameters, priorities and external conditions into an off-the-shelf delivery system". Many of the procurement selection systems developed are deficient (NEDO, 1985; Skitmore & Marsden, 1998; Moshini & Botros, 1990; Ambrose & Tucker, 2000; Cheung et al. 2001)

According to Hammer (2002) and Heikkila (2002), the Standish Group scanned more than 8 000 projects to meet the goal projects and compared their anticipated results with the real outcome. The outcome from the study states that only 16% of the projects were able to meet the goal set in terms of time, budget and quality. This guarantees the need for this study to identify the underlying problems contributing to delay. By identifying the root of their impact, a better understanding of factors influencing project delivery time may contribute to the timely delivery of projects. In addition, it is worth noting that in South Africa no research has been

conducted to identify causes of project delay or any predictive model equation formulated that could be directly used for the estimation of project delivery time.

8.5 Conclusion

Unethical behaviour in the procurement process has detrimental effects on projects, especially construction projects that have large financial value attached. Procurement practices, particularly those in public sector construction projects, need to be open and transparent and need to have policy measures in place to ensure that they come under proper scrutiny. While there are a number of tools and standards that can guide the procurement process, the actions eventually lie with the parties involved in the award and the implementation of the project. South Africa has a working procurement framework for all government procurement processes, which contributes to the transformation of the South African construction industry.

The next chapter examines the management of construction projects and sustainable design in these projects.

CHAPTER 9

MANAGEMENT OF CONSTRUCTION PROJECTS

9.1 Introduction

This chapter sets out the significant aspects of managing a construction project, first by defining concepts and then closely examining the aspects that make up the process, particularly as regards its sustainability.

9.1.1 Terms defined

Project management: The semantics of the definition of project management cannot be fully comprehended without a brief attempt to define the two major components, 'project' and 'management'.

Project: According to Ntamere (1995), a project is a discrete package of investment or endeavour, policy measures and institutional and other activities designed to achieve a specific objective or set of objectives within a designated period and involving the commitment of resources. To Osuagwu (1997), a project simply means a series of related activities with a goal, a beginning and an end. Hemuka (2002), in an unpublished lecture, describes a project as a form of investment or development which entails the injection of scarce resources, and other materials, including land, with the aim of realising its latent potentials in the form of yield, or for satisfying other social or economic benefits.

A project is simply defined as any sequence of events or a process, which entails putting together different resources towards the attainment of a particular goal. A project can be distinguished by the following characteristics:

- There must be a well-articulated aim, goal or screened objective.
- A life cycle with starting and ending points.

- It must have a network of timed and cost activities to produce a specified product.
- The endeavour must be a unique and non-repetitive one-time programme.
- It may cut across many organisational lines.
- Lastly, it may require the establishment of a special organisation for its execution.

Building development is a good example of a project, while projects abound in all other sectors of human endeavour, including Event Planning and Control.

Management: Management is simply defined as “planning, directing, controlling and co-ordinating of individual, group or organisational goals and objectives with the ultimate aim of achieving maximum benefit”. In the view of Baridam and Nwachukwu (2002), management literally means getting things done through and with people, which has to do with the planning and directing of effort toward a common objective. The traditional functions of a manager reflect the activities involved in managing, planning, decision making, organising, staffing, leading, motivating and controlling. These functions constitute a circle of action in which each component leads to the next. Since building development project execution involves a consortium of various professionals – architects, engineers, quantity surveyors, builders, estate surveyors, urban and regional planners, etc. – it will be disastrous if there is no one to co-ordinate their interest and roles as major stakeholders, together with other non-professionals and the client. The person to do the job is the project manager.

Project management involves the proper welding together of the activities of all these professionals and non-professionals by careful selection, co-ordination, programming, budgeting and monitoring their activities during the developmental process. The sequential steps in project management include:

- Defining the objectives of the project.
- Determining the tasks required to complete it.

- Deciding on important project milestones.
- Determining the duration of the project's component tasks.
- Planning the most efficient organisation of tasks.
- Allocating resources to tasks.
- Re-evaluating task relationships and schedules and finally carrying out the project.

Project management is therefore justified as a means of avoiding the ills inherent in building development, the entire construction industry and production sectors of the economy, and for which reasons most projects fail, collapse or are abandoned. The project manager's role arises from the need for a technical expert to take charge and control events in the project implementation process; someone who understands the intricacies of co-ordinating, controlling and directing the efforts and activities of the professional team and the physical problems of the implementation process along with the needs in the decision-making process. The success of any project implementation process in the construction industry in the public and private sectors depends largely on the project manager's concept of staff appointments and control, strict monitoring of time, cost, material, quality and environmental constraints.

9.2 Value management during project briefing

Value management is an analytical and structural process, which seeks to obtain value by providing all necessary functions with the maximum cost and on the basis of necessary efficiency and quality levels. Value management allows the organisation to compete in national and international fields by creating conditions such as decreasing of costs and increasing profit, improving quality, increasing market share, saving time in performance of projects and more effective use of resources.

Project management means application of knowledge, skills, tools and techniques for project activities in order to fulfil the requirements of the project (PMBOK, 2004), justify identification process of the project and determine the organisation of customers' needs in the project primary design stage. A good project justification protects the customers against major sources of delay and high costs (Ann et al., 2006, cited in Yu et al, 2006). In the past few decades, value management was used in many countries as tools to increase demands for the promotion of value level in customers (Barton, 2000). In the USA, all branches of executive bodies and federal offices require the creation and maintenance of procedures and processes of value management in cost-effectiveness in all plans and projects (Save International, 1997). In Iran, improper status of civil projects and deficit on the one hand, and the proven capabilities of value management on the other, caused the State Management and Planning Organisation to consider value management in the form of the third development plan and in paragraph C of Article 61, and emphasise its execution (Plan and Budget Organisation, 1996).

When there is good justification, more rapid design, more effective actions, and less rejection and deviation will be carried out. Lack of a systematic attitude for identification and clarification of customers' needs and communicating them to designers is the main reason for failure in delivery of the project items. (Ann et al. 2006, cited in Yu et al, 2006) conducted different studies on the justification process of projects (Barrett & Stanley, 1999; Ann et al., 2004, cited in Ahmadpour, 2011) and value management as a project management style (Kelly & Male, 2006, 1993; Green, 1994; Barton, 2000; Lozon, 2008; Jabalameli et al., 2004), but the effect of the justification process of projects on the process of applying value management in project management is the subject which needs most work and study. On this basis, the goal of the present research is to determine and explain the role of 13 variables of value management including project charter, beneficiaries, change management, risk management, assessment after the project, team dynamicity, introduction of customer, business type decision making, communication, culture and key factors of success on independent variables of

project management. In the project, value management is a service based on the project, which emphasises clear goals that have been gathered for workshops and improvement of the project performance.

Value management effectiveness is increased when it is clearly defined with the goals and is applied with a commencing and ending date (Ann et al., 2004, cited in Ahmadpour, 2011). Value management can improve communication and understanding of customer consultants and beneficiaries in the nature of the justification process (Green, 1994). Value management has been focused as management style on an evolution trend of value system available in the projects of organisational systems through presentation of a suitable system of shareholders at a proper time (Kelly & Male, 1993).

In most texts relating to project management, the subject has been accepted that identification of the beneficiaries can lead to the success of a project. Therefore, correct recognition of key beneficiaries and even all beneficiaries should be considered (Marjolein, 2007).

Value management has 13 variables including project beneficiaries, change management, knowledge management, risk and conflict management, assessment after application and after the project, teams and team dynamicity, introduction of customer, types of business and organisational theory, decision making, communication, culture and ethics, key factors of business and performance key indices.

A project is an independent and temporary activity of an organisational commercial core which creates change. A justification for a project requires the most primary justification, i.e. acceptance of changes (Nicholas, 2001). In the project justification process, it is important to create benefit for the beneficiaries at the beginning and in all stages of the project, and to keep a balance between the beneficiaries. They should try to establish a good working relationship among all beneficiaries (Pinto,

1998). Management tasks include management of people's understanding. For many managers, this managerial behaviour is complex. With regard to this, they have to help people make changes, and managers also face these challenges (Nikols: 2010).

The project justifying team should understand that people are at the centre of the change process. Therefore, communication and involvement of the organisation with people ensure change management success. Key areas of change management are training, education and exercise, communication, and team and leadership development (Kelly, Male and Graham, 2004).

Knowledge management emphasises the creation and management of a project record and using it as a tool for the conversion of implied to express knowledge so that people can share and publish it throughout the organisation (Maqsood et al., 2006). Knowledge management relies on teamwork, co-operation, face-to-face contact and effective communication structures in justifying of the projects. Therefore, the fundamental principle of justification is to use the co-operation of the members for organisational project knowledge, in order to select project justifying team members (Bender & Fish, 2000).

Risk management means a process of documentation and identification of final decisions and application of criteria that can be used for minimising risk to an acceptable level. Conflict management, recognition and management of conflict are reasonable, fair and efficient. The importance of the execution of risk management techniques during the primary project evaluation phase is to maintain flexibility against the design of variables when there is the highest level of uncertainty. In the justification process, collaboration and problem solving are preferred in removing conflict (Schermerhorn et al., 2003).

Assessment after application and after the project is a diagnostic system and tool for managers to improve quality and efficiency. These assessments are successes,

failures and experiences, which show what has been done well and used so that decision making is best during the project justification process. Assessment after the project is performed in order to ensure successful absorption of commercial core (Preiser, 1995).

Dynamicity of teams is an invisible force, which works among the persons of different groups. Team dynamicity can have an effective role in the reaction of teams (Avi et al., 2008). Value management relies on a project team that discusses with one another in the workshop and adds value to the project in every possible way. The manner of execution of cases depends on the dynamicity of the team and their ability to share and transfer knowledge (Blyth & Worthington, 2001). The suggested value or customer receivable means an internal judgment based on personal assessment, which trades off the obtained profit against the obtained costs (Walker et al., 2006).

A manager should regard himself as a customer and implement his views and attitudes in his projects. In the end, the success of every project is tested by the customer's satisfaction with the work (Yang & Peng, 2008). It is important to ensure the introduction and identification of customer groups in order to supervise their needs and prevent deviations from the project justification. A successful justification relies on analysis of needs and assessment of the cases. When we face complex decisions, there are many true answers. When the best answer is found, it should be preferred and applied. Better decision-making leads to easier execution and obtains the best results (McNamara, 2008).

A good justifying team should not be limited to only one decision-making method, but should determine the possibility of different styles by changing decision-making methods to find the best conformity of position with a problem (Blyth & Worthington, 2001). Communication management determines how managers transfer different information to their personnel, including goals or other administrative issues (Van Reil, 1997). The limit of key factors of success in the

project justification process starts with clear goals and needs of the project and continues to ensuring key beneficiaries of the project. Key indices of performance include time, cost, quality satisfaction of beneficiaries and social and environmental issues (Construction Industry Board, 1997).

9.2.1 Process of value management

Value management evolved within the manufacturing industry during the Second World War owing to shortages of material. It was developed by Lawrence D Miles who worked for the General Electric Company. It aims to realise value for money by minimising the whole life cost without sacrificing the quality and performance of a project (Dellisola, 1997). Since its inception, it has developed rapidly and extended across many industries and countries (Ashworth & Hogg, 2000).

9.2.2 Value management defined

Value management has a broad terminology that is important for both readers and practitioners to understand. The terminology used differs, depending on the situation and context, an aspect that probably puzzles those who are new to the approach of value management (VM). In the UK, the term 'VM' is generic for the whole process, including value engineering, value analysis and value planning.

Value management (VM) is the term used to explain the whole philosophy and range of methods to describe the application of the processes at the early, strategic stages of a project. Therefore, value planning, value engineering and value analysis form part of value management (Ashworth & Hogg, 2000). It explains the whole process of maximising the value of a project for a client from the concept phase to operation and use. It therefore connects to the principle of total quality management (Kelly et al., 2004). Green (1994) defines VM as “a structured process of dialogue and debate among a team of designers and decision makers during an intense short-term conference”.

Value planning is carried out prior to the decision to build the project or at briefing or at outline design stage.

Value engineering denotes value techniques during the detailed design stages and construction stages. In other words, it focuses on enhancing value in the design and construction stages of a project. It connects to the principles of quality assurance. Green (1994) defines it as “a disciplined procedure directed towards the achievement of necessary function for minimum cost without detriment to quality, reliability, performance or delivery”.

Value analysis defines the value techniques that are applied following the completion of a building (Ashworth & Hogg, 2000).

9.2.3 Soft value management methodology

The use of both soft and hard value management tools and techniques in the structured job plan will consider the impact of new and current buildings in terms of achieving sustainable construction principles that will immediately influence the inputs, development and outputs to ensure a ‘best value’ solution to the project (Hayles, 2004). Soft Value Management (SVM) techniques are most frequently used in the early project stages when the project has not been completely defined to reach consensus with stakeholders (Dallas, 2006). It is specifically designed to deal with difficult ‘unstructured’ problems experienced in project initiation, whereby many stakeholders are involved in the course of action and high-level facilitation skills are vital for its accomplishment (Barton, 2000). It derives from the body of knowledge known as ‘group decision support’ which is defined as “any process that supports a group of people seeking individually to make sense of, and collectively act in, a situation in which they have power” (Bryant, 1993, cited in Ntamere, 1995).

Simple Multi-Attribute Rating Technique (SMART) VM methodology was developed by Stuart Green. The distinction of SMART VM is the way in which it offers a framework to facilitate thought and communication. It is confined to the use of VM throughout the briefing and outline design stages of building projects. The determination of all stakeholders and representation of interested parties are necessary for the successful use of this method (Green, 1994). Although the SMART VM approach has its origin in decision analysis, it is mainly focused on decision structuring rather than decision making (Shen et al., 2004).

9.3 Project management

9.3.1 Building construction project management success

According to Nwachukwu et al. (2010), the rate at which building construction projects fail or are abandoned, and the collapse of buildings, some even under construction, is retrogressive in a developing economy like Nigeria for which engineers, in their professional pride and personality ego, accept the blame. Building construction projects must be made to succeed because their execution often involves substantial funds and project failure has a crippling effect on the capabilities of the investors, the financiers and for the fact that scarce resources are tied down for a long time as opportunity cost for its alternative uses.

The importance of this sector as an agent of development is enhanced by its ability to provide gainful employment for the world's teeming population. According to Roy (2005), (cited in Ntamere, 1995), "it is evidenced that noticeable development and the aesthetic transformation of the environment is bound up with and predicated on the building construction industry". The building construction industry is a major factor in the social and political integration of society and ranks as one of the major budgetary areas of developing economies (Nwachukwu, 2008). According to Eric (2003), the industry is likely to remain a major area of development activity as the

need for the provision and replacement of infrastructure becomes more important in the years ahead.

The performance of any building development project (be it public or private) depends on the strategy for success adopted by the organisation responsible for its implementation and execution. The strategies for success in any building project are implemented in the management of project time, cost, quality and material management using the project life cycle concept. New buildings and newly rehabilitated or maintained infrastructure become decrepit and wrecked within a few months of commissioning despite the capital commitments to them.

Project management is believed to be justified as a means of avoiding the ills inherent in the construction and production sectors of the economy and for which reasons most projects fail or are abandoned. The project manager's role arises from the need for a technical expert to take charge and control events on the project implementation process; someone who understands the intricacies of coordinating, controlling, organising and directing the efforts and activities of the professional team and the physical problems of the implementation process with the needs in the decision-making process. Real estate professional practices anchor more on the success of building development success. Real estate investors, either directly or indirectly, purchase rights to a stream of future cash flows expected to be generated by the real estate. The cash flow might come from rental income, from using the property as loan collateral, from cash savings through offsetting otherwise taxable income with tax-deductible losses from the real property interest, or from net profits on resale of the property interest. The price an investor is prepared to pay for a defined property interest depends in part on the amount and the timing of these anticipated cash flows; how much will be received and when, depends on the degree of confidence with which expectations are held and the investor's tolerance for bearing risk. The final variable is the attractiveness of alternative investment opportunities. Virtually any investment can be accommodated with a position in real estate.

Speculators can deal in real estate futures (by buying and selling purchase options); developers can reduce risk exposure by using standby loan commitments or taking a position in interest rate futures; investors can buy fixed-income assets such as mortgage loans or net-leased properties. Real estate can be even more attractive when approached, not as a simple investment, but rather as a business opportunity.

Real estate investors are faced with various risks which may threaten their desire to invest in the sector. The major threats are:

The threat of building failure, abandonment and collapse of buildings during and after construction; where to build, how to build and when to build; the opportunity cost in choosing to invest in real estate; threat of losing a financial asset and the risk associated with the time value of money; environmental challenges that influence or affect demand and supply of building accommodation within a geographical area; the rate of borrowing financial capital to invest and make a profit in time; the mode of measuring profit from real estate investment; a decreasing profit; and finally, government policies.

Project success: According to Cleland and King (1975) a project is termed successful if it passes four success test criteria: the time criterion completed on time; the cost or money criterion completed within budget; the effectiveness criterion completed in accordance with the original set performance and quality standards; and client's satisfaction criterion. Effective project choice, for example, which results in a good project selection, greatly improves the probability of project success especially when the project is executed in accordance with project management implementation guidelines. The Critical Path Method (CPM) and Programme Evaluation and Review Techniques (PERT), for example, contribute much to project success as they foster a great discipline through definition of project scope, time scale/schedule and cost. Empirical evidence suggests that the

importance of networking is far outweighed by the contribution of other project tools that include work breakdown structure, life cycle planning, systems engineering, configuration management and status reports.

Networking contributes to better cost and schedule performance but not necessarily to better technical performance and better client acceptance. Perceived success is more adequately defined as meeting the project's technical specification or mission while at the same time attaining a high level of satisfaction on the part of the organisation, clients, users and the project team (Baker et al., 1988). Effective project success therefore requires judicious trade-off among the four tests or success factors of timeliness, completion within the budget, satisfaction in technical performance, and client or customer acceptance.

Project failure is illustrated by a failure to achieve the four success criteria and is manifested by the lack of application of proven project management techniques. It does not mean that the project may not have been physically completed but the questions are: When is the completion? Is there any time or cost overrun? Is the quality specified standard achieved? Can it stand the test of time? Can its potential be maximally realised? Are the client and end-user satisfied? If the client is proposing another project, can he insist on working with the same team? If the answers to the above questions are in the affirmative, the project is termed successful but if otherwise, it means failure.

Project abandonment is the unplanned suspension of the work progress especially at the execution stage, such as refusal or failure to complete a contract after the practical completion time. Abandonment and failed projects, which are more predominant in the public sector, are scattered all over the country's environment, including government quarters, university campuses and so on. The phenomenon cuts across many economic sectors including the construction, manufacturing/industrial and service sectors.

There have been cases when non-functional, unusable or unserviceable projects have been commissioned as 'completed'. A monumental economic loss is incurred in terms of heavy cost overruns, periodic waste of resources and projects that metamorphose into bottomless pits, swallowing scarce resources with no concrete completion time in sight. This phenomenon would have been avoided or drastically reduced if judicious applications of project management principles had been accepted and applied.

Various reasons were given for the abandonment of many projects in Nigeria. These include: escalation of project cost due to inflation, difficulty in payment to contractors owing to government bureaucracy, contractors performing below expectation, frequent changes in government, inability of sub contractors, such as those in charge of electrification, to adhere to schedule, increase in the scope of work, change in pre-contract consultants such as architects, poor or ineffective project finance arrangement, change in the original design, indiscriminate award of contracts without reference to funds availability, projects completed but technically unsound and unable to function, materials scarcity, poor planning or shoddy work by architects, consultants, etc., specification of costly imported materials, increase in contract sums, poor project definition in terms of project requirements for materials, equipment, personnel, finance and other resources, correlates of effective project management, insufficient working capital, the ailing economy and general inflation.

Contracts for projects are awarded without adequate project planning which includes the costing and scheduling as well as the method for successful implementation. Where projects are awarded for political considerations little or no attention is given to the recommendations of project appraisals, assuming that such specific studies have been undertaken.

Budgetary constraints occur frequently, given the short tenure of governments, reordering of priorities or diversion of funds as time progresses. Project

abandonment or failure is the inevitable outcome of the above-mentioned scenarios. Should the project be included in the new set of priorities, tremendous cost and schedule overruns are highly probable because of likely changes in resource requirements, escalation in input prices and changes in the organisation or implementing unit. This is aggravated by the fact that the contractor may have to deal with different 'owners' or officials at different times during different stages of the project life cycle. Often, projects are completed neither within budget, time and technical specifications nor within customer or client satisfaction. Even though the projects are completed, they cannot function. All the above causes of project abandonment will be minimised or eliminated if a trained project manager is in charge from the conception stage. The collapse of building infrastructure, though prominent in developing economies, is a worldwide issue. Building developments collapse at the construction stages and in some cases after commissioning. Examples abound in recent times in Abuja and Lagos. The major problem is the unquantifiable resources wasted when building construction development collapses. If the answer to this endemic problem is proper project management, it becomes imperative to institutionalise its activities in Nigeria.

The project manager makes use of the life cycle concept as a valuable tool for better understanding of the stages of a project and likely resources required for its successful implementation. The basic life cycle concept holds for all projects and systems. Life cycle management is heeded because the life cycle reflects every different management requirement at its various stages. In the beginning, for example, in terms of work force, human resources research personnel predominate; subsequently, their role diminishes at the planning stage. The execution, which is more about concrete work features, more engineers and finally marketing and sales personnel become more important. In product development, for example, performance would be assessed by the degree to which the product meets the specification or goal set for it.

To enhance project success the following strategies or guidelines are recommended as far as possible: adopt the project management approach; project objectives should be clearly spelt out, clear objectives create the conditions for the attainment of good results; project requirements should be clearly defined in terms of resources, time scale, technical approach and the required technology.

The operators should develop an ability to manage change – a major objective of the project management approach. Plan soundly; good information flow is necessary. There should be a clear definition of responsibilities and project selection; location and implementation should not be politicised; there must be a clear definition of project scope and knowledge of factors that can affect the project scope; and pay critical attention to project financing.

In Nigeria, the time is ripe for increased application of the project management approach in both the private and public sectors. The application will result in effective project selection and execution. The use of task forces to handle specific problems is a pointer to the need for the adoption of a project management strategy. Agencies such as NDDC and ITF are built around the project management idea. Projectisation (application of the project management concept) of certain projects will reduce much of the bureaucracy and redundancy in many organisations. Moreover, the project management elements of planning, scheduling and control will introduce the much-needed discipline for the satisfactory realisation of project goal.

In general, life cycle events vary with phases. Project size is quite different across the phases; the planning and the execution phases have by far the largest project teams. The level of bureaucracy parallels this pattern, with the greatest level corresponding to the greater size. The organisational climate is such that in the early and later phases, it is more participative while it is different in the middle phases. Conflict decreases consistently across the phases while job satisfaction seems to be highest for the smallest, more organic organisations and lower for

those organisations mostly mechanistic in nature (Adams and Barndt 1983). In process, involving initial strategic actions and supporting tactical activities, there are further implications for project performance based on a consideration of strategic and tactical issues.

According to Cleland and King (1975), the process of building project implementation involving the successful development and introduction of projects in the organisation, presents an ongoing challenge for managers. The building implementation process is complex, usually requiring simultaneous attention to a wide variety of human, budgetary and technical variables. A project manager often faces a difficult job characterised by role overload, frenetic activity, fragmentation and superficiality; yet, in spite of all these, a project manager has the responsibility for successful project outcomes without sufficient power, budget or people to handle all the elements essential for project success. In addition, projects are often initiated in the context of a turbulent, unpredictable and dynamic environment. A project manager would be well served by more information about those specific factors critical to project success. The project manager requires the necessary tools to focus attention on important areas and set different priorities across different project elements. It can be demonstrated that a set of factors under the project manager's control can have a significant impact on project implementation success. The project manager should be better able to efficiently and effectively deal with the many demands created by his job, channelling his energy more efficiently in attempting to implement the project under development successfully.

Slevin and Pinto (1986) studied many projects in their bid to evaluate factors that constrain success in project management. They articulated many factors, but narrowed them down to what they called ten key factors of project implementation profile:

Communication: The need for an adequate communication channel is extremely important in creating an atmosphere for successful implementation of a building

project. Communication could best be described as the live wire of any project implementation success. There should be prompt communication to the building or project mission, good information flow with top management, the building or project scheduled plan, always consulting the client, adequate communication on personnel issues like recruitment, motivation and training, etc., good understanding of the technical task and staff, sequential monitoring of all work and processes, giving feedback to the stakeholders, always active in communication with trouble shooting indicators, communicating with the client at all times, sensitising him to every issue that will enable him to accept the product after execution.

Project mission: Project mission is the same as clearly defined goals and objectives. Project mission has been found to refer to the condition where the goals of the building project are clear and understood not only by the project team involved, but also by the other departments in the organisation.

Top management support: Slevin and Pinto (1979) note that management support of projects, especially building construction, has long been considered of great importance in distinguishing between their ultimate success or failure. Beck (1983) sees project management as not only dependent on top management for authority, direction and support, but as ultimately the conduct of implementing top management's plan as goal for the entire project organisation. The degree of ultimate acceptance or resistance to the project shows the degree of management support of the project.

Project scheduled plan: According to Pinto and Slevin (1989) this refers to the importance of developing a detailed plan of the required stages of the implementation process. This is the origin of the life cycle concept in building construction projects.

Client consultation: The need for client consultation has been found to be increasingly important in attempting to successfully implement a building project.

Pinto and Slevin (1989) found that the degree to which clients are personally involved in the implementation process will cause great variation in their support for the project.

Personnel issues: Personnel issues include recruitment, selection and staff training for the building project. An important but often overlooked aspect of the building implementation process concerns the nature of the personnel involved. In many situations, personnel for the building team are chosen by the client, especially in the public sector building construction, with less than full regard for the skills necessary to actively contribute to the implementation success.

Technical tasks: This is very important in that the people who understand the project must manage the implementation. Slevin and Pinto (1986) identifies two of the eight risk factors as being caused by technical incompatibility.

Monitoring and feedback: Monitoring and feedback refer to a building project control system or processes by which at every stage of the implementation, key personnel receive feedback on how the project is comparing or conforming to initial projections in time management, cost, quality and materials.

Trouble shooting: Problems always exist in almost every project, especially in building construction. It could be seen as conflicts that lead to the success or failure based on how they are managed by the stakeholders.

Client acceptance: This is the final stage in the building project implementation process at which time the ultimate efficiency of the project is determined. For there to be a successful handover of the developmental product, there is a need to carry the client along through prompt communication and feedback throughout the stages of the building project life cycle.

Project management tools: Project management tools are mainly planning and implementation tools at various stages of the project life cycle which is expected to foster success in the implementation process. At the conception stage, an effective and efficient appraisal is a strategic and significant tool used in establishing the feasibility and viability of project proposal.

Cost-benefit analyses of economic and social proposals, spillover advantages and disadvantages of project proposals and the rate at which a prudent investor could make profit with time, determine time value of present financial expenditure against future expected income and the environmental impact assessment of project proposal, etc. Appraisals are an instrument used in processing social and economic dreams to a tangible and realisable aim and objective that must be unique in nature. Some of the tools as we know them include: the Net Present Value (NPV), Internal Rate of Return (IRR), Net Terminal Value, Annual Charge, Annual Sinking Fund and Cost-Benefit Analysis.

Network planning: Network planning is one of the most significant project management techniques used in planning, scheduling and controlling a project. Planning technique is vital at all the stages of a project life cycle. It is a continuous process because of the prevailing need to keep track of progress changes, delays or changes in technical conditions. Delays and changes in project implementation are controlled by the application of critical path methods. They enable management to cope with the complexities, masses of data and tight deadlines characteristic of many industries and their environment that is highly competitive.

It is important to note at this stage that planning and scheduling are not synonymous. Planning is the establishment of objectives, the definition of the content of the project and the determination of the relationships between the jobs or activities. On the other hand, scheduling is the development of a timetable that puts time estimates alongside the plan and indicates when activities are to be

accomplished. That is, time estimates, timing calculations and job scheduling are involved.

PERT and CPM networks: Programme Evaluation and Review Technique (PERT) and the Critical Path Method (CPM). The bar and Gantt charts used in scheduling, tracking, resource smoothing and performing time and cost trade-offs at the execution and termination stages are the best tools for project planning and control. The PERT and CPM techniques help to determine cost effectiveness as a way to expedite a project knowing that certain projects can be rushed for a price. This method has been used successfully and advantageously in developed economies for planning large scale and complex projects and we strongly believe that it can be an antidote to transform the building development. PERT was first used in the 1950s to manage the Polaris Missile Program. Since then the technique has been used successfully by private and public industries and sectors such as the construction of complex building structures, shopping centres, office blocks and subways, major maintenance efforts, pilot production runs and the introduction of new products. Whenever faced with complex situations, a manager should use these techniques; their cost is less than the benefits. The two types of PERT are the deterministic and the stochastic. Deterministic PERT assumes that all tasks that make up a project are routine in the sense that the time needed to complete each task is known with reasonable certainty. Stochastic PERT on the other hand is often used to plan either research or a one-of-a-kind development project because of the valuable insights gained by the very act of identifying intermediate milestones and establishing a logical process among them.

9.4 Sustainable construction

According to Al-Yami and Price (2006), the value management approach offers a crucial method for the client to achieve a better built environment and a good chance to encourage upgrading in the construction process. Sustainable construction is broadly taken to signify the responsibility of the construction

industry for the efficient use of natural resources and minimisation of any negative impact on the environment, as well as satisfaction of human needs and improvement of the quality of life. The essence of optimal usage is strongly related to the philosophy of value management (VM), which is applied to satisfy value for money in building and infrastructure projects. Male and Kelly (1998) stated that VM is a very good tool for breaking existing perceptions, to force people to take a fresh approach to problem solving and assisting in setting our tasks and objectives with value for money at the front of their thinking. In some cases, the project is the product of a strategic VM process conducted during its life cycle, which offers a greater opportunity for project stakeholders to exchange different views and perspectives, thereby enabling them to avoid many of the problems that typically arise in building projects, as well as satisfying the demand for long-term value (Best & De Valence, 1999). Egan (1998) defines VM as “a structured method of eliminating waste from the brief before binding commitments are made”.

Briefing is perhaps the most important step in the design process. Here client requirements and needs are identified and the main pledge of resources prepared (Shen et al., 2004). In 1976, the Pruitt-Igoe buildings were demolished as they did not satisfy the requirements and social needs of users (Newman, 1996). This example, as with many others, demonstrates that stakeholder’ needs and sustainable construction in terms of its three dimensions – social, economic and environmental – need to be taken into account in the briefing process. The consideration of sustainable construction during the briefing process may minimise the negative impacts on the environment and satisfy the needs and requirements of the user in addition to minimising the whole life-cost of a project.

Saudi Arabia is currently experiencing a construction boom due to strong oil prices and ongoing reforms in the country. The boom is also spurred on by major government construction activities and the development of building projects, as well as a rapidly expanding tourism sector (Al-Yami & Price, 2006). The lack of attention paid to sustainability issues during the conceptual phase has resulted in

higher consumption of materials and energy during both the construction and operational phases of many building projects (Al-Yami and Price, 2006). Because of this, the implementation of sustainability principles in the Saudi construction industry is crucial and should be taken into account at early stages of building projects to guarantee the advocacy of the key stakeholders.

9.4.1 Sustainable construction

Sustainability is a major concept underlying a variety of efforts to ensure a good quality of life for future generations. The Brundtland Report (1987) defines sustainable development as "...meeting the needs of the present without compromising the ability of future generations to meet their needs". This definition indicates that the environment and social issues are as paramount as economic issues, and suggests that human, natural and economic systems are interdependent. It also involves intergenerational justice, highlights the liability of the current nations for the well-being of millions yet unborn, and involves the idea that the present generation are borrowing the planet's resources, its environmental function and quality from future generations (Kibert, 2005).

The term 'sustainable construction' is generally used to describe the application of sustainable development in the construction industry. In 1994, the Conseil International du Bâtiment (CIB) defined sustainable construction as "...creating and operating a healthy built environment based on efficient resources and ecological principles" (Kibert, 2005). Hill and Bowen (1997) extend the definition to four pillars: social, economic, biophysical and technical. Du Plessis (2002) defined it as a holistic process aiming to restore and maintain harmony between the natural and built environments, and create settlements that affirm human dignity and encourage economic equity. The CIB proposed seven principles of sustainable construction which inform decision makers during every stage of the design and construction process, persisting throughout the whole life cycle of a building, which are: reducing resource consumption; reusing resources; using recyclable

resources; protecting nature; eliminating toxins; applying life cycle costing; and emphasising quality (Kibert, 2005). To obtain optimal solutions to current difficult construction and infrastructure problems, it is vital to consider environmental, technical, social, political and economic aspects, their synergies and the inevitable balances between them.

Sustainability in this way expresses solutions with regard to a whole system, with an entire combination of outcomes as expressed by a variety of comments and conclusions (Feng & Price, 2005). A sustainable construction industry does not simply mean to continue its business and growth, but also needs to meet the principles of sustainable development, which means it may need, in some cases, to stop growing or grow in different ways (Du Plessis, 2002).

9.4.2 Sustainable construction drivers

According to the United States Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED), buildings in the USA constitute 36% of total energy use and 65% of electricity consumption, 30% of greenhouse gas emissions, 30% of waste production and 12% of drinkable water consumption (USGBC, 2003). The advantages of implementing sustainability principles in the briefing process are associated with three main aspects:

- environmental benefits are in the improvement of air and water quality, minimisation of energy and water consumption and reduction of waste disposal;
- economic benefits are reducing operating and maintenance cost and increasing revenue (sale price or rent); and
- health and community benefits are enhancing occupant comfort and health and minimising absenteeism, turnover rate and liabilities (Kats & Alevantis, 2003).

Moreover, achieving sustainable design will produce buildings with lower embodied energy and harmful emissions; using reusable, renewable, recyclable and repairable resources; and using water and energy more efficiently. It will increase the demand of practitioners (buildings, designers, consultants, etc.) and increase marketing and promotional opportunities associated with sustainable building ((Ashe et al, 2003). Hayles (2004) states that the adaptation of sustainable construction principles delivers better long-term value to the built environment and its occupants.

Manoliadis et al., (2006) outline 15 drivers for change to implement sustainable construction. They are: energy conservation; waste reduction; indoor environmental quality; environmentally friendly energy technologies; resource conservation; incentive programmes; performance based on standards; land use regulations and urban planning polices; education and training; re-engineering the design process; sustainable construction materials; new cost metrics based on economic and ecological value systems; new kinds of partnerships and project stakeholders; product innovation and/or certification; and recognition of commercial buildings as productivity assets. These drivers should stimulate stakeholders to adopt sustainable design in their building project at the briefing process.

9.4.3 Sustainable construction barriers

There are several potential barriers to the implementation of sustainable construction, with the main one being perceived as cost. The common perception of sustainable buildings appears to be that they cost more than ordinary buildings. They increase initial costs by an average of 2 to 7% over ordinary building cost, and only some projects can recoup overall net costs in a short period. Decision makers rarely use whole life cycle costs to estimate reduced operating expenses (Castillo & Chung, 2005). These barriers can be overcome by moving the thinking of stakeholders from cost to value and from short term to long term.

To manage and control projects, there are various procurement strategies. Most popular of these strategies include traditional management, integrated services and in-house teams. Despite various management practices, construction projects in many countries are still faced with the problem of project delay and cost overrun. The Vietnamese government acknowledged construction delays and cost overrun problems as primary problems, especially with government funded projects. A study of more than 4 000 construction projects showed that projects were rarely finished on time nor were within the allocated budget.

In South Africa, the construction industry is one of the major industries contributing significant growth to socio-economic development. In recent years, there has been rapid growth of this industry in South Africa. Although much money has been spent in construction, the industry is facing many challenges such as delays, expenditure exceeding the budget, construction defects and dependency on foreign workers.

To control construction projects in South Africa, various procurement strategies are commonly adopted. These include the traditional lump sum system, design and build/turnkey system and Construction Project Management/Contract Management.

Angelo and Reina (2002) state that the problem of cost overruns is critical and should be explored further to mitigate this problem in future. They also point out that cost overruns are a major problem in both developing and developed countries. The trend is more acute in developing countries where these overruns sometimes exceed 100% of the estimated project cost. Lack of management and lack of ability to prevent cost overruns or to control construction costs cause construction companies to fail so there is a need for effective cost management and cost control systems. To avoid this problem, the important steps are to identify and understand the causes and factors responsible for this.

Time and cost are among the major considerations throughout the project management life cycle and can be regarded as the important parameters of a project and the driving force of project success. Despite its proven importance, it is not uncommon to see a construction project failing to achieve its objectives within the specified time and cost. Time and cost overruns occurring in most construction projects vary considerably. Time overruns and cost overruns have contributed to the high cost of construction in many countries for many years. Research has shown that time overruns have a positive and strong linear relationship with cost overruns in a construction project.

Some researchers argue that construction cost overruns are one of the effects of project delay. The responsibility for project delay is reflected in whether the contractor is liable for costs and additional time to complete the project. In the study of the growing problem of construction delay in Nigeria, through a questionnaire survey and study of 61 construction projects, it was concluded that cost overrun is one of the effects of project delay.

Ghana studied 26 factors that cause cost overruns in the construction of ground water projects and found that according to the contractors and consultants, monthly payment difficulties was the most important cost overruns factor, while owners ranked poor contractor management as the most important factor. Despite these differences in viewpoints among the three groups surveyed, there is a high degree of agreement among them with respect to their ranking of the factors. The overall ranking results indicate that the three groups felt that the major factors that can cause excessive groundwater project cost overruns in developing countries are poor contractor management, monthly payment difficulties, material procurement, poor technical performances and escalation of material prices.

Studies done in Kuwait about delays and cost increases in the construction of private residential projects, found that cost increase was greater when the total cost of a residential project was higher. A major factor contributing to the time

delay and cost increase was the inadequacy of money and time allocated to the design phase. The three main causes of cost overruns on the other hand were, in order, contractor and material related problems as well as owners' financial constraints. Four major factors that cause cost overruns are design changes, inadequate planning, unpredictable weather conditions and fluctuations in the cost of building materials.

Saudi Arabia found that about 70% of the projects experienced time overruns. Malaysia found 15 causative factors responsible for cost overrun in MARA large projects. The results showed that cash flow and financial difficulties faced by contractors, contractor's poor site management and supervision, inadequate contractor experience, shortage of site workers and incorrect planning and scheduling by contractors were significant factors affecting construction cost.

9.5 Conclusion

Project management in construction projects, as with other projects, revolves around the general project management principles of time, cost and quality when considering the performance of the projects. Project managers in this type of project are contributing to the industry by adopting modern views surrounding sustainable and 'green' developments on an increasing scale, along with considerations for socio-economic improvements in their project environments while maintaining the ethos of value management principles.

While there is no shortage of problems in construction projects, project management in this field allows for a centralised point of control for operations which enables rapid response to these problems as they are identified throughout the project life cycle, which in turn, leads to smoother workflow on these projects.

In the next chapter a case study is used to investigate how the aspects of quantity surveying are applied to a working environment.

PART 3: CHAPTER 10

CASE STUDY ON SCHOOLS PROJECTS IN THE FREE STATE PROVINCE

10.1 Introduction

The objective of Chapter 10 is to illustrate the inconsistency of budget estimates (specifically on school projects, mainly because of similarities of the extent of the scope of works) when compared to contract sums as well as the disparity of contract sums when compared to the final accounts. Moreover, this chapter investigates how preliminaries, contingencies and provisional sums influence the budget estimate when compared to contract sums and final account.

10.2 Introduction to the case study

A total of 38 firms in the Free State Province were approached to complete a questionnaire during the period from November 2012 to February 2013. This questionnaire was specifically for those firms that had completed school projects since 2003. Twenty firms indicated they had worked on schools projects and of these 12 provided responses. From these 12 firms a total of 44 projects were examined. The Department of Education and the Department of Public Works in the Free State Province were approached in pursuit of more data. Permission was granted in writing by the Free State Department of Public Works, that firms which completed schools projects in the past must assist by providing information for the purpose of this research, some firms ignored the request, others indicated that these projects were confidential and they were not willing to share the information, even for research purposes. Therefore, to respect the participants' rights to privacy, the researcher kept their names and related project titles strictly confidential.

10.3 Research of the case study

The purpose of the case study is to prove that the initial cost plan can make or break the project, especially when the first estimate is inaccurate. A questionnaire survey was circulated to 20 firms in and around the Free State Province of South Africa. Responses were received from 12 firms (60% response rate) constituting a total of 44 projects.

Table 9 shows the results of the respondents in respect of how the contract sum (tender amount) relates to the quantity surveyor's estimate. It is clear from Table 9 that 9 (20%) out of 44 project's contract sums (tender amounts) is on average 18% higher than the quantity surveyor's estimate.

Column 1 shows the project names, Column 2 the tender amounts, Column 3 the quantity surveyor's (QS) estimates and Column 4 shows the average percentages of the tender amounts higher than the QS estimates.

Table 9: Contract sums (tender amount) higher than the initial quantity surveyor's (QS) estimate

	Number of projects	% of total projects	Average % higher
Tender amount higher than QS estimate	9	20%	18%
Project by project breakdown for tender amount higher than QS estimate			
Project name	Tender amount	QS estimate	% higher
1. Manthatisi Sec 2012	R839 948.95	R790 000.00	6%
2. Hlohlobo 2006	R1 173 270.00	R1 154 667.00	2%
3. Primary School 2011	R1 487 054.00	R1 435 000.00	4%
4. Bodikela Prim 2007	R3 155 930.00	R3 010 755.00	5%
5. Nteboheng 2006	R2 737 899.00	R2 518 850.00	9%
6. Excelsior 2011	R3 830 784.00	R3 168 055.00	21%
7. Mautsi Primary 2007	R12 996 000.00	R11 506 776.00	13%
8. Mofulatshope Primary School 2011	R7 400 000.00	R7 200 000.00	3%
9. Kamohelo 2012	R29 624 940.86	R14 625 087.89	103%

From Table 9 above it is evident that projects that are greater than the quantity surveyor's estimate range from as high as 2% to 103% over the initial estimate. The results of this could be the various factors dealt with in the literature review.

Table 10 below shows the results of the respondents in respect of how the contract sum (tender amount) relates to the quantity surveyor's estimate. This part looks specifically at projects with contract sums that are lower than the quantity surveyors estimate. It is clear from Table 10 that 25 (57%) out of 44 project's contract sums (tender amounts) are on average 13% lower than the quantity surveyor's estimate.

Column 1 shows the project names, Column 2 the tender amounts, Column 3 the quantity surveyor's (QS) estimates and Column 4 shows the average percentages of the tender amounts lower than the QS estimates.

From Table 10 below it is evident that a higher percentage (57%) of projects has contract sums that are lower than the QS estimate by an average 13%, with projects ranging from as low as 0.14% to about 90%.

The results of Table 10 below could mean that in some of these projects the quantity surveyor's estimate was known to some contractors. And for projects with 22%, 25%, 29% and 90% respectively lower than the estimate it could mean that the client had decreased the scope.

Table 10: Contract sums (tender amount) lower than the initial quantity surveyor's (QS) estimate

	Number of projects	% of total projects	Average % lower
Tender amount lower than QS amount	25	57%	13%
Project by project breakdown for tender amount lower than QS estimate			
Project name	Tender amount	QS estimate	% lower
1. Kgola Thuto Sec 2012	R335 389.47	R375 500.00	11%
2. Clubview Sec 2012	R883 535.96	R1 077 500.00	18%
3. Sasamal Sec 2012	R894 853.58	R1 300 000.00	31%
4. Sekgutlong Sec 2012	R852 385.97	R1 163 934.00	27%
5. Bluegumbosch Sec 2012	R882 207.00	R1 130 460.00	22%
6. Mohaladite Sec 2012	R860 445.00	R1 210 760.00	29%
7. Harrismith Sec 2012	R1 262 555.00	R1 674 600.00	25%
8. Lehutso 2006	R1 163 850.00	R1 303 520.00	11%
9. Mohobo 2007	R886 477.00	R912 439	3%
11. Primary School 2011	R1 418 334.40	R1 450 000.00	2%
12. Hlohlolwane 2007	R1 983 438.00	R2 153 220.00	8%
13. Excelsior Admin 2011	R3 472 489.00	R3 563 251.00	3%
14. Sakubusu 2007	R9 599 020.00	R10 078 970.00	5%
15. Virginia: Marematlou Sec School	R15 945 418.00	R16 409 889.00	3%
16. New EE Monseese Comprehensive School 2006	R21 706 336.00	R23 600 288.00	8%
17. Kopanong School Bloemfontein 2006	R20 720 691.89	R21 046 700.00	2%
18. Kopanong Hlanganani Warden 2008	R23 846 032.33	R24 442 183.14	2%
19. Mehopung Ficksburg 2008	R23 305 197.21	R23 761 046.87	2%
20. Mohlodi Thuto Sec. Marquard 2008	R28 077 912.74	R28 597 915.68	2%
21. Kgetha Tsebo Tshiami 2008	R28 403 590.91	R28 809 762.26	1%
22. Tsebong Ulwazini Harrismith 2008	R21 575 657.06	R21 932 086.91	2%
23. Boitumelong Special School 2012	R16 077 815.79	R16 100 000.00	0%
24. Winnie Mandela Primary 2009-2011	R5 655 400.00	R58 000 000.00	90%
25. Diepsloot Secondary School 2009-2011	R55 250 000.00	R60 000 000.00	8%
26. Sakhisizwe Secondary School	R58 180 000.00	R60 000 000.00	3%

Table 11 below shows the results of the respondents in respect of how the contract sum (tender amount) relates to the quantity surveyor's estimate. This part looks specifically at projects with contract sums that are equal to the quantity surveyor's estimate. It is clear from Table 11 that 5 (11%) out of 44 project's contract sums (tender amounts) are equal to the quantity surveyor's estimate. This is due to the fact that these projects were conducted following a design and building contract, where the quantity surveyor was appointed by the contractor, not the client, and the method of appointment of the contractor was based on the best proposal, e.g. design, cost and capacity.

Table 11: Contract sums (tender amount) equal to quantity surveyor's (QS) estimate

	Number of projects	% of total projects	Average % lower or higher
Tender amount equal to the QS amount	5	11%	0
Project by project breakdown for tender amount equal to QS estimate			
Project name	Tender amount and QS estimate		
1. Viljoenskroon 2009	R 29 774 508.50		
2. Koppies 2009	R 29 685 271.91		
3. Villiers 2009	R 28 792 755.10		
4. Deneysville 2009	R 29 181 439.99		
5. Steynsrus 2009	R 19 666 791.90		

Table 12 below shows the results of the respondents with insufficient data; 5 (11%) out of the 44 projects were unable to be analysed because of insufficient information.

Table 12: Projects with insufficient data

	Number of projects	% of total projects	Average % lower or higher
Projects with insufficient data	5	11%	n/a
Projects for which data was insufficient			
1. Gonyane School 2008 2. Relebeletse 2008	3. Refentse 2008 4. Lemotso 2008	5. SA Mokgothu 2008	

Table 13: Projects with final accounts higher than the contract sum (tender amount)

	Number of projects	% of total projects	Average % higher
Final account higher than tender amount	25	57%	53%
Project by project breakdown for final account higher than tender amount			
Project name	Tender amount	Final account	% higher
1. Kgola Thuto Sec 2012	R335 389.47	R351 132.27	5%
2. Manthatisi Sec 2012	R839 948.95	R1 084 288.15	29%
3. Sasamala Sec 2012	R894 853.58	R1 086 602.79	21%
4. Sekgutlong Sec 2012	R852 385.97	R1 124 518.39	32%
5. Bluegumbosch Sec 2012	R882 207.00	R1 052 352.31	19%
6. Mohaladite Sec 2012	R860 445.00	R1 183 709.58	38%
7. Harrismith Sec 2012	R1 262 555.00	R1 612 238.55	28%
8. Lehutso 2006	R1 163 850.00	R1 273 689.00	9%
9. Mohobo 2007	R886 477.00	R905 407.00	2%
10. Bodikela Primary 2007	R3 155 930.00	R4 056 516.85	29%
11. Excelsior Admin 2011	R3 472 489.00	R3 583 024.00	3%
12. Mautsi Primary 2007	R12 996 000.00	R20 895 186.86	61%
13. Mofulatshepe Primary School 2011	R7 400 000.00	R8 000 000.00	8%
14. Sakubusu 2007	R9 599 020.00	R10 340 650.00	8%
15. Viljoenskroon 2009	R29 774 508.50	R29 826 689.24	0%
16. Koppies 2009	R29 685 271.91	R29 772 720.70	0%
17. Deneysville 2009	R29 181 439.99	R29 234 096.03	0%
18. Steynsrus 2009	R19 666 791.90	R20 921 724.19	6%
19. Virginia: Marematlou Sec School	R15 945 418.00	R17 011 775.00	7%
20. New EE Monsese Comprehensive School 2006	R21 706 336.00	R22 765 092.63	5%
21. Kopanong School Bloemfontein 2006	R20 720 691.89	R21 715 085.41	5%
22. Kamohelo 2012	R29 624 940.86	R35 108 393.81	19%
23. Lemotso 2008	R27 774 816.84	R30 236 757.11	9%
24. Winnie Mandela Primary 2009-2011	R5 655 400.00	R60 500 000.00	970%
25. Diepsloot Secondary School 2009-2011	R55 250 000.00	R56 800 000.00	3%

Table 13 above shows the results of the respondents in respect of how the contract sum (tender amount) relates to the final account. It is clear from Table 13 above that 25 (57%) out of 44 project's contract sums (tender amounts) are on average

53% higher than the contract sum (tender amount). This reflects bad or poor management of funds, too many scope changes in the form of variation orders, etc. This is particularly worrying because of the fact that a large number of projects, in this case 53%, are performing this badly in terms of cost. The cost overruns from Table 13 range from as little as 2% but increases to 970%. This case study also reveals that even though some of these projects double in cost, this does not guarantee that they would finish on time.

Table 14: Projects with final accounts lower than the contract sum (tender amount)

	Number of projects	% of total projects	Average % lower
Final account lower than tender amount	19	43%	5%
Project by project breakdown for final account lower than tender amount			
Project name	Tender amount	Final account	% lower
1. Clubview Sec 2012	R883 535.96	R782 226.18	11%
2. Hlohlobo 2006	R1 173 270.00	R1 167 089.00	1%
3. Primary School 2011	R1 418 334.40	R1 418 308.21	0%
4. Primary School 2011	R1 487 054.00	R1 485 963.61	0%
5. Nteboheng 2006	R2 737 899.00	R2 708 860.00	1%
6. Hlohlolwane 2007	R1 983 438.00	R1 970 815.00	1%
7. Excelsior 2011	R3 830 784.00	R2 996 588.00	22%
8. Villiers 2009	R28 792 755.10	R27 721 004.56	4%
9. Kopanong Hlanganani Warden 2008	R23 846 032.33	R23 287 006.74	2%
10. Mehopung Ficksburg 2008	R23 305 197.21	R22 617 310.84	3%
11. Mohlodi Thuto Sec Marquard 2008	R28 077 912.74	R26 871 714.86	4%
12. Kgetha Tsebo Tshiami 2008	R28 403 590.91	R27 977 537.05	1%
13. Tsebong Ulwazini Harrismith 2008	R21 575 657.06	R21 357 742.92	1%
15. Boitumelong Special School 2012	R16 077 815.79	R16 593 090.07	3%
16. Gonyane School 2008	R29 272 873.04	R26 979 558.00	8%
17. Relebeletse 2008	R21 974 389.66	R19 551 043.83	11%
18. Refentse 2008	R28 653 665.07	R27 054 955.26	6%
19. SA Mokgothu 2008	R 37 352 418.61	R 31 163 656.97	17%
20. Sakhisizwe Secondary School	R 58 180 000.00	R 57 960 000.00	0%

Table 14 above shows the results of the respondents in respect of how the contract sum (tender amount) relates to the final account. It is evident from Table 14 above that 19 (43%) out of 44 project's contract sums (tender amounts) is 5% on average lower than the contract sum (tender amount). Fifteen (79%) of the 19 projects have a final account which is lower than the contract sum but, most importantly, which fell within a 10% margin; this is actually a very good margin from a quantity surveying point of view. Only 4 (21%) of the projects had final accounts which are lower by more than a 10% margin, which could mean that there was a significant omission in the contract by means of a variation order or the quantity surveyor overmeasured some of the trades in the bills of quantities. Furthermore, there were no projects with a final account equal to the contract sum. This is caused by variation orders in projects including trades or items that are measured provisionally.

Table 15: Comparison of preliminaries & generals (P&G)

	Number of projects	% of total project	Average % higher or lower
Final P&Gs higher than original P&G estimate	11	25%	67%
Final P&Gs lower than original P&G estimate	13	30%	45%
Final P&Gs equal to original P&G estimate	12	27%	0%
Insufficient data to calculate	8	18%	n/a

Table 15 above indicates that 11 (25%) of the 44 projects' P&Gs are on average 67% higher than the original P&G allowed in the estimate by the quantity surveyor. Furthermore, Table 15 shows that 13 (30%) of the 44 projects have P&Gs which are on average 45% lower than the P&G allowed within the quantity surveyor's estimate. Twelve (27%) of the 44 projects had P&Gs equal to the QS estimate. This could also mean that the particulars of the projects in question may have been

disclosed to some contractors. Eight (18%) of the 44 projects analysed had insufficient information and as a result could not be analysed.

Of the 16 projects for which the difference between the original P&G estimate and the final adjusted amount was outside the 10% margin, only 3 (19%) were completed on time.

Table 16 below shows the results of the respondents in respect of how the original provision sums in the contract sum (tender amount) relate to the provisional sums in the final account. Evidence is drawn from Table 16 that 14 (32%) of the 44 projects had provisional sums which were 217% higher than the original provisional sums in the tender amount. This part of the case study revealed that some quantity surveyors cut and paste in some projects. This conclusion is drawn as a result of projects with different contract sums having the same provisional sums inserted. It also appears as if quantity surveyors do not request information when pricing for the provisional sums. They allow inexperienced members of staff to do the assumptions for allowances in the provisional sums. Table 16 shows that some projects have final provisional sums that range between 47%, 66%, 755%, 957% and as high as 1028%. These figures as they appear below on Table 16 lead to project failures and cost overruns.

Table 16: Final provisional sums higher than provisional sums in tender

	Number of projects	% of total projects	Average % higher
Final provisional amount higher than original provisional amount	14	32%	217%
Project by project breakdown for final provisional amount higher than original provisional amount			
Project name	Original provisional amount	Final provisional amount	% higher
1. Kgola Thuto Sec 2012	R16 000.00	R180 442.80	1028%
2. Manthatisi Sec 2012	R400 000.00	R490 994.20	23%
3. Sasamala Sec 2012	R460 000.00	R764 419.21	66%
4. Sekgutlong Sec 2012	R48 000.00	R507 382.42	957%
5. Bluegumbosch Sec 2012	R355 000.00	R520 445.31	47%
6. Mohaladite Sec 2012	R480 000.00	R669 080.83	39%
7. Harrismith Sec 2012	R580 000.00	R788 860.00	36%
8. Lehutso 2006	R10 000.00	R13 437.00	34%
9. Primary School 2011	R297 500.00	R317 957.56	7%
10. Steynsrus 2009	R4 450 000.00	R5 839 080.00	31%
11. New EE Monseese Comprehensive School 2006	R271 710.00	R2 322 439.00	755%
12. Kopanong School Bloemfontein 2006	R270 500.00	R285 313.25	5%
13. Kopanong Hlanganani Warden 2008	R4 684 725.66	R4 689 824.53	0%
14. Mohlodi Thuto Sec Marquard 2008	R5 317 413.20	R5 542 151.67	4%

Table 17 below shows the results of the respondents in respect of how the original provision sums in the contract sum (tender amount) relate to the provisional sums in the final account. Evidence is drawn from Table 17 that 13 (30%) of the 44 projects had provisional sums which are on average 19% lower than the original provisional sums in the tender amount. Table 17 below also shows that there were projects that have final provisional sums reduced by 32%, 79% and up to 80% respectively when compared to the original provisional sums.

Table 17: Final provisional sums lower than provisional sums in tender

	Number of projects	% of total projects	Average % lower
Final provisional amount lower than original provisional amount	13	30%	19%
Project by project breakdown for final provisional amount lower than original provisional amount			
Project name	Original provisional amount	Final provisional amount	% lower
1. Clubview Sec 2012	R355 000.00	R309 390.22	13%
2. Primary School 2011	R324 000.00	R304 552.52	6%
3. Mofulatshepe Primary School 2011	R40 000.00	R35 000.00	13%
4. Viljoenskroon 2009	R1 704 828.00	R1 682 851.00	1%
5. Koppies 2009	R40 000.00	R35 000.00	13%
6. Villiers 2009	R1 608 930.00	R1 554 945.71	3%
7. Deneysville 2009	R1 754 168.00	R1 732 191.60	1%
8. Mehopung Ficksburg 2008	R3 773 727.70	R3 699 248.61	2%
9. Kgetha Tsebo Tshiami 2008	R4 126 625.00	R4 053 773.00	2%
10. Tsebong Ulwazini Harrismith 2008	R3 613 362.50	R3 574 446.59	1%
11. Winnie Mandela Primary 2009	R2 800 000.00	R600 000.00	79%
12. Diepsloot Secondary School 2009	R2 500 000.00	R500 000.00	80%
13. Sakhisizwe Secondary School	R2 500 000.00	R1 700 000.00	32%

Table 18 below shows the results of the respondents in respect of how the original provision sums in the contract sum (tender amount) relate to the provisional sums in the final account. Evidence is drawn from Table 18 that 16 (36%) of the 44 projects had provisional sums that did not change in the final account when compared to the original provisional sums in the contract amount. Furthermore, Table 18 below indicates that only 1 (2%) of the 44 projects had insufficient information to be included for analysis.

Table 18: Unchanged provisional sums in final account

	Number of projects	% of total projects	Average % higher or lower
Final provisional amount equal to original provisional amount	16	36%	0
Project by project breakdown for final provisional amount equal to original provisional amount			
Name of project	Final and original provisional amount		
1. Mohobo 2007	R20 000.00		
2. Hlohlobo 2006	R30 000.00		
3. Bodikela Prim 2007	R0.00		
4. Nteboheng 2006	R30 000.00		
5. Hlohlolwane 2007	R0.00		
6. Excelsior 2011	R44 000.00		
7. Excelsior Admin 2011	R13 000.00		
8. Mautsi Primary 2007	R0.00		
9. Virginia: Marematlou Sec School	R0.00		
10. Kamohelo 2012	R0.00		
11. Boitumelong Special School 2012	R146 250.00		
12. Gonyane School 2008	R110 000.00		
13. Relebeletse 2008	R110 000.00		
14. Refentse 2008	R110 000.00		
15. Lemotso 2008	R110 000.00		
16. SA Mokgothu 2008	R110 000.00		
	Number of projects	% of total projects	Average % higher or lower
Insufficient information to determine	1	2%	n/a
Project for which data was insufficient			
1. Sakubusu (2007)			

Table 19 below shows the results of the respondents in respect of contingencies allowed in the quantity surveyor’s estimate. Table 19 shows that 10 (23%) had a 23% (average) contingencies allowed in the QS estimate. This was somehow strange because the rule-of-thumb is a maximum of 10%. Despite these 10 (23%) projects, when an average of the entire project is taken, an average of 8.25% contingency allowance on project is achieved.

Table 19: Contingencies

	Number of projects	% of total projects	Contingencies as % of final amount: Average
Contingencies estimates more than 10% of QS amount	10	23%	23%
Average percentage that the contingencies were of QS amount (all projects)	44	100%	8.25%

Table 20 below shows the results of the respondents in respect of how projects performed in respect of time. Table 20 shows that 26 (59%) out of the total 44 projects were on average overdue by six months. Furthermore, it is evident that 13 (50%) of the 26 projects that experienced a time delay were as a result of natural causes, and these projects suffered about three and a half months’ delays. A further 7 (27%) of the 26 projects suffered a delay due to non-payments and this was on average 10 months’ delays. Ten (38%) out of 26 projects suffered a time delay owing to other causes (strikes, etc.) and this resulted on a delay of about 6 months. Refer to Table 20 below.

Table 20: Project time performance

	Number of projects	% of total projects	Average number of months overdue
Total Projects overdue	26	59%	6.06 months
Projects overdue due to natural causes	13	50%	3.54 months
Projects overdue due to payment related issue	7	27%	10.79 months
Projects overdue due to other causes	10	38%	5.6 months

Note: The percentages for reasons for delays will not add up to a 100 since some projects were delayed for more than one reason.

10.4 Conclusion

This case study examined the importance of the accuracy of the initial cost plan in construction project estimates. Contractor estimates and quantity surveyor estimates may have significant differences and this may be used as a method of gauging prospective contractor estimating abilities for the given project. This case study has also highlighted the differences, although discrete, between values for contractor assigned quantity surveyors and client assigned quantity surveyors as well as the impacts of variation orders on current construction projects with regard to both time and expenses. Contingency and P&G estimates are also crucial aspects of construction projects and the differences in their estimation and calculation vary from project to project.

The next chapter presents an investigation into procurement, its irregularities and its effects on construction projects, especially regarding delays and cost aspects.

CHAPTER 11

CASE STUDY ON PROCUREMENT IRREGULARITIES

11.1 Introduction

This report investigates alleged procurement irregularities, focusing on the consultants' inputs within the procurement process pertaining to the subject construction project. A commission of enquiry was appointed in terms of the *Commissions of Inquiry Act*, (Republic of South Africa, 1998), to undertake the investigation. To respect the participants' rights to privacy the researcher kept their names strictly confidential, in this matter the researcher was appointed as a specialist witness to assist the commissioner with the technical aspects of the report, of which the contents thereof was written by the researcher.

11.1.1 Terms of reference (ToR)

The Terms of Reference (ToR) of the Commission of Inquiry were to investigate and report on alleged irregularities regarding the procurement of service providers in the construction of the Provincial Archives Building and the construction of the Provincial Disaster Management Centre, as well as procedural scopes of government procurement, with specific reference to the following:

- Persons involved in identifying the need for the construction of the building projects as well as those responsible for ensuring that the building projects were adequately budgeted for prior to and for the full duration of the projects.
- Persons/departments responsible for procuring services for the building projects.
- Persons/departments responsible for determining specifications/requirements and the subsequent preparation and approval thereof in the building projects.

- Persons/departments responsible for determining the appropriate method for calling bid proposals to be followed in procuring the required services for the building projects, including the reasons and the extent to which specification requirements were included in all proposals or made available to interested potential service providers.
- Persons responsible for determining the responsiveness of all bid proposals received with reference to timeous receipt before closing dates for bids, the validity of the required supporting bid documentation (valid tax clearance certificates, etc.).

This also includes the role, responsibilities and conduct of the relevant departmental bid evaluation committee and the role, responsibilities and conduct of the respective heads of department in the procurement process in procuring the services for the building projects. The extent to which the department verified the bid proposals submitted by the successful service providers to ensure that the department receives value for money referring to preliminaries, contingencies, escalation allowances and professional fees and identification and appointment, by the department concerned, of all other role players in addition to successful service providers for the building projects. The extent to which service level agreements were sound, comprehensive, detailed and ensured value for money for the Department and the compliance by the successful service providers in their respective obligations in terms of the service level agreements.

The report must indicate instances of fraudulent or corrupt acts uncovered, abuse of the department's supply chain management system and irregular, authorised and fruitless and wasteful expenditure in procuring the required services for the building projects, including the identification of all persons or entities (including public servants) involved. Firm recommendations regarding possible criminal or disciplinary steps should also be included in the report. The report must also make

firm recommendations regarding the improvement/enhancement of the departmental procurement system within the prescribed procurement framework.

11.1.2 Limitations and constraints on the report

The following constraints are identified in limiting the extent of certain outcomes and conclusions:

No interviews were conducted with the consultants. Information was sourced through the commission; findings and conclusions are based on the information available at the time; no information was provided regarding correspondence, approvals or confirmations between the accounting officer (HoD), the supply chain management office or chief financial officer(s).

11.1.3 Literature review

The *Preferential Procurement Policy Framework Act* of 2000 under the General Procurement Guidelines mentions the five pillars of procurement – value for money, open and effective competition, ethics and fair dealing, accountability and reporting, and equity (Republic of South Africa, 2000). These are presented in more detail in the next sections.

11.1.4 Value for money

Price alone is not a reliable indicator and departments will not necessarily obtain best value for money by selecting the bid with the lowest price that meets mandatory requirements. The procurement function itself must provide value for money in a cost-effective way by using the following prescripts:

To avoid any unnecessary costs and delays, monitor the supply arrangements and reconsider if they do not provide the expected benefits and ensure continuous improvement in the efficiency of internal processes and systems.

11.1.5 Open and effective competition

This requires a transparent framework of procurement laws, policies, practices and procedures; openness in the procurement process; encouragement of effective competition through procurement methods suited to market circumstances; observance of provisions in the *Preferential Procurement Policy Framework Act*.

Departments need to ensure that suppliers have reasonable access to procurement opportunities with sufficient notification of these opportunities; recognise where market competition is limited and use procurement methods that account for this; and supply adequate and timely information. They also need to ensure that bias and favouritism are eliminated, that the costs of bidding do not discourage potential competent suppliers; and that costs incurred in promoting competition are commensurate with benefits received.

11.1.6 Ethics and fair dealing

In procurement, parties complying with ethical standards can deal with one another on a basis of mutual trust and respect and conduct their business in a fair and reasonable manner and with integrity.

All government staff associated with procurement must:

- Recognise conflicts of interest;
- Deal with suppliers even-handedly;
- Ensure they do not compromise the standing of the state through acceptance of gifts or hospitality;
- Be scrupulous in their use of public property; and
- Provide all assistance in the elimination of fraud and corruption.

11.1.7 Accountability and reporting

Within the procurement framework heads of departments are accountable to their ministers for the overall management of procurement activities and heads of procurement and senior procurement directors are accountable to heads of departments for various high-level management and co-ordination activities. This includes that individual procurement officers are accountable to heads of procurement and their clients for the services they provide; that all people exercising procurement functions must have regard for these guidelines; and are accountable to management.

11.1.8 Equity

The word 'equity' in the context of these guidelines means the application and observance of government policies which are designed to advance persons or categories disadvantaged by unfair discrimination.

In accordance with the Reconstruction and Development Programme (ANC, 1994). SMMEs and HDIs need to play a greater role in the economy. Greater participation in the economy and more diversified representation of blacks and gender ownership is essential.

The government implemented the *Preferential Procurement Policy Framework Act* as the foundation on which all procurement activities are to be based, with the aim to advance the development of SMMEs and HDIs and promote women and physically handicapped people. They must also create new jobs; promote local enterprises in specific enterprises in specific provinces in a particular region in a specific local authority or in rural areas; and support the local product. A list of legislative documents referred to was quoted.

11.1.9 Technical analysis of project procurement, planning, bidding and award

On 23 July 2008 the then Department of Public Works called for tenders for the project under investigation. The tender was a sequel tender and a letter of invitation to tender was issued. Note: Tender invitation was issued via a close or selective tendering method, which entails selection from a pre-selection or ad hoc basis.

11.2 Findings

Findings of the actual procedures indicate that the Department of Public Works acted in line with regulation in using the preference point system for allocation of tenders. The Department adopted Method 1 procedure of the procurement system for evaluation; 20 points for financial offer and 70 for functionality and that selective tendering was used, but the principle price was relegated in favour of functionality scoring.

It was concluded that the Department of Public Works had followed procedure in calling for bid proposals; however, price was not considered the crucial criterion in determining the contractor.

11.2.1 Assessment of consultant's adjudication report

The National treasury document states, "Bids should only be evaluated in terms of the criteria stipulated in the bidding documents" and "Amending the evaluation criteria after the closure of the bid should not be allowed." (Republic of South Africa. Treasury, 2004: 45).

Section 4.12 states:

"Suppliers should be assessed by SCM practitioners for possible risks."

“Before a contract of over R10 million is awarded, clearance should be obtained from the DTI regarding the National Industrial Participation Programme.”

The *Preferential Procurement Policy Framework Act*, Act No. 5, sub-section 2(f), (Republic of South Africa, 2000), states:

“The contract must be awarded to the tenderer who scored the highest points, unless objective criteria justify the award to another tenderer.”

Sub-section 12(7) states:

“Points scored must be rounded off to two decimals.”

The Supply Chain Management Policy, (Republic of South Africa, 1999) sub-section 8.6.1 states:

“All bids duly lodged are taken into consideration. The Department is not obliged to accept the lowest price or the highest points scored by any bid.”

On 3 October 2007 a revised tender report No. 3 was written where eight tenderers submitted their bids for construction of the new disaster management centre. Tenders were evaluated according to the methods stipulated in the tender document. Tender was awarded and terminated. Tenders were invited under closed tender/selective tendering for the continuation of the project.

The basis for the recommendation was the following: the contractor had a minimum CIDB grading of 8GB; he was the only tenderer to submit a responsive tender; he could submit a construction guarantee as per the submitted bank letter; it scored 69 points and was lowest in terms of price; and the consultant conducted site visits to other projects and was satisfied with received testimonials.

Findings in the consultant’s adjudication report indicated that bids were not evaluated according to criteria on the bidding documents because the priced bills of quantities would only be requested from successful bidders. The consultant’s

adjudication report, however, disqualifies two bidders based on their non-submission of priced bills of quantities. The two incorrectly disqualified bidders were not assigned points and bidders were assessed for possible risks. The project was more than R10 million, so clearance was needed from the DTI regarding the National Industrial Participation Programme, which had not been done. There was no proper planning and co-ordination among the consultants at planning stage and beyond.

Based on this, it was concluded that the consultants did not follow correct procedure in adjudicating the bids and an improper recommendation was made to the Bid Committee.

11.2.2 Assessment of roles of the Bid Evaluation Committee, Bid Adjudication Committee and the Supply Chain Management Unit

The Policy Strategy to Guide Uniformity in Procurement Reform Processes in Government, 2003, sub-section 3.6.1 as stated in the Public Finance Management Act (Republic of South Africa, 1999), states:

“Accounting officers/authorities should ensure that a format set of delegations is issued to bid evaluation committees. Bid evaluation committees should be constituted of at least one member. When it is deemed necessary, independent experts may also be co-opted to a bid evaluation committee in an advisory capacity.”

The Supply Chain Management Policy, Section 3.8 states:

"The Supply Chain Management Office must monitor all public sector procurement and should assist any accounting officer in rectifying any deviations from the national policy guidelines, should such deviations occur.”

The Treasury Regulations in terms of the *Public Finance Management Act*, (Republic of South Africa, 1999). Framework for Supply Chain Management, sections 4, 5 and 6 states:

According to the report submitted by the Bid Evaluation Committee to the Bid Adjudication Committee, the recommendations were that the tender was not awarded to two other contractors because they had not submitted priced bills of quantities. According to the consultant, the two companies did not understand the requirements of the tender and that awarding the tender to one of the companies would have placed the Department in financial risk. The winning bidder submitted all required documentation and was recommended based on its bid being 3.88% below QS estimate on 12 August 2008. On 14 August 2008 the bid adjudication committee submitted its final decision to the head of department citing disagreement with the bid evaluation committee's contention that the other two bidders did not submit priced bills of quantities.

11.2.3 Findings to the Bid Evaluation Committee (BEC) and the Bid Adjudication Committee (BAC) Role, Conduct and Report(s)

The findings are as follows:

The Bid Evaluation Committee (BEC) was in agreement with the consultant's Tender Adjudication Report recommendation, which was incorrect. The BEC did not thoroughly investigate the consultant's recommendations before making its recommendations to the Bid Adjudication Committee (BAC). This resulted in the BEC confusing all stakeholders in their report and the BAC was correct in its recommendation to the head of Department of Public Works. The supply chain office was not included in any of the correspondence provided.

11.2.4 Assessment of head of department's role, conduct and report(s)

Chapter 5 of the *Public Finance Management Act*, Act No. 29, (Republic of South Africa, 1999), section 36, sub-section 2(a) states:

“The head of a department must be the accounting officer of the department.”

The Policy Strategy Guide to Uniformity in Procurement Reform Processes in Government, 2003, sub-section 3.6.1 states:

“Accounting officers/authorities should ensure that a formal set of delegations is issued to bid evaluation committees.”

The National Treasury Regulations in Terms of the PFMA, (Republic of South Africa, 1999): Framework for supply chain management Chapter 26, sub-section 26.1.2 states:

“The accounting authority must quarterly report to the executive authority through the designated accounting officer on the extent of compliance on the *Public Finance Management Act*, 1999 and regulations.”

The findings of this section were dealt with by the delegated component of the commission of enquiry and were as follows:

11.2.5 Assessment of bidder’s post-award compliance with the contract requirements

The conditions for the tenderer were as follows:

- Forward the following documentation: letter of acceptance within 7 days of appointment; construction programme within 7 days of appointment; name and contact details of the appointed site manager within 7 days of appointment; priced bill of quantities within 7 days of appointment; all insurances within 14 days of appointment; Occupational Health and Safety Plan within 14 days of appointment; upfront submission of performance guarantees within 14 days of appointment.

- For the duration of the contract, the principle agent will handle all correspondence, claims for payment and negotiations on behalf of the Department.
- Arrangement to be made with the principal agent for the signing of the prescribed programme agreement and the contract documents as soon as possible.
- The handing over of site as soon as possible after completion.
- The project is awarded on the condition that EPWP is complied with.
- Bidder must supply postal address as soon as possible.
- All invoices must be on the company letterhead with banking details and signed by authorised signatories.

Findings in bidder's post-award compliance with the contract requirements stated that first contractors were given site possession on 15 April 2008. The contractor was required to forward relevant documentation within 14 days and it was found the contractor did not submit a priced BoQ and upfront performance guarantee. As a result of non-compliance the contractor was terminated and the same tender was later awarded to a different contractor who seemed to be in compliance of all terms and conditions.

The conclusion was that the site should never have been handed over for possession as the relevant documentation was deemed outstanding.

It is also not clear how the consultants checked for arithmetical errors in the BoQs as it is reported that this contractor did not submit BoQs. It is also unclear how payments could have been processed without the contractor's tender document as no information was provided for verification of payments to the contractor.

11.2.6 Summary

The findings of the technical report are that the Department acted well within protocol in calling for bids according to the PPPFA. The proposed evaluation method was included in the bid invitation and document and adopted verbatim in evaluating bidders. Although the Department deviated from the open tendering system, due process was followed in requesting permission. However, no correspondence is in place that grants this permission. The consultants did not follow the correct procedure in adjudicating the bids by deviating from their own authored bid documents. Some bidders were incorrectly disqualified by the consultants for being non-responsive and as a result of poor planning. There was no proper communication between the consultants, Bid Evaluation Committee and Bid Adjudication Committee.

11.2.7 Financial analysis of pricing, allowances and escalation

Analysis of consultant's tender estimates

The first pre-tender estimate was issued in July 2007 and the second in July 2008. The report prepared by the QS attempted to present an account and the reconciliation of the two different estimates.

The report states that the prices received in 2007 were well within market range. The revised prices in 2008 also reflected market range compared to the tenders received in August 2008. The increase over the 12-month period resulted in 54.62%.

According to the report from the QS, the escalation amounted to 22.22%. It was then established that the allowance for escalation should have been 15.43% and is used to calculate future adjustments.

Table 21: Cost analysis for project escalation

Scenario	Pre-Tender Estimate No. 1	Escalation Allowance	Net Cost Effect
1	R49 731 140	54.62%	R76 892 324
2	R19 731 140	15.43%	R57 404 655
Variance:		39.19%	R19 487 669

This analysis indicates that the second consultant's pre-tender estimate should have been in the region of R57 404 655. The amount of R19 487 669 (the difference) should be fully accounted for.

Findings about the consultant's tender estimates:

The following findings were made regarding the consultant's tender estimates:

There was massive fluctuation in the costs, yet no variance in the building size and there were no unreasonable increases in cost from the first to the second estimate. The preliminaries were underestimated in the first tender estimate and the contingency allowances were insufficient in the first estimate. The consultants could not account for the increase in the revised budgetary allowances/provisional sums and this increase was mainly due to the underestimated preliminaries and the adjusted provisional amounts. The differences in the first and second estimate reveal that there was underestimation in some of the costs in the first estimate, which had a knock-on effect on the escalation on the second estimate. There were also some cost increases in provisional amounts that could not be accounted for. There is no evidence to suggest that the consultants warned the Department about the drastic increases, nor that the Department gave the go ahead for proceeding with tender documentation for the revised scope of work and budgets.

These findings indicate that part of the cost increase was because of the consultants correcting their under-estimates in the first tender estimate. Other costs could not be accounted for based on the information available and the consultants' non-disclosure of the drastic increases between estimates indicates that the team acted against professional ethics and fair dealing.

Assessment of consistency of quantities and specification in the tender documents

The two consultants' estimates correspond with the two tenders received in July 2007 and July 2008.

Assessment of quantities and bills of quantities

A comparison between the quantities of the tender document of 2007 and the tender document of 2008 reveals that similar quantities of work were used for both tenders and that there was a fair level of certainty about the quantities in the two tendering processes. These findings indicate that there was no contribution by these factors to the unreasonable increases in costs.

Assessment of specification in the bills of quantities

The specification of items for building works mirror the findings above. Assessment on the specification of the provisional sums indicate consistency in the two amounts, however the increase of 105.84% raises questions about the accuracy and certainty of the initial budgetary allowance for both provisional sums.

Based on these findings, it is clear that the quantities in the bills of quantities did not contribute to the unreasonable cost increases. The specifications for the building works and the provisional sums did not contribute to the unreasonable increases in cost and the increase in costs in the provisional sums is partly due to the consultants' lack of certainty about adequate provisions.

Evaluation of cost-push factors in the tender documents

This evaluation takes into account the differences of the tender documents of the two appointed contractors (2007 and 2008) as well as the Contract Sum Cost Comparison Report in an Annexure prepared by the QS.

It indicates that the size of the building did not change, the quantities in the bills of quantities did not change, the specifications in the bills of quantities did not change and the correct escalation allowance between 2007 and 2008 is 15.43%.

The financial findings indicate that the gross savings that would have been realised amount to a 57.63% increase between 2007 and 2008. The question of ‘Value for Money’ is highlighted in the literature review.

Comparison between the 2007 and 2008 contract sums

The following extract is presented from the QS report featuring the 2007 and 2008 contracts:

Table 22: Comparison between contract sum of 2007 and 2008

	December 2007	July 2008
Preliminaries	R2 080 000.00	R9 485 273.31
Building, Electrical, Mechanical and External Works	R34 513 003.69	R40 406 524.94
Provisional Sums	R1 819 400.00	R18 727 500.00
Contingencies	R1 500 000.00	R4 000 000.00
Sub-Total	R39 912 403.69	R72 619 298.25
VAT @ 14%	R5 587 736.52	R10 166 701.76
Contract Sum	45 500 140.21	R82 786 000.01

Pricing of preliminaries

Reference to an extract from the QS report on pricing on preliminaries:

The extract points to both the consultants’ and the contractor’s provisions for the preliminaries that were underestimated. This underestimation in preliminaries in 2007 resulted in a specific cost increase in the 2008 contract and the consultants did not give account of why the underestimation occurred, leading to the “Value for Money” question in the literature review.

Provision for contingency allowance

Contingency was under-provided in the 2007 contract and the contingency allowance in the 2008 contract is a clear corrective measure.

Provision for escalation allowance

The market related escalation between 2007 and 2008 is 15.43%. The actual cost increase between 2007 and 2008 is 57.63% giving a variance of 42.20%. The major cost increases are attributed to adjustment of preliminaries and re-pricing of provisional amounts. The market related escalation is not the cause of the unreasonable increase in costs, but the change in cost is due to the elements above.

Pricing of the provisional sums

There was a variance increase in the provisional sum allowance of 929.32% between 2007 and 2008. As mentioned, this increase is partly due to the pre-pricing of items as well as factors that the consultants could not account for.

Loading of prices

The consultants refer to the existence of the loaded prices in their own 2008 report of which an extract was given.

The amount was determined to be significant in pushing the overall costs upward. Questions arise regarding the fact that these increases were not addressed with the preferred bidder before allocating the contract. This does not add 'Value for Money' to the contract.

Based on the findings it is concluded that the 2007 contract contained items that were substantially underestimated. The 2008 contract includes costs that the consultants did not account for and contains items of which the prices were loaded, which should have been addressed by the consultants. The 2008 contract is an

over-expenditure in view of the first two items and the project does not bring 'Value for Money' to the Department.

In summary, there was loading of prices in the second contract of which the consultants were aware. There was underestimating in preliminaries, contingency allowances and provisional sums and the Department was not alerted to the impending increase in costs in the second tender. The 2008 contract is an over-expenditure and this project did not embrace 'Ethics and Fair Dealing' nor 'Value for Money' as two of the Pillars of Procurement.

Conclusion

The following technical and financial conclusions are drawn from the investigations:

The Department exposed itself to financial risk by allocating too much weight on functionality; the adoption of the selective tendering (closed tendering) method was not properly applied in maximising value for money benefits to the Department; there was no proper co-ordination, planning or communication between the consultants, the Department and the User Department in the planning stage and further; the Bid Adjudication Committee was correct in their recommendations in including the previously disqualified bidders on the points allocations and later recommendations; and the Supply Chain Management Unit in the Department was passive during the entire process.

Financial

There was a lack of proper planning for the project and there was a lack of proper communication between the client's team and the consultants' team. There was poor cost control on this project and there was an over-expenditure of the project. The procurement process did not add 'Value for Money' for the client.

11.3 Financial conclusion

Procurement irregularities occur in construction projects because of actions from clients, as well as contractors. Careful consideration is needed when contractors are appointed via tender processes and quantity surveyors have an obligation to their clients and to their profession to identify these potential irregularities or irregular behaviour in construction projects. When construction projects are closed because of abnormal circumstances, or fail for whatever reason, there is great expenditure in both time and finances when the project has to be taken up again. A number of regulations are in place to ensure that quantity surveyors in construction projects adhere to the standards of the industry and this includes ethical considerations for the quantity surveyor, the client and the contractor.

The next chapter presents the results of the empirical study examining various aspects from the point of view of role-players and the processes and challenges in bringing a construction to fruition.

CHAPTER 12

EMPIRICAL STUDY

12.1 Introduction

In Chapter 12 the empirical data is considered and analysed. Findings from the empirical research are used to recommend best practices, which relates to quantity surveyors doing preliminary estimates.

12.2 Objective

The objective of this chapter is to analyse the opinions of the respondents regarding factors contributing to project failure, accuracy of cost estimated, experience of estimates, the methodology preferred when allocating contingency, factors contributing to cost overruns and factors that may improve procurement policies. The opinions of the respondents are also evaluated in the context of improving the ability of quantity surveyor's best performance during the cost-planning process for the whole life cycle of a development project.

12.3 Empirical review

The empirical research represents findings from the questionnaire survey.

Questionnaire survey

An electronic questionnaire survey was conducted via email in 2013. The questionnaire was sent to a randomly selected group of construction professionals consisting of quantity surveyors, architects, engineers, project managers and contractors.

The returned questionnaires' responses were entered into the SPSS program to develop data and to eliminate errors; ICT services transformed the data into usable statistics.

Table 23 shows the response rates. Column 1 shows the response group, column 2 the number of questionnaires sent, column 3 the number of questionnaires received, and column 4 the responses in percentages.

Table 23: Response rate on questionnaires

Response group	Sent	Received	Response (%)
Architects	10	1	10
Quantity Surveyors	100	43	43
Engineers	25	4	16
Project Managers	30	6	20
Contractors	30	8	27
Other	5	1	20
Total	200	63	

The number of questionnaires circulated was 200. The sample size is determined according to the formula by Stoker (1981). The total response rate was 31,5% and for the purpose of this study regarded as representative of the population.

All the respondents who received a questionnaire via email or had it delivered by hand were phoned after two months to inform them of the importance of their reply to the study. Some responded and some ignored the reminder.

12.4 Empirical data

The questionnaire consisted of seven parts with 320 questions. Part 1 dealt with questions related to the profile of the respondents. Part 2 dealt with the factors that contribute to project failures. Part 3 investigated opinions of factors affecting the accuracy of project estimates. Part 4 dealt with allocations of contingencies in

project estimates. Part 5 dealt with factors influencing the performance of contractors, whereas Part 6 concentrated on factors contributing to cost overruns of projects. Part 7 dealt with factors that may improve procurement policies.

The empirical data is presented in seven parts. Firstly the profile of respondents, followed by parts 2 to 7.

12.5 Profile of the respondents

The sample consisted of 63 respondents. The majority of the respondents was from the private sector (81%) and were mostly in the quantity surveying (68%) and construction (13%) sectors. There were a considerably higher percentage of males (83%) than females (18%) in the sample¹. All the respondents had some form of tertiary education, with the majority having obtained either a BSc (27%) or a BSc Honours (29%) degree. Only 2% of respondents held PhDs, while 13% held master's degrees. As regards professional registration, the majority of the respondents were registered in the quantity surveying field (62%), with a further 13% registered as engineers, and 11% registered in the construction field. Only 2% of the respondents were registered as architects. Just more than half of the respondents had more than ten years' experience in their fields (54%), with the years of experience of the remainder of the sample evenly distributed between nought to ten years. Respondents were mostly appointed either as directors (38%) or quantity surveyors (37%) in their companies, with a further 11% being appointed as project managers.

12.6 Factors that contribute to project failure

As regards factors that may lead to project failure, the majority of the respondents (74%) either agreed or strongly agreed that a lack of quality contributed to project failure. Respondents also felt that time was an important contributor to projects

¹ Percentages do always add up to 100% owing to rounding off of numbers.

failing, with more than 80% either agreeing or strongly agreeing that time constraints played a role. The same trend could be seen in the influence of cost on project failings, with 85% of respondents agreeing to some extent that the high costs of projects could lead to their failure. Responses were more evenly distributed on the impact of the scope of a project. Approximately 50% of respondents either did not agree or disagree, or disagreed to some extent that scope may have an impact, while the other 50% agreed to some extent that scope might have an impact. Only 11 respondents indicated that they felt that factors other than those mentioned in the survey could lead to project failure. Of these, eight strongly agreed that other factors played an important role.

The graph in Figure 10 below indicates the distribution of responses for factors that may lead to project failure.²

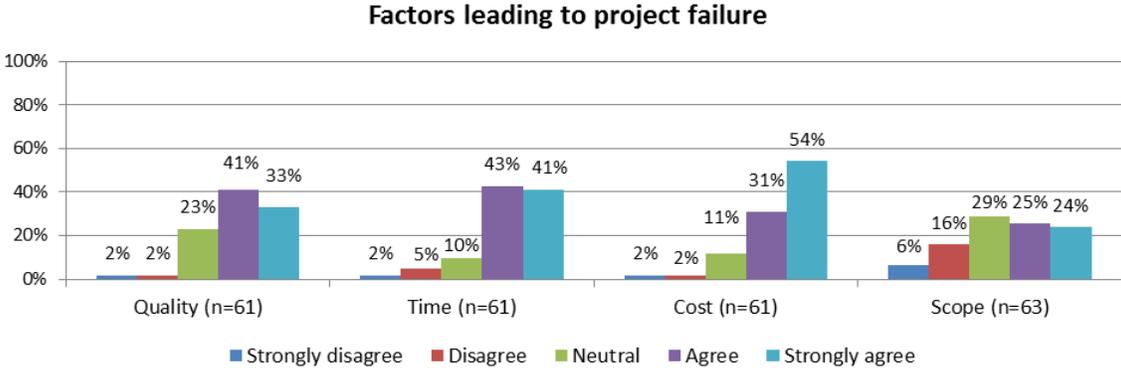


Figure 10: Factors leading to project failure

Respondents were asked about the influence of pressures imposed by clients on project failures. The vast majority of respondents (85%) agreed to some extent that unrealistic delivery times played a role in the failure of projects. Responses were more evenly distributed on complicated briefings by clients. Approximately 50% of respondents agreed to some extent that complicated briefings had an influence on project failure, while 36% was undecided on the issue. More than half of the respondents agreed to some extent that pressures imposed through political

² The sample size (n value) will differ within and among questions throughout this chapter, since not all respondents answered every question and sub-option within questions.

interest in blue chip projects contributed to project failure, while 27% was undecided on the issue, and only about 16% disagreed to some extent. Responses were mixed on pressures imposed by an increase in the number of organisations involved in projects. A third of respondents agreed that the latter issue contributed to project failure, while roughly a third was undecided on the issue. Only 10% of respondents strongly agreed, while 25% disagreed to some extent. The majority of respondents felt that the pressures imposed by a fixed budget (74%), as well as pressures imposed by red tape by treasury (70%) contributed to the failure of projects. Finally, the vast majority of respondents (78%) agreed to some extent that understaffing of technical personnel was a problem.

Figure 11 below indicates the distribution of responses to the influences of pressures imposed by clients on project failures.

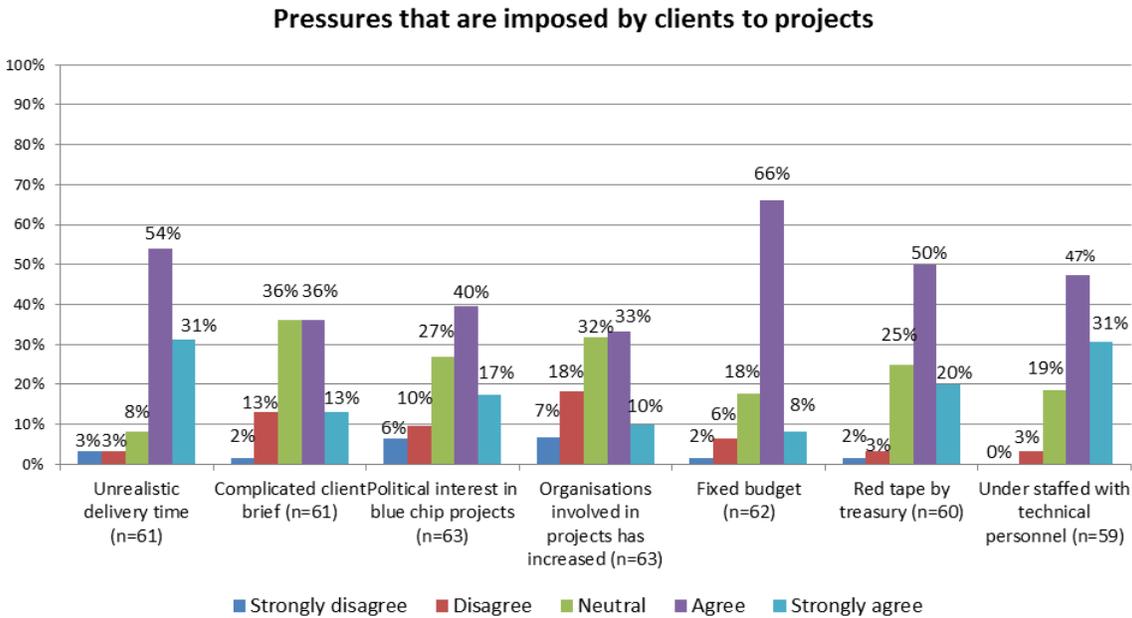


Figure 11: Pressures that are imposed by clients to projects

Respondents were also asked about the influence of challenges faced by quantity surveyors in performing their duties on the failure of projects. Of the respondents, 79% agreed to some extent that changes without revisions of drawings contributed to project failure, while 21% was undecided on the issue, and none disagreed.

More than two-thirds of respondents (67%) agreed to some extent that difficulty with keeping the expenditure within the allowed budget was a problem, while 26% was undecided on the issue, and only 7% disagreed. Only 2% of respondents disagreed that the issue of the final account exceeding the first estimate was a problem, with 74% agreeing to some extent that this contributed to project failure. Almost half of the sample (49%) agreed that no consultation with the project manager contributed to the failure of projects, although only 8% of respondents strongly agreed. Of the remaining respondents, 30% was undecided on the issue, while only 13% disagreed to some extent.

Figure 12 below indicates the distribution of responses for the influence of challenges faced by quantity surveyors on the failure of projects.

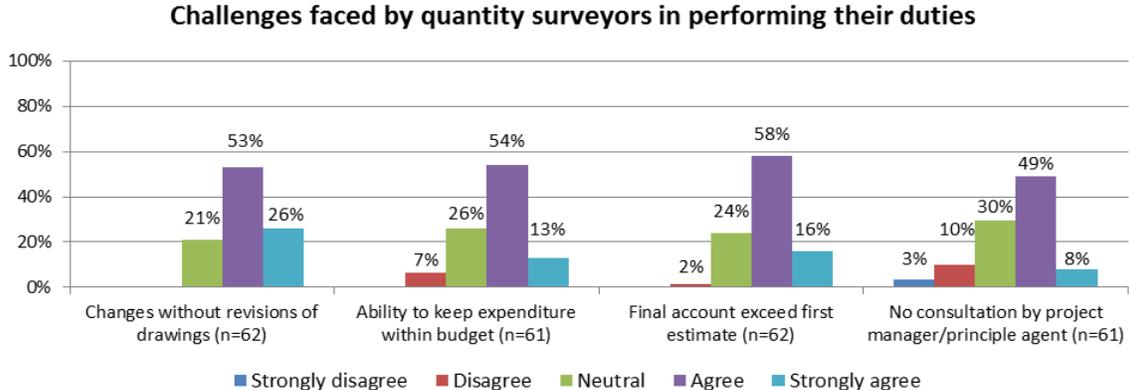


Figure 12: Challenges faced by quantity surveyors in performing their duties

12.7 Factors affecting accuracy of project estimates

As regards the important issues in project estimation, the majority of the sample either agreed (40%) or strongly agreed (42%) that measurements were very important. Similarly, the majority of the sample (92%) agreed to some extent that pricing was an important issue in project estimating, with none of the respondents disagreeing. The same trend could be seen for the importance of information, with nearly all respondents (97%) either agreeing or strongly agreeing on the importance of this issue. Only five respondents responded to the category ‘other’.

Of these, four either agreed or strongly agreed that other factors were important in project estimations, while one was undecided on the issue.

Figure 13 below indicates the distribution of responses for important issues in project estimating.

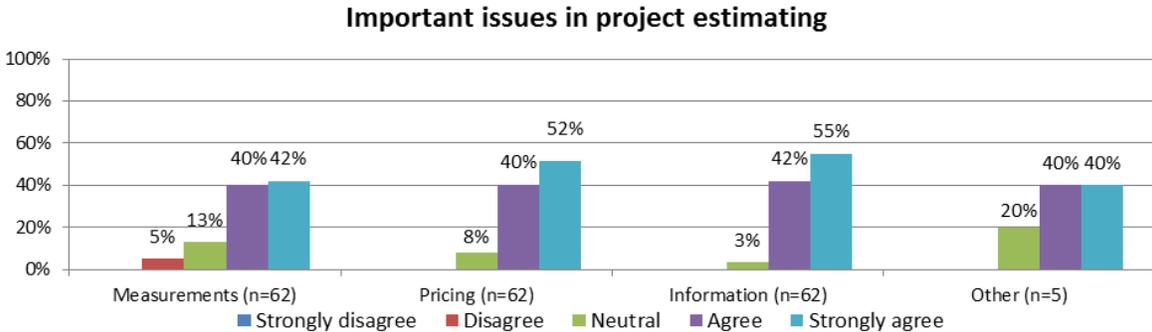


Figure 13: Important issues in project estimation

Concerning the percentage that the project estimate deviated from the tender amount, more than half of respondents (57%) agreed or strongly agreed that, according to experience, the project estimates were often less than 5% lower than the tender amount, whereas only 42% agreed to some extent that the project estimates were often less than 10% lower. Only a quarter of respondents (25%) indicated that, according to experience, the project estimates were often less than 15% lower than the tender amounts. More than two-thirds of respondents (68%) indicated that the project estimates were often 5% higher than the tender amount, whereas approximately half of the respondents (52%) agreed that the project estimates were often 10% higher than the tender amount. Only 28% of respondents agreed that the project estimates were often 15% higher than the tender amount. Only six of the respondents responded to the category 'other', with two of them disagreeing that the project estimate deviated from the tender amount by a percentage other than those provided in the survey. Two respondents were neutral on the subject, while the other two agreed that the project estimate deviated from the tender amount by other percentages than those provided.

Figure 14 below indicates the distribution of responses for the closeness of the project estimates to the tender amounts.

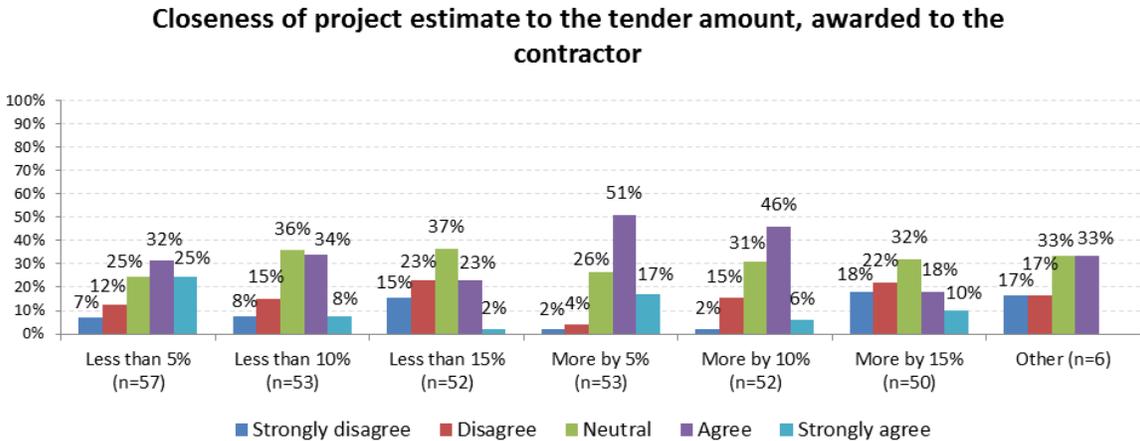


Figure 14: Closeness of project estimate to the tender amount, awarded to the contractor

As regards programs that are preferred most by quantity surveyors to prepare bills of quantities, the highest percentage of respondents (90%) agreed to some extent that WinQS was the most preferred program. This was followed by Excel, with 55% of respondents agreeing to some extent that this was the program they preferred to use. Respondents were mostly uncertain or disagreed to some extent that QS-Plus and CCS were programs preferred by quantity surveyors to prepare bills of quantities (with only 28% and 38% of respondents respectively agreeing to some extent that these are useful programs). Only two respondents responded to the category ‘other’, with one respondent strongly disagreeing that programs other than the ones mentioned in the survey were most preferred by quantity surveyors, and the other respondent being undecided on the issue

The next item in the survey dealt with the manner in which bills of quantities are mostly issued to tenderers. The majority of respondents agreed to a large extent (91%) that hard copies are mostly used to issue bills of quantities, while only 41% of respondents agreed to some extent that soft copies are used. Only one respondent responded to the category ‘other’, and indicated that he was uncertain whether something other than hard or soft copies were used to issue bills of quantities to tenderers.

Table 24 below indicates the distribution of responses for the manner in which bills of quantities are mostly issued to tenderers.

Table 24: Bills of quantities are mostly issued to tenderers in the following manner

	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
	n	%	n	%	n	%	n	%	n	%
Hard Copy (n=63)	0	0%	1	2%	5	8%	15	24%	42	67%
Soft Copy (n=59)	7	12%	10	17%	18	31%	14	24%	10	17%
Other (n=1)	0	0%	0	0%	0	100%	0	0%	0	0%

As far as estimating methods used by cost planners to yield project success are concerned, 30% of respondents were undecided on whether area method was an estimating method used by cost planners, while 36% of respondents agreed that this was a method used by cost planners. Similarly, a large percentage of the sample (42%) was also undecided on whether the storey enclosure method was a method used by cost planners to yield project success. In contrast, the vast majority of the sample (84%) agreed to some extent that elemental estimate was a method used by cost planners to yield project success. For the method ‘rough quantities’, a considerable percentage of the sample (25%) were undecided on whether this was a method used, while more than half of the sample (57%) agreed to some extent that this was a method used. Only four respondents responded to the category ‘other’. Of these, three respondents agreed to some extent that other methods were important, while one respondent was undecided on the issue.

Table 25 below indicates the distribution of scores for estimating methods used by cost planners to yield project success.

Table 25: Estimating methods used by cost planners to yield project success

	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
	n	%	n	%	n	%	n	%	n	%
Area method (n=56)	5	9%	9	16%	17	30%	20	36%	5	9%
Storey enclosure method (n=55)	13	24%	6	11%	23	42%	13	24%	0	0%
Elemental estimate (n=62)	2	3%	2	3%	6	10%	28	45%	24	39%
Rough quantities (n=56)	4	7%	6	11%	14	25%	22	39%	10	18%
Other (n=4)	0	0%	0	0%	1	25%	1	25%	2	50%

Concerning the question on whether experience plays a role in the accuracy of the estimate, the vast majority of the sample (94%) felt that experience did play a role.

As regards recommendations on how estimates can be improved, the vast majority of the sample agreed to some extent that the ability to check for errors (87%), the recognition of inflation factors (82%) and getting experienced staff to do estimates (94%), would lead to an improvement of estimates. The recommendation of pricing risk separately met with a somewhat greater uncertainty, with roughly a third of the sample undecided on the issue. Only three respondents responded to the category 'other', with two out of the three either agreeing or strongly agreeing that other factors played a role, and one respondent being undecided on the issue.

Figure 15 below indicates the distribution of responses for recommendations on how estimates can be improved.

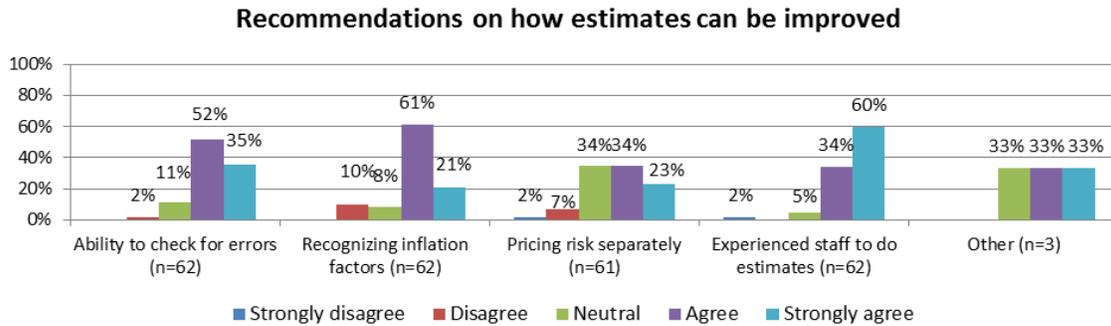


Figure 15: Recommendations on how estimates can be improved

The next question concerned the ideal profile of an estimator. In this regard, the majority of the sample agreed to some extent that an estimator needs to be able to work under pressure (83%), and should also be interested in prices and financial viabilities (84%). About a quarter of the sample (26%) was unsure about whether the ideal estimator should be inquisitive about market conditions, while most of the remainder of the sample (73%) felt that this was an important attribute of the ideal estimator. Nearly all respondents agreed to some extent that a good level of accuracy was important (97%) and that the ideal estimator should be able to pay attention to detail (93%). The majority of the sample (77%) also agreed to some extent that the ideal estimator should be a contemporary to construction developments. Only two of the respondents responded to the category 'other'. Only one of these, however, strongly agreed that other attributes were important, while the other one was undecided on the issue.

Figure 16 below provides the distribution of responses for the ideal profile of an estimator.

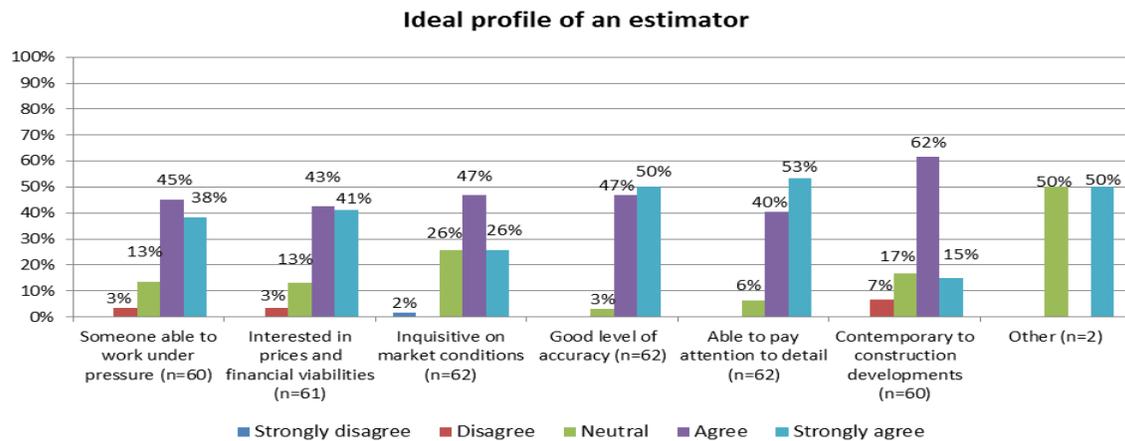


Figure 16: Ideal profile of an estimator

The next question entailed factors that have an influence on the accuracy of the estimate, in particular, factors that related to consultants and design parameters. In this regard, all of the respondents (100%) agreed to some extent that the experience and skill level of the estimator was important. The majority of respondents felt that the project team's experience in the construction type (84%), the designer's experience level (77%), the project team's capability to control the project (83%), and the use of checklists to ensure completeness (77%) influenced the accuracy of the estimate. Responses were more varied on the importance of the number of estimating team members. More than a third of the sample (39%) agreed to some extent that this was an important factor, while 27% were undecided on the issue, and 34% disagreed to some extent. Approximately two-thirds of respondents felt that the availability of all consultants of specialisation in the project team (67%), the use of a database of bids on similar projects (67%), and the time allowed for preparing the cost estimate (67%), had an important influence on the accuracy of the estimates. Concerning the level of involvement of the project manager, nearly a third of respondents (32%) was undecided on the issue. The vast majority of respondents (91%), felt that quality of information and information flow requirements, the completeness of cost information (95%), the accuracy of reliability of cost information (98%), the procedure for updating cost information (88%), and the quality of the assumptions used in preparing the

estimate (84%), were important factors influencing the accuracy of the estimate. None of the respondents disagreed that the estimating method used would influence the accuracy of the estimate. Responses were varied on the effect of the volume of the estimator's workload during estimating, with 32% of respondents undecided on the issue, and 59% agreeing to some extent. Again, the vast majority of the sample (90%), felt that the completeness of project documents, clear and detailed drawings and specifications (95%), and the level of communication with the client and other design team consultants (90%), had an important influence on the accuracy of the estimate. None of the respondents disagreed that the buildability of the design would influence the accuracy of the estimate, while 74% either agreed or strongly agreed, and 26% was undecided on the issue. Only two respondents responded to the category 'other'. One of them strongly agreed that factors other than those mentioned in the survey were important, while the other one was undecided on the issue.

Table 26 below indicates the distribution of responses for factors that have an influence on the accuracy of the estimate (related to consultants and design parameters).

Table 26: Factors that have an influence on the accuracy of the estimate (related to consultants and design parameters)

	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
	n	%	n	%	n	%	n	%	N	%
Experience and skill level of estimator (n=57)	0	0%	0	0%	0	0%	26	46%	31	54%
Project team's experience in construction type (n=57)	0	0%	1	2%	8	14%	27	47%	21	37%
Designer's experience level (n=57)	0	0%	2	4%	11	19%	29	51%	15	26%
Number of estimating team members (n=56)	10	18%	9	16%	15	27%	17	30%	5	9%
Availability of consultants of specialisation (n=58)	0	0%	5	9%	14	24%	25	43%	14	24%
Project team's capability to control project (n=57)	0	0%	3	5%	7	12%	29	51%	18	32%
Level of involvement of project manager(n=57)	2	4%	5	9%	18	32%	21	37%	11	19%
Quality of information and information flow requirements (n=57)	0	0%	0	0%	5	9%	23	40%	29	51%
Data base of bids on similar projects (n=56)	0	0%	6	11%	13	23%	30	54%	7	13%
Completeness of cost information (n=57)	0	0%	1	2%	2	4%	30	53%	24	42%
Accuracy of reliability of cost information (n=57)	0	0%	0	0%	1	2%	33	58%	23	40%
Procedure for updating cost information (n=57)	0	0%	1	2%	6	11%	36	63%	14	25%
Utilisation of checklists for completeness (n=57)	0	0%	1	2%	12	21%	32	56%	12	21%
Quality of assumptions in preparing estimates (n=57)	0	0%	1	2%	8	14%	29	51%	19	33%
Estimating method used (n=57)	0	0%	0	0%	10	18%	26	46%	21	37%
Volume of estimator's workload during estimating (n=56)	3	5%	2	4%	18	32%	20	36%	13	23%
Time allowed for preparing cost estimate (n=57)	2	4%	3	5%	14	25%	22	39%	16	28%
Completeness of project documents (n=57)	0	0%	0	0%	6	11%	22	39%	29	51%
Clear and detailed drawings and specifications (n=57)	0	0%	0	0%	3	5%	22	39%	32	56%
Buildability of design (n=57)	0	0%	0	0%	15	26%	25	44%	17	30%
Level of communication between client and team (n=57)	1	2%	0	0%	5	9%	29	51%	22	39%
Other (n=2)	0	0%	0	0%	1	50%	0	0%	1	50%

The final question on factors influencing the accuracy of project estimates dealt with factors related to project characteristics that influenced the accuracy of the estimate. Responses were varied on the influence of the type of project, as well as the influence of the project schedule, with only slightly more than half (56% and 57% respectively) of respondents agreeing to some extent that the type of project would have an influence on the accuracy of the estimate. Approximately two-thirds of the sample agreed to some extent that the type of structures (65%), site constraints (69%) and the method of construction techniques (67%) would influence the accuracy of the estimate. Responses were varied on the influence of project size, with 63% of respondents feeling that project size influenced the accuracy of the estimate, while 18% was undecided on the issue. Responses were mostly distributed evenly for the influence of project duration, as well as for the influence of the location of the project. In contrast, the majority of respondents felt that site conditions (topography, etc.) (70%) and project complexity (83%) would influence the accuracy of estimations. Only one respondent responded to the category 'other', and this respondent felt uncertain about the possible influence of other factors.

Table 27 below indicates the distribution of responses for factors influencing the accuracy of the estimate, related to project characteristics.

Table 27: Factors influencing the accuracy of the estimate (based on project characteristics)

	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
	n	%	n	%	n	%	n	%	n	%
Type of project (n=57)	8	14%	5	9%	12	21%	24	42%	8	14%
Type of structures (n=57)	6	11%	8	14%	6	11%	27	47%	10	18%
Project size (n=56)	4	7%	7	13%	10	18%	25	45%	10	18%
Project duration (n=57)	5	9%	9	16%	14	25%	20	35%	9	16%
Location of project (n=57)	4	7%	11	19%	11	19%	18	32%	13	23%
Site condition (n=57)	4	7%	4	7%	9	16%	27	47%	13	23%
Site constraint (n=57)	2	4%	7	12%	9	16%	26	46%	13	23%
Project complexity (n=57)	1	2%	2	4%	7	12%	26	46%	21	37%
Method of construction techniques (n=57)	1	2%	4	7%	14	25%	25	44%	13	23%
Impact of project schedule (n=57)	2	4%	3	5%	20	35%	26	46%	6	11%
Other (n=1)	0	0%	0	0%	1	100%	0	0%	0	0%

12.8 Allocation of contingencies in project estimates

As regards the approach used to allocate contingency for project risk during estimating, the highest percentage of respondents (74%) agreed to some extent that they used building contract contingencies to allocate contingency for project risk. Furthermore, two-thirds of respondents (66%) agreed to some extent that they used price and detail development contingencies, while 26% of respondents were undecided on the issue. No respondents responded to the category 'other'.

Table 28 below indicates the distribution of responses for the approach used to allocate contingency for project risk during estimating.

Table 28: What approach do you use to allocate contingency for project risk during estimating?

	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
	n	%	n	%	n	%	n	%	n	%
Price and detail development contingencies (n=61)	4	7%	1	2%	16	26%	31	51%	9	15%
Building contract contingencies (n=63)	2	3%	5	8%	9	14%	38	60%	9	14%

The next question in this regard relates to factors to take into account for contingency allowance. More than 90% of respondents agreed to some extent that insufficient information (92%) and lack of detail from drawings (95%) should be taken into account for contingency allowance. In addition, approximately 80% of respondents also felt that client risk items and budgetary items should be taken into account. Only three of the respondents responded to the category 'other'. Of these, two respondents were undecided on whether other factors should be taken into account, while one respondent agreed that other factors should be taken into account.

Figure 17 below provides the distribution of responses for factors to take into account for contingency allowance.

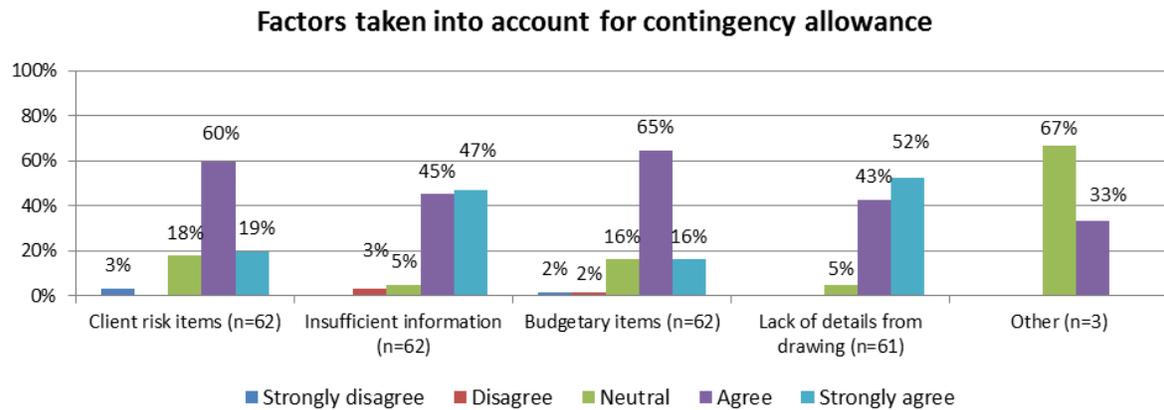


Figure 17: Factors taken into account for contingency allowance

The next item related to the percentages used in allocating contingencies to project estimates. The majority of the sample indicated that they used either 10% of the estimated amount (73% agreed to some extent), or 5% of the estimated amount (60% agreed to some extent). Only 12% of respondents agreed to some extent that they used 2.5% of the estimated amount. Only six respondents responded to the category 'other', of which five agreed to some extent that they used other percentages than those mentioned in the survey, and one was undecided on the issue.

Figure 18 below indicates the distribution of responses for percentages used in allocating contingencies to project estimates.

Contingencies to project estimates

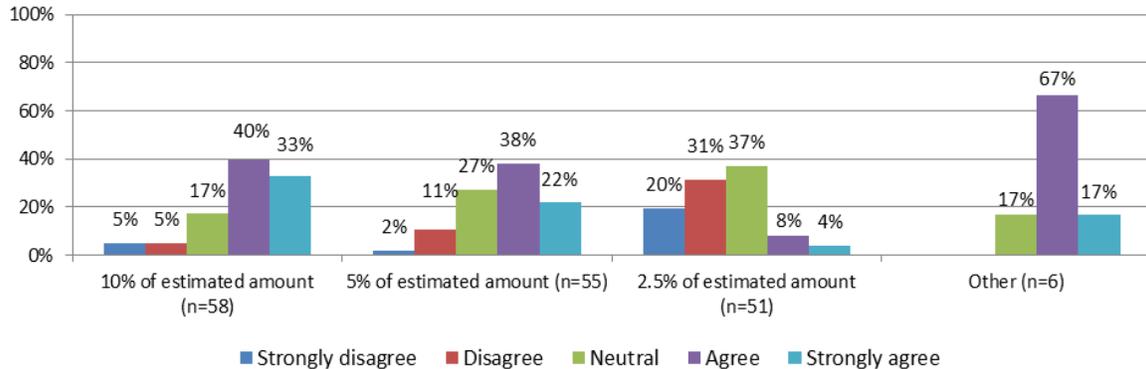


Figure 18: Contingencies to project estimates

12.9 Factors influencing the performance of contractors

Concerning factors that contribute to poor performance by contractors in respect of cost and time, the highest percentage of participants (95%) agreed to some extent that lack of good planning was an important factor, followed by bad construction management (with 90% of participants agreeing to some extent). In addition to these two factors, more than 80% of participants felt that insufficient control on sites (88%), shortage of educated and skilled labourers (81%), and unrealistic programmes (84%) contributed to poor performance. The majority of participants, but a smaller percentage, agreed to some extent that incompetent construction project managers (79%) and miscommunication (72%) contributed to poor performance. Approximately two-thirds of respondents felt that tight profit margins (68%) and the working load of contractors (69%) were important factors. It seems that natural causes and constructability of designs were viewed as having a low impact on the performance of contractors, with only 31% and 48% of respondents respectively agreeing to some extent that these factors contribute to poor performance.

Table 29 below indicates the distribution of responses for factors that contribute to poor performance of contractors in respect of cost and time.

Table 29: Factors that contribute to poor performance by contractors in respect of cost and time

	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
	n	%	n	%	n	%	n	%	n	%
Incompetent construction project managers (n=62)	4	6%	1	2%	8	13%	27	44%	22	35%
Bad construction management (n=62)	0	0%	2	3%	4	6%	30	48%	26	42%
Insufficient control on site (n=62)	0	0%	2	3%	5	8%	30	48%	25	40%
Lack good planning (n=62)	0	0%	1	2%	2	3%	23	37%	36	58%
Miscommunication (n=62)	0	0%	2	3%	15	24%	23	37%	22	35%
Shortage of educated and skilled labourers (n=62)	0	0%	1	2%	11	18%	31	50%	19	31%
Unrealistic programmes (n=62)	1	2%	1	2%	8	13%	31	50%	21	34%
Tight profit margins (n=62)	2	3%	2	3%	16	26%	27	44%	15	24%
Working load of contractors (n=62)	2	3%	1	2%	16	26%	30	48%	13	21%
Natural causes (n=62)	7	11%	15	24%	21	34%	16	26%	3	5%
Constructability of designs (n=59)	1	2%	9	15%	21	36%	18	31%	10	17%

12.10 Factors contributing to cost overruns of projects

The first item in the survey in this regard asked whether clients understood the term 'cost overrun' in a project. The majority of respondents (60%) indicated that clients do understand the terms 'cost overrun' in a project.

The next item asked whether clients understood the role of the quantity surveyor in a project. The majority of respondents (84%) felt that clients did understand the role of the quantity surveyor in a project.

As regards critical factors that contribute to cost overruns, the highest percentage of respondents (90%) agreed to some extent that incomplete design at time of tender contributed to cost overruns. Change in scope of work on site, as well as completeness of design and specifications during compilation of bills of quantities seem to be important factors, with 89% and 85% of respondents respectively agreeing to some extent that these are critical factors contributing to cost overruns. Respondents were somewhat more undecided on the impact of unexpected unmeasured conditions on site, lack of cost planning and monitoring of funds, delays in costing variation and additional works on cost overruns of projects (with 76%, 72%, and 71% of respondents respectively agreeing to some extent, and more than 15% of respondents in each case indicating uncertainty). However, the factor that respondents were most uncertain of regarding its influence on cost overruns was the provisional bills of quantities, with 27% of respondents indicating that they were undecided on the issue, and only 66% of respondents agreeing to some extent that this is an important factor. Only one respondent responded to the category 'other', and indicated that he was undecided on whether other factors than those mentioned above were of critical importance in contributing to cost overruns.

Figure 19 below indicates the distribution of responses regarding critical factors contributing to cost overruns.

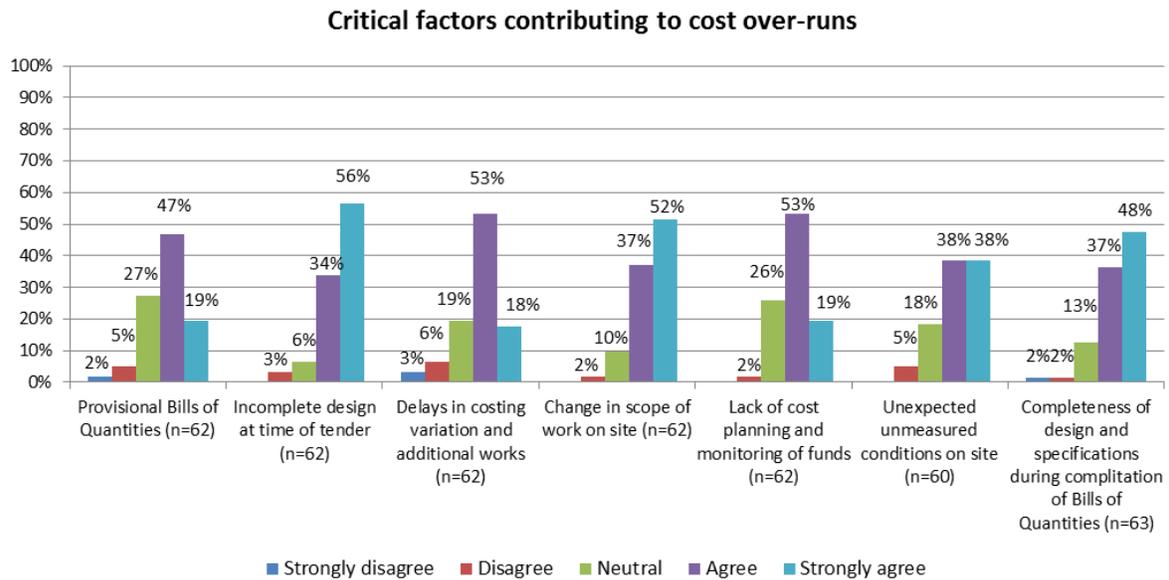


Figure 19: Critical factors contributing to cost overruns

Concerning moderate critical factors contributing to cost overruns, the highest percentage of respondents (82%) agreed to some extent that a delay in issuing information to the contractor during the construction stage was a moderately important factor. More than 70% of respondents also agreed to some extent that lack of timeous cost reports during the construction stage contributed to cost overruns. Respondents were more uncertain on the influence of ignoring items with abnormal rates during tender evaluation, and good and effective communication among parties. Approximately a quarter of respondents indicated uncertainty about the influence of each of these factors (21% and 25% respectively), and about two-thirds of respondents agreed to some extent that these factors are moderately important (69% and 65% respectively). Respondents did not feel that the requirement to have a minimum CIDB rating was a moderately important factor contributing to cost overruns, with the majority (69%) indicating that they either disagreed that this was an important factor or were undecided on the issue. Only 31% of respondents agreed to some extent that this was a moderately important contributing factor. Only one respondent responded to the category 'other', and

agreed that other factors than those mentioned above were moderately important contributors to cost overruns.

Figure 20 below indicates the distribution of responses to moderately critical factors contributing to cost overruns.

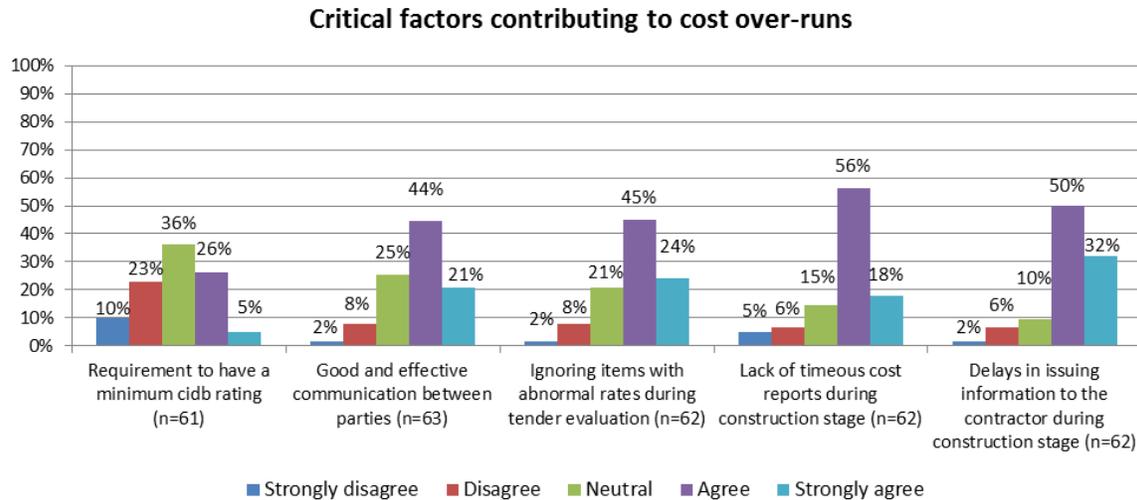


Figure 20: Moderately critical factors contributing to cost overruns

As far as less critical factors contributing to cost overruns are concerned, more than half of respondents agreed to some extent that clarity of drawings and documentation (60%), as well as re-measurement/adjustment of provisional sums (51%), were less critical factors contributing to cost overruns. Approximately a quarter of the sample (26%) disagreed that omission and errors in the bills of quantities was a less critical factor, while 48% agreed to some extent that this was a less critical factor. There was a high level of uncertainty on whether adjustment of prime cost and distribution of state budget (financial year) were less critical factors contributing to cost overruns (with 35% and 39% of respondents respectively being undecided on the issue). Only one respondent responded to the category 'other', and indicated that he was undecided on whether other factors could be seen as less critical factors contributing to cost overruns.

Table 30 below indicates the distribution of responses for less critical factors contributing to cost overruns.

Table 30: Less critical factors contributing to cost overruns are?

	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
	n	%	n	%	n	%	n	%	n	%
Omission and errors in Bills of Quantities (n=62)	4	6%	16	26%	12	19%	22	35%	8	13%
Clarity of drawings and documentation (n=62)	6	10%	9	15%	10	16%	27	44%	10	16%
Adjustment of prime cost (n=62)	2	3%	11	18%	22	35%	22	35%	5	8%
Re-measurement of provisional sums (n=63)	5	8%	11	17%	15	24%	24	38%	8	13%
Distribution of site budget (n=61)	6	10%	8	13%	24	39%	15	25%	8	13%
Other (n=1)	0	0%	0	0%	1	100%	0	0%	0	0%

12.11 Factors that may improve procurement policies

Concerning procurement success guidelines for the delivery of projects, nearly all respondents agreed to some extent that being sufficiently skilled and resourced to deliver the project successfully (97%) and having sufficient time allowed for the design estimating stage (96%), are important guidelines. In addition, the majority of respondents agreed to some extent that the project team having been selected on the basis of their competence (94%), and their being responsible and accountable for their services (89%), are important guidelines for successful project delivery. None of the respondents disagreed that a reasonable design and construction program was an important guideline for success, with 87% agreeing to some extent, and the remaining 13% being undecided on the issue. Similarly, none of the respondents disagreed that effective communication with stakeholders was an important guideline for success, with 81% of respondents agreeing to some extent,

and the remaining 19% being undecided on the issue. For the guidelines ‘careful selection of materials’, and ‘careful selection of a procurement method’, a high number of respondents were undecided on whether these were procurement success guidelines (25% and 23% respectively), with the remaining respondents mostly agreeing or strongly agreeing that these were indeed success guidelines (65% and 76% respectively). Only three respondents responded to the category ‘other’. All three either agreed or strongly agreed that factors other than those mentioned in the survey were important procurement success guidelines.

Figure 21 below indicates the distribution of responses for procurement success guidelines for the delivery of projects.

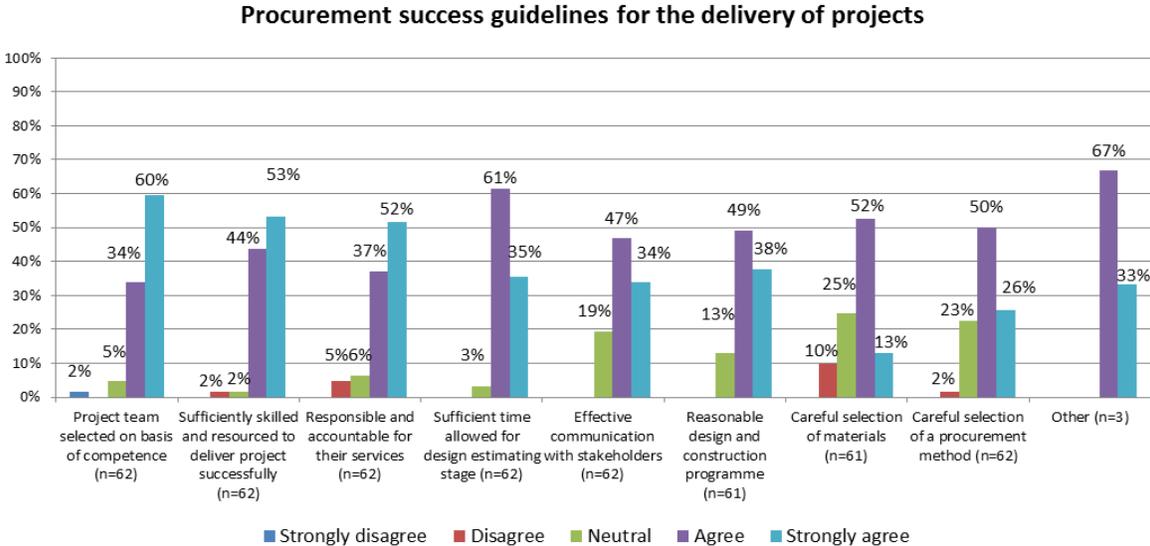


Figure 21: Procurement success guidelines for the delivery of projects

The next item in the survey referred to factors that may improve procurement policies related to the criteria that should be used to eliminate cost overruns and irregularities in the award of tenders. The highest percentage of respondents (94%) agreed to some extent that tenderers must confirm to the essential requirements of the notice or tender documentation. This was followed by 83% of respondents agreeing to some extent that obvious errors in the tender document should be corrected before adjudication of tenders can proceed.

A lower percentage, but still a majority (approximately three-quarters) of respondents agreed to some extent that the bid document must include evaluation and adjudication criteria (74%), and that a presentation must be made by the contractor on his company's capability to complete the work before the tender can be awarded (71%). A still lower percentage (approximately two-thirds) of respondents agreed to some extent that the procuring entity deciding not to award the contract if there is no responsive tenderer (67%), the verification of abnormally low tenders to ensure ability to perform (66%), and a presentation by the contractor on the project plan (65%), may eliminate cost overruns and irregularities in awarding tenders. Respondents showed a high level of uncertainty regarding the influence of the appointment of a validating agency to validate tender awards and appointments (31% was undecided on the issue), the presentation by a contractor on the cost plan for the duration of the project (26% was undecided on the issue), and the tenderers being allowed to make a presentation on how they will carry out the project (28% was undecided on the issue), on the elimination of overruns and irregularities. The majority of respondents did not feel that awarding the lowest evaluated tender in price based on prescribed criteria (only 18% of respondents agreed to some extent), or estimates being known to tenderers beforehand (only 15% of respondents agreed to some extent) would eliminate cost overruns and irregularities.

Table 31 below indicates the distribution of responses for criteria that may be used to eliminate cost overruns and irregularities in the award of tenders.

Table 31: Criteria that may be used to eliminate cost overruns and irregularities in the award of tenders

	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
	n	%	n	%	n	%	n	%	n	%
Lowest evaluated tender in price must be awarded (n=62)	15	24%	18	29%	18	29%	6	10%	5	8%
Bid document must include evaluated & adjudicated criteria (n=62)	2	3%	2	3%	12	19%	29	47%	17	27%
Abnormally low tenders verified to ensure ability to perform (n=62)	10	16%	5	8%	6	10%	18	29%	23	37%
Procuring entity may decide not to award contract if no responsive tender (n=63)	1	2%	2	3%	18	29%	18	29%	24	38%
Obvious errors in tender document should be corrected before adjudication of tenders can proceed (n=62)	1	2%	2	3%	7	11%	30	48%	22	35%
Tenders must confirm to essential requirements of notice or tender documentation (n=61)	1	2%	1	2%	2	3%	37	61%	20	33%
Estimates must be known to tenderers beforehand (n=61)	26	43%	16	26%	10	16%	6	10%	3	5%
Tenderers must be allowed to make a presentation on how they will carry out the project (n=61)	6	10%	5	8%	17	28%	24	39%	9	15%
Presentation by contractor or project plan (n=62)	3	5%	4	6%	15	24%	31	50%	9	15%
Presentation by contractor on cost plan for the duration of the project (n=62)	3	5%	6	10%	16	26%	28	45%	9	15%
Presentation by contractor on his company's capabilities to complete the work before award can be done (n=62)	1	2%	4	6%	13	21%	30	48%	14	23%
Appointment of validating agency to validation tender awards and appointment (n=62)	4	6%	5	8%	19	31%	20	32%	14	23%

12.12 Conclusion

In the empirical study a number of factors that contribute to construction project failures were examined, including quality, time, cost and scope, of which the majority of the respondents found cost to be the leading factor. Fixed budgets and unrealistic delivery times were noted as the greatest pressures imposed by clients on construction projects. There was an even spread of respondent opinions on the factors affecting accuracy of project estimates as well as the issues that are considered important in project estimating. Distribution methods of bills of quantities and the estimating methods used by cost planners in the planning of the financial aspects of these projects were also examined, as well as recommendations on how these estimates can be improved, and the respondent opinion on the ideal profile of a proficient estimator. Methods of assessing risk and contingency and factors in this consideration process had varying responses. The most critical factor in cost overruns was noted as incomplete design at the time of tender, but aspects around procurement and procurement processes had mixed responses.

PART 4: CHAPTER 13

SUMMARY OF STUDY, FINDINGS AND CONCLUSION

13.1 Introduction

The study comprises of four parts, of which Part 1, Chapter 1, presents the research proposal and introduction to the study. Part 2 contains the literature review and this section contains Chapters 2 to 9. Part 3 presents the empirical research and contains Chapter 10, the evaluation of a case study on school projects, and Chapter 11 evaluates the case study on procurement irregularities. Chapter 12 presents the empirical data. Part 4 presents the conclusion and consists of Chapter 13, the summary of the study, findings and conclusions. Chapter 14 presents the final conclusions and recommendations.

13.2 Summary of study

The main problem of the study is defined as follows:

Cost overruns and delays in project schedules are problems that are often experienced in construction projects. While there is no clear way of avoiding cost overruns, proper planning can decrease the chances of these overruns occurring and thereby contributing to project stability. As with risk, there is an element of probability in the occurrence of cost overruns. Delays in projects cause time overrun and these can affect not only current projects, but future projects as well as time constraints and adjusted deadlines impact their implementation. This is particularly true for large construction projects where there are various possibilities of risk based events occurring, including overruns.

In Chapter 2, a comprehensive overview is presented regarding the roles and functions of a construction client. Large projects are contracted out to third parties

who have the experience and expertise the client lacks, and with these contracts, both parties have a responsibility to ensure that goals and objectives of clients are clearly set out. The client's involvement is not limited to 'looking over the contractor's shoulder', but active participation in the processes of the running of the project, such as cost management and decision making, will assist in achieving project success. Therefore, Chapter 2 reviews the role of the client, the client's needs, and the involvement of the client in the cost management of the project. These reviews are vital mainly to illustrate the fundamental role clients can play in the success of construction projects.

In Chapter 3, the roles and competencies of the quantity surveyors are investigated. To fulfill his duties require certain competencies of a quantity surveyor, both from an ethical and a practical perspective. These competencies and general skill as a quantity surveyor, differs between age groups and proven experience in the profession. These skills include, but are not limited to, feasibility and viability appraisal of construction investments; drafting, compilation and documentation of construction contracts; preparation and subsequent analysis of construction contract bids, quotes or tenders; contractor selection advice and financial management of all construction works; and allied reporting, including auditing, cost planning, cost indexing etc. They are also very relevant in construction project management, value management, facilities management, management contracting, construction dispute resolution, research consultancy. Therefore, Chapter 3 deals with the roles of the quantity surveyors in the built environment, their competencies, and their leadership roles in the profession. This review is important, specifically when estimates are compared to contract sums, and the accuracy thereof.

In Chapter 4, accuracy of estimates is reviewed, mainly because estimation is one of the key skills of the quantity surveyor as it is at the heart of the initial financial planning phase of the construction project. Various techniques are used to gauge the approximate values in construction projects of various sizes. Accuracy in cost

forecasting is a sensitive issue as the accuracy of an estimate relies on a number of factors, including the experience of the quantity surveyor. This on-going process may yield different values at different stages of the project, and these aspects need to be kept in mind by both clients and contractors, especially those involved in high-risk construction projects where internal and external factors contribute to uncertainty in cost structures. Therefore, in Chapter 4, the techniques used to estimate cost and the skills and necessity of estimators in construction projects, as well as the role played by risk in the estimation process, are evaluated.

In Chapter 5, risk management tools are examined for the accurate contingency allocation. Chapter 5 reviews the risk management process when considering and managing risks associated with a construction project and using this risk information to plan for contingencies and outcomes that may have an undesirable effect on the work flow of the project life cycle.

In Chapter 6 the allowance for contingencies is reviewed. This review is done mainly as a result of the fact that there are a number of methods used to calculate contingency for risks in construction project environments. If these contingencies are unplanned for and risk associated events occur, it may lead to cost overruns, which in turn may damage the project life cycle. Accurate estimating for project cost contingency, especially in the early phases of the project lifecycle, is crucial, as these estimates will be used as a cost baseline for the duration of the project. Therefore, in Chapter 6, the introduction to contingencies, traditional percentage, estimating contingency and client contingencies are reviewed.

In Chapter 7, cost overruns are examined. Cost overruns and delays in project schedules are problems often experienced in construction projects. While there is no clear way of avoiding cost overruns, proper planning can decrease the chances of these overruns occurring, thereby contributing to project stability. As with risk, there is an element of probability in the occurrence of cost overruns. Delays in projects cause time overrun and these can affect not only current projects, but

future projects as well, as time constraints and adjusted deadlines affect their implementation. Chapter 7 addresses factors causing cost overruns.

In Chapter 8, procurement processes are investigated. Unethical behaviour in the procurement process has detrimental effects on projects, especially construction projects with large financial values. Procurement practices, particularly those in public sector construction projects, need to be open and transparent and need to have policy measures in place to ensure that they are sufficiently scrutinised. Chapter 8 attempts to address the legislation that deals with procurement issues in South Africa.

In Chapter 9, management of construction projects is considered as this can influence the success of construction projects. This chapter sets out the significant aspects of managing a construction project, first by defining concepts and then closely examining the aspects that make up the process, particularly as regards its sustainability.

In Chapter 10, Case studies on comparison of schools projects in the Free State Province regarding estimates, contract sums and final accounts are reviewed. Recommendations are made in terms of the lessons learnt to enhance cost planning in future projects.

In Chapter 11, a second case study in procurement irregularities in South Africa is reviewed and recommendations are made in terms of lessons learnt to enhance the effective procurement system, which must not be prone to abuse by client members, and professional teams, including the contractors.

In Chapter 12, the empirical data are analysed to determine findings on the role that quantity surveyors must play in making project successful through accurate estimation, determining appropriate procurement methods, managing cost properly

and allocating appropriate contingency in their estimate, which will deal with the appropriate risk involved.

13.3 Findings

13.3.1 First hypothesis

The first hypothesis of the study is:

Adequate or sufficient provision for contingencies is a major pitfall to be considered during cost estimating.

Incomplete design at the time of tender ranked as the most influential factor leading to cost overruns of construction projects. The research supports this hypothesis in the sense that when project go out on tender with incomplete designs, it results in many variation orders being issued during the construction phase, eventually leading to cost overrun. Change in scope of work on site and delays in pricing of variation orders are ranked second. Completeness of design and specifications during compilation of bills of quantities is ranked third. It is important to note that the respondents have ranked most of the design-related aspects as most influential to cost overruns.

13.3.2 Second hypothesis

The second hypothesis of the study is:

Sound knowledge, experience and adequate consideration of market conditions can improve project cost estimates.

The data supports this hypothesis. Experience and information were ranked first by the majority of respondents. This indicated that if an experienced quantity surveyor compiles an estimate, the results should be within a 5% range.

The vast majority of the respondents ranked unrealistic delivery time second in terms of compiling estimates and bills of quantities. This results in the quantity surveyor's estimate being inaccurate because of a lack of information during this process, with little time to collect relevant information.

Fixed budget allocated to projects was ranked third, and this influenced designers and quantity surveyors to leave out many items just to get the project started. This means that the project team can bring these items back as variation orders at a later stage. This hypothesis is also best explained by the case study in Chapter 10.

13.3.3 Third hypothesis

The third hypothesis of the study is:

Major factors for successful projects are allowing adequate time in preparing initial cost estimate with good level of accuracy to minimise the risk of cost overruns.

The data supports this hypothesis. The majority of respondents indicated that a lack of details from drawings poses a bigger risk than project risk. Insufficient information was ranked second. Furthermore, respondents were of the opinion that client risk and budgetary items should be taken into account during the cost-planning process.

13.3.4 Fourth Hypothesis

The fourth hypothesis of the study is:

Contractors perform poorly because they take on too much work and plan badly.

The research supports this hypothesis as the experience and the skill level of the estimator were ranked as the most important tools to reduce errors in estimates. Project teams' experience in a specific project type was ranked second and the ability of an estimator to pay attention to detail was ranked third.

13.3.5 Fifth Hypothesis

The fifth hypothesis of the study is:

Selecting the correct procurement method is a major factor for a successful project.

The data supports this hypothesis as the respondents indicated that the experience of the estimator, the ability to check for errors, getting experienced staff to do the estimates and recognising inflation factors will reduce the risk of budget overruns. It was evident that the experience of the project team, the designer's experience in the construction type and their teams' capabilities to control the project were also viewed to be important in the successful management of the construction project.

13.4 Conclusion

Cost overruns and delays in projects are often experienced in construction projects. While there is no clear way of avoiding cost overruns, proper planning can reduce the chances of these occurring, thereby contributing to project stability.

In large projects, clients have experience or require the services of an experienced consultant to assist with project deliveries. This will assist the client in selecting a competent professional team, whereby design, estimates and management of the project will be done by experienced personnel, therefore reducing the threat of cost overruns through the whole project life cycle. A model is presented and suggested in a project success flow chart.

Chapter 14 presents the final conclusions and the interpretation of the model as suggested.

CHAPTER 14

PROPOSED PROJECT FLOW CHART MODEL

14.1 Introduction

In Chapter 14 four spiderweb models and a flowchart model in project estimate, management and procurement are proposed, which might benefit the construction industry and perhaps assist in minimizing cost overruns and project failure.

Methods of improving and managing cost plans, and allocating experienced estimators to complex projects, are illustrated.

The literature reviewed in Chapters 2 to 9, clearly stated that cost overrun is an inherent problem. It has been shown that accurate estimates, appropriate risk, and letting experienced staff do cost plans and manage projects, might yield positive results.

Four different types of models are proposed as a process flow chart for successful project delivery.

The first model is illustrated in Figure 22 (below) – “pitfalls to consider during estimating”. The model that has been developed, forms a spider web diagram, with percentages from 0 to 90. This diagram clearly shows that when a quantity surveyor starts with any estimating in any project, the biggest pitfall will be the complexity of the project. If the project is too complex, it is easy to make mistakes and an experienced estimator must do the estimate to avoid the risk of under/over-estimation. The model in Figure 22 suggests that after project complexity, building contract contingencies will follow as the second important aspect, followed by site conditions, methods of construction, type of structure, project size, impact of project schedule, type of project, location of project and lastly project duration.

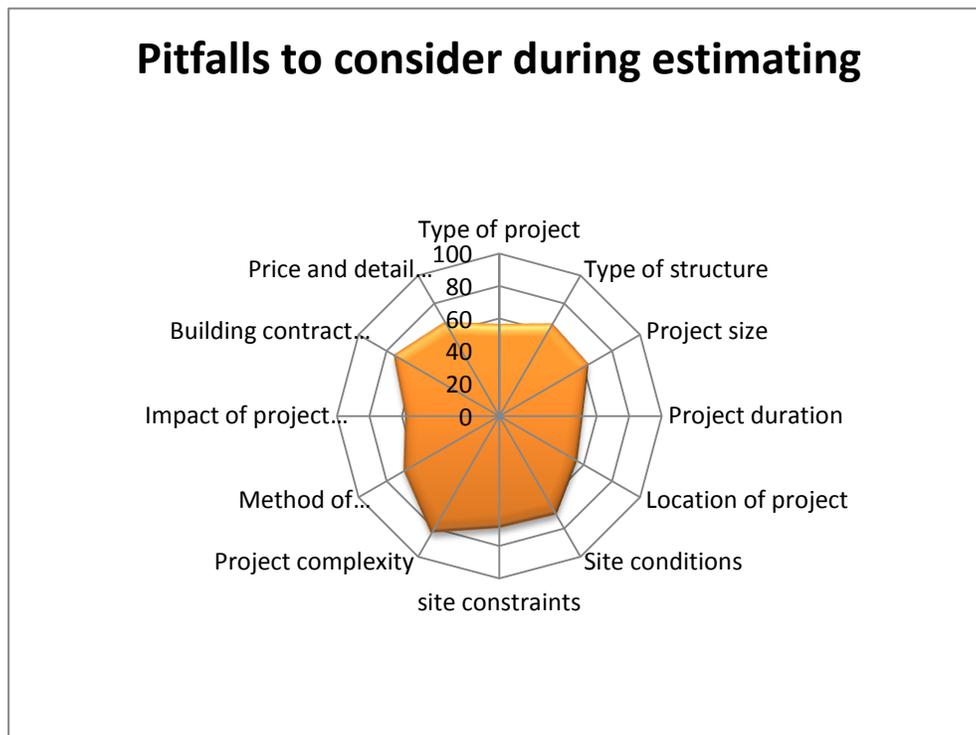


Figure 22: Pitfalls to consider during estimating

After one has identified all the relevant pitfalls, the second model is presented in Figure 23 (below) – “how estimates can be improved”. This spider web diagram emphasises the attitude of the estimator. It also reveals the profile of the estimator, and to minimize risk associated with estimate. A good level of accuracy by the estimator will improve the quality of the estimate and this will contribute to the success of the project. Secondly, an estimator must be capable of paying attention to detail, and anticipate what the designers will have as their final product. Thirdly, the estimator must be highly interested in prices and financial viabilities; this will help the estimator to cost the different elements accurately. The estimator must also be able to multi-task and work very well under pressure. Furthermore, the estimator must have a contemporary understanding of the construction development. Finally, the estimator must be inquisitive about market conditions, to assist in gaining knowledge of the market conditions.

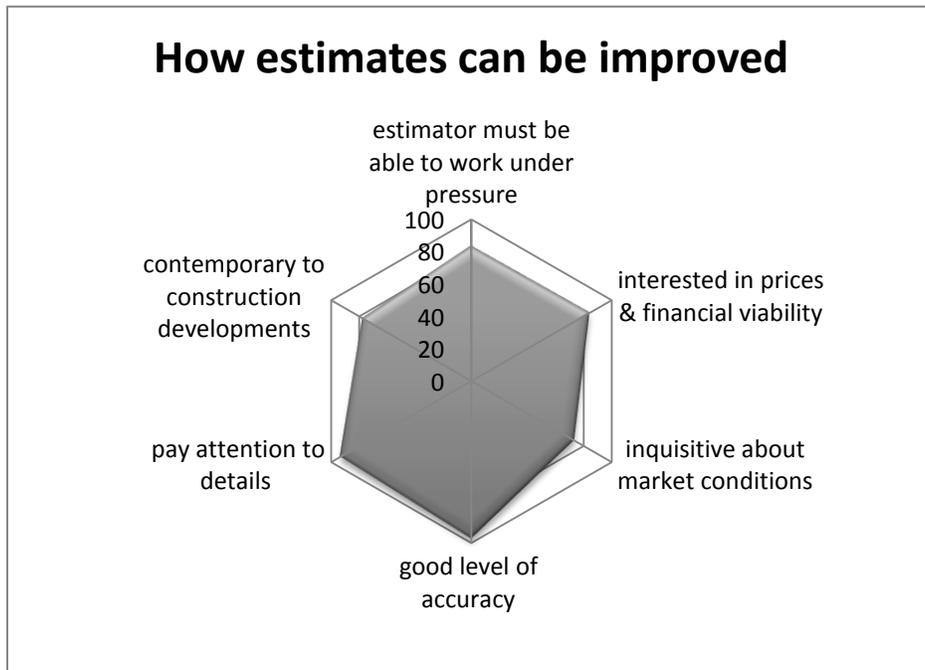


Figure 23: How estimates can be improved

Figure 24 (below) refers to the model on project success. The model in Figure 24 outlines the fundamental issues in project success. The two key issues in this model to take cognisance of, is the profile of the estimator, and the experience and skill that the estimator must have. Therefore, before any project can be estimated, it is important to have a look at the profile of the person who is going to estimate the project. The next step will be to check what sort of information is available. Then, once the estimator knows what information is available, the estimator can make an informed decision about what sort of contingency can be allocated to the project. Experience will play a role when pricing the estimate. When all this information is taken into account, an accurate estimate can be produced with minimal risk attached to it and keeping up to date with market conditions assists in making accurate estimates. The estimator must request more time when preparing estimates, especially on complex projects. A sound and accurate estimating method must be used to yield project success. Once the designers revise their designs, the estimator has to make revisions and indicate the revision number on

the estimate. Finally, if the estimate is well prepared and following the guidelines in this model (Figure 24), the estimate will correlate reasonably to the tender sum.

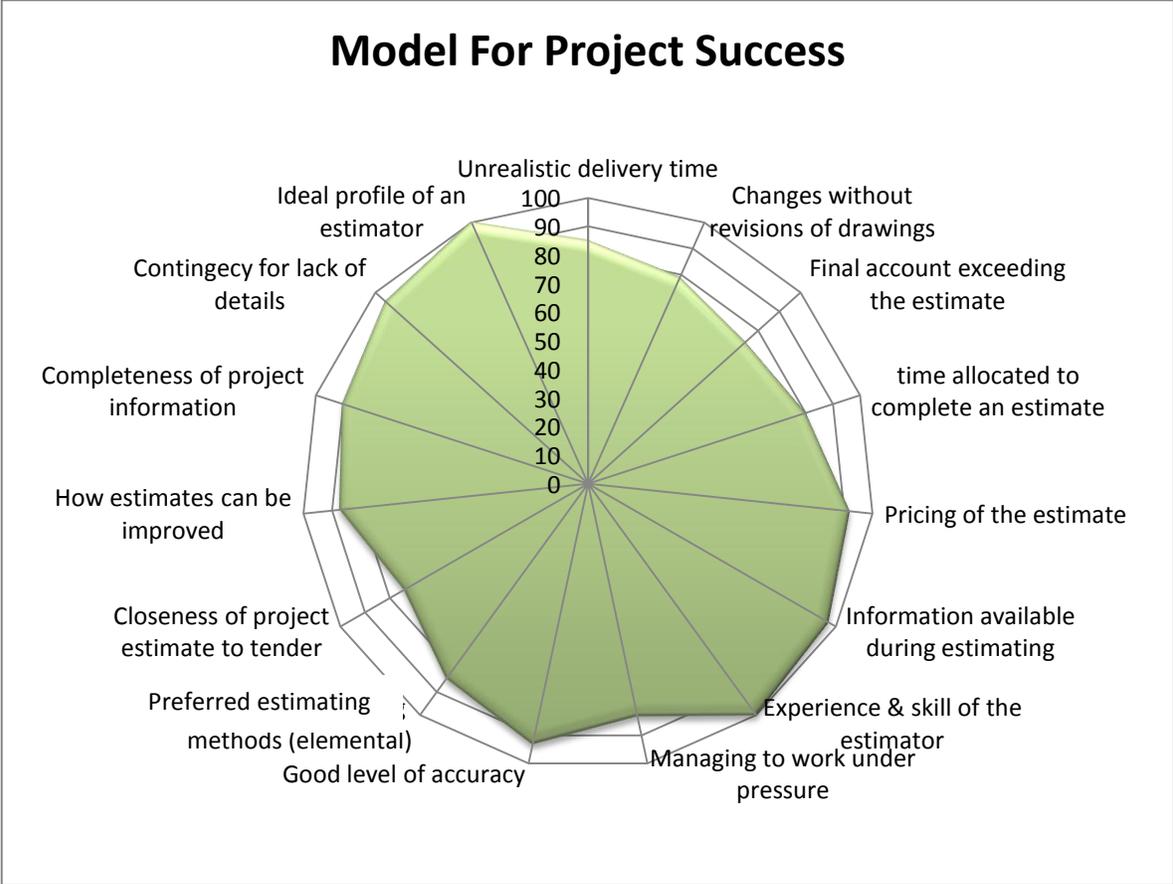


Figure 24: Model for Project Success

Figure 25 (below) – “Poor performance by contractors”, is caused by a lack of good planning, bad construction management, and insufficient control on site, unrealistic programme, and shortage of skilled labourers, incompetent construction project managers and miscommunication. If all these problems are dealt with, the contractors will perform much better and will achieve success in construction projects. The other factors, for example, work load, tight profit margins, constructabilities of designs and natural causes should not be ignored as they have an influence in project success.

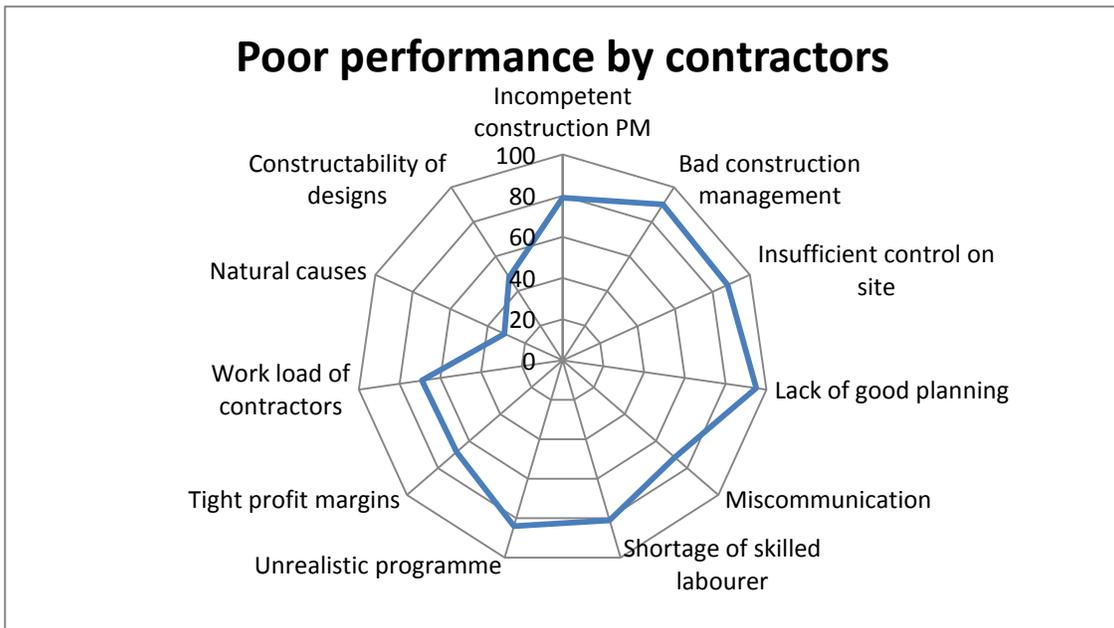


Figure 25: Poor performance by contractors

Figure 26 presents a model of procurement guidelines for project success. This model gives guidance to clients that, when a project team is selected, it must have the following qualities in the following order:

Sufficient skill to deliver the project; sufficient time allowed to design and estimate; the project team must be selected on competence; and it must be a responsible and accountable team. The construction and design programme must be reasonable, and there should be constant communication amongst stakeholders. Lastly, the procurement method must be selected carefully, the materials to be used should be investigated in advance and the availability, verified.

14.2 Recommendations for future research

The following questions emerged during the course of this study and are proposed as areas for future study.

- Can estimators undergo continual professional training on a regular basis, particularly on aspects such as contingency allocation and provisional sums?
- Should construction projects not include provisional sums in the bills of quantities rather than expected to have the information available before going out on tender?
- Can construction clients be actively involved in projects from the initiation, design, estimation and construction stages? All government departments should be expected to have a professional person in their service, and if not available, a private firm should be used for consultation purposes

14.3 Conclusion

- From literature review, it is evident that construction clients are becoming increasingly involved in projects that they procure. Against this background, a comprehensive look is needed at their roles and functions in the construction project life cycle.
- The role and responsibility of quantity surveyors also came on the spotlight particularly during initial estimating and during the adjudication of tenders. These were found to be areas where the competence of the quantity surveyor is tested, and where ethical conduct is key and experience play a fundamental role.
- It was also discovered through the case study that procurement irregularities occur in construction projects through actions by clients and contractors. Careful consideration is required when contractors are appointed through tendering processes and quantity surveyors have an obligation to their clients and their profession to identify these potential irregularities.
- The empirical study revealed that cost is the greatest thread of project failure. Thus, as a result of inaccurate estimating, unrealistic delivery times or lack of experience in the quantity surveying profession.

The estimator must be experienced to be able to accurately estimate, price and plug the gaps posed by incomplete designs, and still be able to achieve an accurate cost plan.

REFERENCE LIST

- AACE (American Association of Cost Engineers).(2000). AACE International's risk management dictionary. *Cost Engineering*, 42(4), pp. 28-31.
- AACE International .(2008). Risk analysis and contingency determination using range estimating. International recommended practice No.41R-08 TCM Framework: 7.6 – Risk Management.
- AACE International. (2007). *Cost engineering terminology, recommended practice. IOS-90*. [online].Available from: <<http://www.aacei.org>> [Accessed 10 June 2012].
- Abdou, O.A. (1996). Managing construction risks. *Journal of Architectural Engineering*, 2(1), pp. 3-10.
- Ahmad, I. (1992). Contingency allocation: a computer-aided approach, AACE Transactions, F.4.1-7.
- Ahmadpour, M. (2011). Investigation of Value Management Effects on Projects Briefing Process in National Iranian Gas Transmission Company “NIGTC”. Report and opinion 3(8) pp.3-9
- Ahmed, S., Azher, S., Castillo, M. and Kappagantula, P. (2002). Construction delays in Florida; an empirical study, Florida, 2002. [Available from: <<http://www.cm.fiu.edu/publication/Delays.pdf>>
- Ahmed, S.M. and Kangari, R. (1995). Analysis of Client Satisfaction Drivers in Construction Industry. *Journal of Management in Engineering*, ASCE, 11(2), 36-44.
- Ahuja, H., Dozzi, S. and Abou Rizk, S. (1994). *Project management techniques in planning and controlling construction projects*, 2nd edition. Hoboken, NJ: Wiley & Sons.
- Aibinu, A.A. and Jagboro, G.O. (2002). The effects of construction delays on project delivery in Nigerian construction industry. *International Journal of Project Management*, 20(8), pp. 593-599.

- Aibinu, A.A. and Pasco, T. (2008). The accuracy of pre-tender building cost estimates in Australia. *Construction Management and Economics*, 26(12), pp. 1257-1269.
- Akinsola, A.O. (1996). Neural network model for predicting building projects' contingency. In: Thorpe, A. (ed.). *ARCOM 96: 12th Annual Conference and Annual General Meeting*, 11- 13 September 1996. Leicestershire, England: ARCOM. pp. 507-516.
- Akinsola, A.O., Potts, K.F., Ndekugri, I. and Harris, F.C. (1997). Identification and evaluation of factors influencing variations on building projects. *International Journal of Project Management*, 15(4), 263-267.
- Akintoye, A. and Fitzgerald, E. (1999). A survey of current cost estimating practice in the UK. *Construction Management and Economics*, 18(2), pp. 161-172.
- Akintoye, A. and Skitmore, M. (1991a). Profitability of UK Construction Contractors. *Construction Management and Economics*, 9(4), pp. 311-325.
- Akintoye, A. (1998). Analysis of factors influencing project cost estimating practice. *Construction Management and Economics*, 18(1), pp. 77-89.
- Akintoye, A. S. and MacLeod, M. J. (1997). Risk analysis and management in construction. *International Journal of Project Management*, 15(1), pp. 31-38.
- Alaghbari, W., Kadir, M.R.A., Salim, A. and Ernawati. (2007). The significant factors causing delay of building construction projects in Malaysia. *Engineering, Construction and Architectural Management Journal*, 14(2), pp. 192-206.
- Albratt, R., Nel, D. and Higgs, N.S. (1992). An examination of the ethical beliefs of managers using selected scenarios in a cross-cultural environment. *Journal of Business Ethics*, 11(1), pp. 29-35.
- Alfred, O.O. (2007). Conflict of Interest within Construction Practitioners: Quantity Surveying, Case Study. *Surveying and Built Environment Vol. 18(1)*, 35-50.
- Ali, R. (2005). The application of risk management in infrastructure construction projects. *Cost Engineering*, 47(8), pp. 20-27.
- Alkass, S., Mazerolle, M. and Harris, F. (1996). Construction delay analysis techniques. *Construction Management and Economics*, 14, 375-394.

- Al-Khalil, M.I. and Al-Ghafly, M.A. (1999). "Important Causes of Delay in Public Utility Projects in Saudi Arabia" *Journal of Construction Management and Economics*, Vol. 17, 647-655.
- Al-Thunaiyan, S. (1996). *Cost estimation practices for buildings by A/E firms in the eastern province, Saudi Arabia*. Unpublished thesis (MSc) Construction Engineering and Management. Dhahran, Saudi Arabia: King Fahd University of Petroleum and Minerals.
- Al-Yami A. and Price, A.D.F. (2006). Assessing the feasibility of using value management to accelerate the implementation of sustainability. In: Amaratunga, D. et al. (eds). *Proceeding of the 6th International Postgraduate Research Conference in the Built and Research Institute for the Built and Human Environment, 6-7th April*. Salford: Research Institute for the Built and Human Environment. pp. 765-774.
- Ambrose, M. and Tucker, S.N. (2000). Procurement system evaluation for the construction industry. *Journal of Construction Procurement*, 6(2), pp.121-134.
- Ameh, O.J., Soyngbe, A.A. and Odusami, K.T. (2010). Significant factors causing cost overruns in telecommunication projects in Nigeria. *Journal of Construction in Developing Countries*, 15(2), pp. 49-67.
- American Public Transit Association. (1990). Off track: Response of the American Public Transit Association to the UMTA report "Urban rail transit projects: Forecast versus actual ridership and costs." Washington, DC: Author.
- Andawei, M.M. (2002). Motivation: an alternative to improve workers' performance in today's construction industry. *The Quantity Surveyor*, 40(3), pp. 2-6.
- ANC (African National Congress). (1994). *The Reconstruction and Development Programme*. Johannesburg: Umanyano Publications.
- Andi, A. and Minato, T. (2003). Representing casual mechanism of defective designs: a system approach considering human errors. *Journal of Construction Management and Economics*, 21(3), pp. 297-305.
- Andi, A. (2004). Appropriate allocation of contingency using risk analysis methodology. *Civil Engineering Dimension*, 6(1), pp. 40-48.

- Angelo, W.J. and Reina, P. (2002). Megaprojects need more study up front to avoid cost overruns. *Engineering news Record*, 249(3), pp.11.
- Argenti, J. (1969). *Management techniques: a practical guide*. London: Allen & Unwin.
- Ariditi, D., Akan, G. and Gurdamar, S. (1985). Reasons for delays in public projects in Turkey. *Journal of Construction Management and Economics*, 3 (2), pp. 171-81.
- Arrowsmith, S. (1995). Public procurement as an instrument of policy and the impact of market liberalization. *Law Quarterly Review*, 111, pp. 235-285.
- Arrowsmith, S.L., Linarelli, J. and Wallace, D. (2000). *Regulating public procurement: national and international perspectives*. London: Kluwer Law International.
- Ashe, B., Newton, P.W., Enker, R., Bell, J., Apelt, R., Hough, R., Thomas, P.C., McWhinney, S., Loveridge, R., Davis, m., Patterson, m., Pham, L., and Hargreaves, R. (2003). Sustainability and the building code of Australia. Research Program B: Sustainable Built Assets, Report 2001-013-B.
- Ashworth, A. and Hogg, K. (2000). *Added value in design and construction*. Harlow: Longman.
- Ashworth, A. and Skitmore, M. (1982). Accuracy in estimating. *Chartered Institute of Building Occasional Paper*, no.27, London.
- Ashworth, A. and Skitmore, M. (1983) Accuracy in estimating. *Chartered Institute of Building Occasional Paper*, no. 27, Ascot.
- Ashworth, A. (1994). *Cost studies of buildings*, 2nd Edition, Longman Group UK Limited, pp. 60-85.
- Ashworth, A. (1988). *Cost studies of buildings*. Harlow: Longman Scientific & Technical.
- Ashworth, A. (1994). *Cost studies of buildings*. 2nd edition. Harlow: Longman.
- Ashworth, A. (1999). *Cost studies of building*. 2nd edition. New York: Addison Wesley Longman.
- Ashworth, A. (2002) *Pre-contract studies-development economics, tendering and estimating*. Oxford: Blackwell.

- Aspinall, A. and Trueman, P. (2006). Optimising asset management decision making and budgeting using risk management techniques. In: Mathew, J. et al. (eds). *Engineering Asset Management: Proceedings of the 1st World Congress on Engineering Asset Management (WCEAM)*, 11–14 July 2006. [S.l.]: Cieam/mesa, pp. 229-236.
- Assaf, S.A. and Al-Heijji S.A. (2006). Causes of delay in large construction projects. *International Journal of Project Management*, 24(4), pp. 349-357.
- Association for the Advancement of Cost Engineering (AACE¹) (2009) Construction cost estimating working manual.
- Association of South African Quantity Surveyors (ASAQS), (1998). Guide to Elemental cost estimating and analysis for building works. South Africa, September.
- Atkin, B. and Flanagan, R. (1995). *Improving value for money in construction*. London: Royal Institutions of Chartered Surveyors.
- Atkin, B. (1998). Unravelling the value chain in construction. In: Ballard, G. et al. (eds). *Proceedings of 6th Annual Conference of the International Group for Lean Construction (IGLC)*, Guarujá, Brazil, 13–15 August.
- Avi, P.S., David, L. and Brenda, N.(2008) Factored reasoning for monitoring dynamic team and goal formation. *Information Fusion*, 10:99-106.
- Ayodele, E.O. (2004). *A study of contractual procedures in the execution of building projects by Nigeria tertiary institutions*. Thesis (MSc). Nigeria: University of Benin.
- Azzaro, D., Hubard, J. & Robertson, D. (1987). *Contractors' estimating procedures: an overview*. London: Royal Institution of Chartered Surveyors.
- Baccarini, D. (2005). "Understanding project cost contingency: A survey." *Proc., COBRA International Construction Conference*, Queensland University of Technology, Australia.
- Baccarini, D. (1996) The concept of project complexity: a review. *International Journal of Project Management*, 14(4): pp. 201-204.
- Baccarini, D. (2004a). Accuracy in estimating project cost construction contingency – a statistical analysis. In: Robert, E. & Malcolm, B. (eds.). *Proceedings of*

- the Construction Building and Building Research Conference of RICS*, Headingly Cricket Club, Leeds, 7-8 September 2004. London: RICS
- Baccarini, D. (2004b). Estimating project cost contingency: a model and exploration of research questions. In: Khosrowshahi, F. (ed.). *20th Annual ARCOM Conference*, Heriot Watt University, 1-3 September 2004. [S.I.]: Association of Researchers in Construction Management, Vol. 1, pp. 105-13.
- Baccarini, D. (2005). Understanding project cost contingency: a survey. In: Sidwell, A.C. & Baccarini, D. (eds). *Proceedings of the Queensland University of Technology Research Week International Conference*, Brisbane, Australia, 4-8 July 2005. Perth: Curtin University.
- Badger, W.W. and Gay, W.W. (1996). The top ten lessons learned in construction contracting. *Cost Engineering*, 38(5), pp. 20-29.
- Bajaj, D. (2001). Risk response and contingency strategies among contractors in Sydney, Australia. *AACE International Transactions*, pp. P.1.1
- Baridam, M. and Nwachukwu, C.C. (2002). *Fraud risk management, business principles and ethics*. Shell Petroleum Development Company Workshop.
- Barnes, N.M. (1977). Cost modelling: an integrated approach to planning and cost control. *Engineering and Process Economics*. 2(1), pp. 45-51.
- Barrett, P.S. and Stanley, C. (1999). *Better construction briefing*. Oxford: Blackwell Science.
- Barton, R.T. (2000). Soft value management methodology for use in project initiation: a learning journey. *Journal of Construction Research*, 1(109), pp.109-122.
- Beeston, S.T. (1983). *Statistical methods for building price data*. London: Spon.
- Beh, L.S. (2007). Copenhagen Business School & Asia Research Centre. Administrative reform: issues of ethics and governance in Malaysia and China. *Working paper*, 2007-23, pp. 36.
- Bell, L.C. and Bozai, G.A. (1987). Preliminary cost estimating for highway construction Projects. *AACE International Transactions*, pp. C.6.1-6.4.

- Bello, W.A. and Odusami, K.T. (2008). The practice of contingency allocation in construction projects in Nigeria. In: Brown, S. (ed.). *Proceedings of the construction and building research conference of the Royal Institution of Chartered Surveyors*. Dublin Institute of Technology, 4-5 September 2008. London: RICS.
- Belout, A. and Gauvreau, C. (2004). Factors influencing project success: The impact of human resource management. *International Journal of Project Management*, 22(1), pp.1-22
- Bender, S., and Fish, A. (2000). The transfer of knowledge and the retention of expertise: the continuing need for global assignments. *Journal of Knowledge Management*, 4(2), pp. 125-37.
- Bennet, J. and Barnes, M. (1979). Outlines of a theory of measurement. *Chartered Quantity Surveyor*, 2(3), pp. 53-56, October.
- Bennett, J. and Grice, T. (1990). Procurement systems for building. In: Brandon, P. (ed.). *Quantity Surveying Techniques. new directions*. Oxford: Blackwell Scientific.
- Bennett, J., Flanagan, R., Goodacre, P., Gray, C., McLaughlin, N. and Norman, G. (1979). *UK and US construction industries: a comparison of design and contract procedures*. London: Surveyors Publications.
- Bennett, J., Flanagan, R., Lansley, P., Gray, C. and Atkin, B. (1988) *Building Britain 2001*. Centre for Strategic Studies in Construction, University of Reading, UK.
- Bent, J.A. and Humphreys, K.K. (1996). *Effective project management through applied cost and schedule control*. New York: Dekker.
- Berliner, C. and Brimson, J. (1998). *Cost management for today's advanced manufacturing*. Boston: Harvard Business School.
- Bertisen, D. and Davis, G. (2008). Bias and error in mine project capital cost estimation. *The engineering Economist*, 53(2), 118-139.
- Best, R. and De Valence, G. (eds). (1999). *Building in value*. London: Arnold.
- Betts, M. (1990). Methods and data used by large building contractors in preparing tenders. *Construction Management and Economics*, 8(4), pp. 399-414.

- Birnie, J., and Yates, A. (1991). "Cost prediction using decision/risk analysis methodologies." *Constr. Manage. Econ.*, 9(2), 171-186.
- Black, J. (1984). Application of parametric estimating to cost engineering, *AACE International Transactions*, pp. B.10.1-B.10.5
- Bledsoe J.D. (1992). *Successful estimating methods: from concept to bid*. Norwell, MA: R.S. Means Company Construction Consultants & Publishers, pp. 3-23.
- Blyth, A. and Worthington, J. (2001). *Managing the brief for better design*. London: Spon Press.
- Boehm, B.W. (1989). *Software risk management*. Piscataway, NJ: IEEE Computer Society Press.
- Borkowski, S.C. and Ugras, U.J. (1992). Ethical attitudes of students as a function of age, sex and experience. *Journal of Business Ethics*, 11(12), pp.961-979.
- Boukendour, S. (2005). *A new approach to project cost overrun and contingency management*. OCRI Partnership Conferences Series Process and Project Management, 22 March 2005, Ottawa.
- Bowen, P.A. (1993). A communication-based approach to price modelling and price forecasting in the design phase of the traditional procurement process in South Africa. Unpublished thesis (PhD). Port Elizabeth: University of Port Elizabeth, Faculty of Economic Sciences.
- Bowen, P.A., Pearl, R.G. and Edwards, P.J. (1999). Client Briefing Process and Procurement Method Selection: A South African Study. *Engineering, Construction and Architectural Management*, 6(2), 91-104.
- Bowen, S.A. (2004). Organizational factors encouraging ethical decision making: an exploration into the case of an exemplar. *Journal of Business Ethics* 52(4), pp. 311-324.
- Boyd, D. and Chinyio, E. (2006). *Understanding the construction client*. Oxford: Blackwell Publishing Ltd.
- Brandon, P.S. (1990). *Quantity surveying techniques: new directions*. Oxford: BSP Professional Books.

- Bresnen, M.J., Haslam, C.O., Beardsworth, A.D., Bryman, A.E. and Keil, E.T. (1990). Performance on site and the building client. *Chartered Institute of Building*, Occasional Paper 42, Ascot.
- British Standard BS6079-1: (2000). Project Management – Part 1: Guide to project management, British Standards Institute, ISBN 0-580-25594-8
- British Standard BS6079-2: (2000). Project Management – Part 2: Vocabulary, British Standards Institute, ISBN 0-580-331484-2
- British Standard BS6079-3: (2000). Project Management – Part 3: Guide to the management of business-related project risk, British Standards Institute, ISBN 0-580-33122-9
- British Standards Institute. (2002). *British Standard BS6079-1:2002 Project Management – Part 1: Guide to project management*. London, UK: British Standards Institute.
- Bromilow, F.J. and Henderson, J.A. (1976). *Procedures for reckoning and valuing the performance of building contracts*. 2nd edition. Melbourne, Division of Building: CSIRO.
- Bromilow, F.J., Hinds, M.F. and Moody, F. (1980). AIQS survey of building contract time performance. *The Building Economist*, 19(2), pp. 79-82.
- Brook, M. (2004). *Estimating and tendering for construction work*. Oxford: Elsevier Ltd.
- Brundtland, G.H (1987). Our common future: The world Commission on Environment and Development. Oxford: Oxford University Press.
- Bruzelius, N., Flyvbjerg, B. and Rothengatter, W. (2002). Big decision, big risks: improving accountability in mega projects. *Transport Policy*, 9(2), pp. 143-54.
- Bryan, S. (1991). Assembly pricing in construction cost estimating. *Cost Engineering*, 33(8), pp.17-21.
- Bryde, D.J. & Robinson, L. 2005. Client versus contractor perspective on project success criteria. *International Journal of Project Management*, 23 (8), pp. 622-629.

- Buerty, J.I.T., Abeere-Inga, E. And Kumi, T.A. (2012) Estimating cost contingency for construction projects: The challenge of systemic and project specific risk. In: Laryea, S., Agyepong, S.A., Leiringer, R. And Hughes, W. (eds) Procs 4th West Africa Built Environment Research (WABER) Conference, 24-26 July 2012, Abuja, Nigeria, 413-426.
- Burati, J.L., Farrington, J.J. and Ledbetter, W.B. (1992). Causes of quality deviations in design and construction. *Journal of Construction Engineering and Management*, 118(1), pp. 34-49.
- Burke, R. (2006). *Project management planning and control technique*. 5th edition. Hong Kong: Burke Publishing.
- Cane, P. (2004). *Administrative Law*. 4th edition. London: Oxford University Press.
- Carey, J.L. and Doherty, W.O. (1968). *Ethical standards of the accounting profession*. New York: American Institutes of Certified Public Accountants.
- Cartlidge, D. (2006). *New aspects of quantity surveying practice* (2nd Edition), London: Butterworth-Heinemann.
- Cartlidge, D. (2002). *New aspects of quantity surveying practice*. London: Butterworth-Heinemann.
- Castillo, R. and Chung, N. (2005). *Last update, the value of sustainability*. [online]. Available from: <<http://www.stanford.edu/group/EIFE/online.publications/WP091.pdf>> [Accessed 21 April 2005].
- Chalkey, R. (1990). *Professional conduct: a handbook for chartered surveyors*. Surveyors London: Holding Ltd.
- Chan S.L., and Park M. (2005). Project cost estimation using principal component regression. *Construction Management and Economics*, 23(3), pp. 295-304.
- Chan, A.P.C. (2001). Time cost relationship of public sector projects in Malaysia. *International Journal of project Management*, 19(4), pp. 223-229.
- Chan, D.W.M. and Kumaraswamy, M.M. (1996). An evaluation of construction time performance in the building industry. *Building and Environment*, 31(6), pp. 569-578.

- Chan, D.W.M. and Kumaraswamy, M.M. (1997). A comparative study of causes of time overruns in Hong Kong construction projects. *International Journal of Project Management*, 15 (1), pp. 55-63.
- Chan, D.W.M., and Kumaraswamy Mohan M., (2002), Compressing construction durations: lessons learned from Hong Kong building projects, *International Journal of Project Management*, Vol. 20, pp. 23-25.
- Chang, A. S. T. (2002). Reasons for cost and schedule increase for engineering design projects. *Journal of Management in Engineering*, 18(1), pp. 29-36.
- Chapman, C. and Ward, S. (2000). Project risk management: the required transformations to become project uncertainty management. *PMI Research Conference*, Paris, 2-4th June. Paris: PMI. pp. 405-417.
- Chapman, R. (1997). Managing design changes. *The Architects' Journal*, 205(7), pp. 47-49.
- Chartered Institution of Building (CIOB). (1997). *Code of estimating practice*. 6th edition. London: Longman.
- Chau, D.K.H., Kog, Y.C., Loh, P.K. and Jaselskis, E.J. (1997). Model for construction budget performance – neural network approach, *Journal of Construction Engineering and Management*, 214-222
- Chauchau, R.L. and Chiang, W.C. (1988). Weighting Factors in Construction Management Performance Evaluation, *Proceedings of Conference on Applied Construction Management University of NSW, Sydney February*, 137-145.
- Chen, D. And Hartman, F.T (2000) A neural network approach to risk assessment and contingency allocation. *AACE Transactions*, 24th-27th June, Risk. 07.01-6
- Cheung, S.O., Lam, T.I., Leung, M.Y. and Wan, Y.W. (2001). An Analytical Hierarchy Process based Procurement Selection Method. *Construction Management and Economics*, 19(4), 427-437
- Chihuri, S. and Pretorius, L. (2010). Managing risk for success in a South African engineering and construction project management. *South African Journal of Industrial Engineering*, 21(2), pp. 63-77.

- Christian, J. and Newton, L. (1999). Highway construction and maintenance costs. *Canadian Journal of Civil Engineering*, 26(4), pp. 445-452.
- CIC (1994). "Dispute Resolution", A report by the dispute resolution risk force of the construction industry council which identifies the disputes that arise in the construction industry and existing methods of their resolution, Construction Industry Council.
- CIRIA (Construction Industry Research and Information Association) (1996) *Control of risk: a guide to the systematic management of risk from construction*. London: CIRIA
- Clark, D.E. (2001). Monte Carlo analysis: ten years of experience. *Cost Engineering*, 43(6), pp. 40-45.
- Clark, F.D. and Lorenzoni, A.B. (1985). *Applied cost engineering*. New York: Dekker.
- Cleland, D.I. and King, W.R. (1975). *System analysis and project management*. 2nd edition. New York: McGraw-Hill.
- Clough, R. (1986). *Construction contracting*. 5th edition. New York: Wiley & Sons.
- Conrow, E.H. 2003. *Effective risk management: some keys to success*. 2nd edition. Reston VA: American Institute of Aeronautics and Astronautics.
- Construction Industry Board. (1997). *Briefing the team*. London: Thomas Telford.
- Construction Industry Research and Information Association (CIRIA). (1996). *Control of risk: a guide to the systematic management of risk from construction*. London: CIRIA.
- Cooke-Davis, T. (2001). The 'real' success factors on projects. *International Journal of Project Management*, 20(3), pp. 185-190.
- Collins. (1979) Collins Dictionary of the English language, pub. William Collins Sons and Co Ltd, Glasgow. ISBN 0.00.433078-1
- Cooper, D.F. and Chapman, C.B. (1987). *Risk analysis for large projects*. Chichester, UK: Wiley.
- Cooper, R. and Slagmulder, R. (1997). *Target costing and value engineering*. Montvale, NJ: Productivity Press.

- Cooper, R. (1995). *When lean enterprise collide – competing through confrontation*. Boston, MA: Harvard Business School Press.
- Courtney, R. (2008). Enabling clients to be professional. In: Brandon, P. & Lu, S-L. *Clients driving innovation*. Chichester: Blackwell Publishing Ltd. pp 33-42.
- Cox, A. and Thompson, I. (1998). *Contracting for Business Success*. London: Thomas Telford.
- Cox, I.D., Morris, J.P., Rogerson, J.H. and Jared, G.E. (1999). A quantitative study of post contract award design in construction. *Construction Management and Economics*, 17(4), pp.427-439.
- Craig, P.P. (2003). *Administrative law*. 5th edition. London: Sweet & Maxwell.
- Curran, M.W. (1989). Range estimating. *Cost Engineering*, 31(3), pp. 19-26.
- Dainty, A.R.J., Cheng, M. and Moore, D.R. (2003). Redefining performance measures for construction project managers: an empirical evaluation. *Journal of Construction Management and Economics*, 21(2), pp. 209-218.
- Dallas, M.F. (2006). Maximising project value through integrated risk and value management: SAVE International.
- Daschbach, J.M. and Apgar, H. (1988). Design analysis through techniques of parametric cost estimating. *Engineering Cost and Production Economics*, 14(2), pp. 87-93.
- Dellisola, A.J. (1997) *Value Engineering: Practical applications for design, construction, maintenance and operations*. Kingston, Mass: R.S Means Company.
- Dey, P., Tabucanon, M.T. and Ogunlana, S.O. (1994). Planning for project control through risk analysis; a petroleum pipelaying project. *International Journal of Project Management*, 12(1), pp. 23-33.
- Diekmann, J.E., Sewester, E.E., and Taher, K. (1988). “ Risk Management in Capital Projects.” Construction Industry Institute Source Document 41.
- Dillon, R. (1999). *Programmatic risk analysis: engineering and management risk trade-offs for interdependent projects*. Thesis (PhD). Stanford, CA: Stanford University.

- Dillon, R.L., and Pate-Cornell, M.E. (2001) "APRAM: An advanced programmatic risk analysis method." *International Journal Technology, Policy and Management*, 1(1) 47-65.
- Dillon, R.L., Pate-Cornell, M. D., and Guikema , S.D (2003). " Programmatic risk analysis for critical engineering systems under tight resource constraints" *Operations Research*, 51(3), 353-370
- Dolecheck, M.M. and Dolecheck, C.C. (1987). Business ethics: a comparison of attitudes of managers in Hong Kong and the United States. *The Hong Kong Manager*, April/May, pp. 38-43.
- Donaldson, L. (2008). Ethics problems and problems with ethics. toward a pro-management theory. *Journal of Business Ethics*, 78(3), pp. 299.
- Du Plessis, C. (2002). *Agenda 21 for Sustainable Construction in Developing Countries*. Pretoria: CSIR Building and Construction Technology.
- Dubinsky, A., Berkowitz, E. and Rudelius, W. (1980) Ethical problems of field sales personnel, *MSU Business Topics*, 28(Summer), pp 11-16.
- Dysert L.R. and Elliot, B.G. (2000). The organization of an estimating department. *Cost Engineering*, 42(8), pp.38-44.
- Dysert, L.R. (2006). Is "estimate accuracy" an oxymoron? AACE International Transactions, AACE International, West Virginia.
- Dysert, L.R. (2003). Sharpen your cost estimating skills. *Cost Engineering*, 45(6), p. 22.
- Egan, J. (1998). *Rethinking construction: report of the construction task force to the Deputy Prime Minister, DETR*. Hoboken: Wiley.
- Elhag T.M.S., Boussabaine, A.H., and Ballal, T.M.A. (2005). Critical determinants of construction tendering costs: quantity surveyors standpoint. *International Journal of Project Management*, 23(7), pp. 538-545.
- Ellis, R.C.T., Wood, G.D. and Keel, D.A. (2005). Value management practices of leading UK cost consultants. *Construction Management and Economics*, 23(5), pp. 483-493.
- Enshassi, A., Mohamed, S. and Madi. I. (2007). Cost estimation practice in the Gaza Strip: a case study. *The Islamic University Journal*, 15(2), pp. 153-176.

- Enshassi, A., Mohammed, S. and Madi, I. (2005) Factors affecting accuracy of cost estimation of building construction in the Gaza Strip, *Journal of Financial Management of Property and Construction*, Vol. 10, No.2, pp.115-124.
- EPU (2008). Mid-Term Review of the Ninth Malaysia Plan 2006-2015. Kuala Lumpur.
- Eric, C.E., (2003) Facility Design and management Hand book, McGraw-Hill, New York.
- Fan, L.C.N., Fox, P.W. and Wan, J.C.Y. (2003). An investigation of ethical behaviour of construction professionals in quality management. In: Ahmed, SM (ed.). *Proceedings of the second International Conference on Construction in the 21st Century: sustainability and innovation in management and technology*, 10-12 December, Hong Kong. [Hong Kong: Hong Kong Polytechnic University]
- Faridi, A.S. and El-Sayegh, S.M. (2006) Significant factors causing delay in the UAE construction industry. *Journal of Construction Management and Economics*, 24(11), pp. 1167-1176.
- Fay, R. (2000). Life-cycle energy analysis of buildings: a case study. *Building research and information: the international journal of research, development and demonstration*, 28(1), pp. 31-41.
- Fayek, A., Young, D.M. and Duffield, C.F. (1998). A survey of tendering practices in the Australian construction industry. *Engineering Management Journal*, 10(4), pp. 29-34.
- Fellows, R. (1996). Monte Carlo simulation of construction costs using subjective data: comment. *Construction Management and Economics*, 14(5), pp. 457-60.
- Fellows, R.(1989). Development of British building contracts. In: Cheetham, D., Carter, D., Lewis, T. & Jagger, D.M. (eds), *Contractual procedures for building: Proceedings of the International Workshop*, 6-7 April, University of Liverpool, Liverpool, UK. pp. 14-19.

- Fellows, R., Liu, A. and Fong, C.M. (2003). Leadership style and power relations in quantity surveying in Hon Kong. *Construction Management and Economics*, 21(8), pp. 809-818.
- Fenton, R.E, Cox, R.A. and Carlock, P. (1999). Incorporating contingency risk into project cost and benefits baselines; a way to enhance realism. INCOSE Conference
- Ferng, J. and Price, A.D.F. (2005). An exploration of the synergies between Six Sigma, total quality management, lean construction and sustainable construction. *International Journal of Six Sigma and Competitive Advantage*, 1(2), pp. 167-187.
- Ferrell, O.C. and Weaver, K.M. (1978). Ethical beliefs of marketing managers. *Journal of Marketing*, 42(3), pp. 69-73.
- Ferry, D.J. and Brandon, P.S. (1991). *Cost planning of buildings*. 6th edition. Great Britain: BSP Professional Books.
- Fine, B. (1982). *The control of site costs. Construction project their financial policy and control*. Harlow: Construction Press.
- Fischhoff, B., Lichtenstein, S., Slovic, P., Derby, S.L. and Keeney, L. (1981) *Acceptable risk*. Cambridge, UK: Cambridge University Press
- Fishhoff, B. (1985). Managing risk perceptions. *Issues in Science and Technology*, 2(1), pp. 83-96
- Flanagan R. and Tate, B. (1997). *Cost control in building design*. Oxford: Blackwell Science Ltd.
- Flanagan, D.J. and Norman, G. (1983). The accuracy and monitoring of quantity surveyor's price forecasting for building work. *Construction Management and Economics*, 1(2), pp. 157-180.
- Flanagan, R., Norman, G., Ireland, V. and Ormerod, R. (1986). *A fresh look at the UK and US building industries*. Bedford: Construction Industry Publications Ltd.
- Flyvberg, B. and COWI. (2004). Procedures for dealing with optimism bias in transport planning: guidance document. [online] London: Department for

Transport. [Available from: <<http://flyvberg.plan.aau.dk/0406DfT-UK%200ptBiasASPUBL.pdf>> [Accessed 13 August 2011]

- Flyvberg, B., Holm, M.K.S. and Buhl, S.L. (2005). How (in)accurate are demand forecasts in public works projects? The case of transportation. *Journal of the American Planning Association*, 71(2), pp. 131-146.
- Flyvbjerg, B. (2006). From nobel prize to project management: getting risks right. *Project Management Journal*, 37(3), 5-15.
- Flyvbjerg, B. (2006). From Nobel Prize to project management: getting risks right. *Project Management Journal*, 27(3), pp. 5-15.
- Flyvbjerg, B., Holm, M.S. and Buhl, S. (2002). Underestimating costs in public works projects: error or lie? *Journal of the American Planning Association*, 68(3), pp. 279-295.
- Flyvbjerg, B., Holm, M.S. and Buhl, S. (2005a). How (in)accurate are demand forecasts in public works projects? *J. Amer. Plan. Assoc.*, 71(3), 131-146.
- Flyvbjerg, B., Holm, M.S. and Buhl, S. (2005b). What causes cost overrun in transport infrastructure projects? *Transport Reviews*, vol. 24(1), 3-18.
- Flyvbjerg, B., Nils, B. and Werner, R. (2003). *Megaprojects and Risk : An Anatomy of Ambition* (Cambridge University Press)
- Forbes, D., Smith, S. and Horner, M. (2008). Tools for selecting appropriate risk management techniques in the built environment. *Construction Management and Economics*, 26(11), pp. 1241-1250.
- Frimpong, Y., Oluwoye, J. and Crawford, L. (2003). Causes of delay and cost overruns in construction of groundwater projects in a developing countries: Ghana as a case study. *International Journal of Project Management*, 21(5), pp. 321-326
- Ganiya, B.O. and Zubairu, I.K. (2010). Project Cost Prediction Model using principal component regression for public building projects in Nigeria. *Journal of Building Performance*, 1(1), pp. 21-28
- Giridhar, P. and Ramesh, K. (1998) Effective management of Turnkey projects. *AACE International Transactions*, pp. PM7-PM11. Istanbul

- Giwa, S.L. (1988). *Differences between initial final contract sums of construction projects in Nigeria, causes and solutions: Seminar organized by the Nigerian Institute of Quantity Surveyors*. Lagos: NIQS.
- Gkritza, K. and Labi, S.(2008). Estimating cost discrepancies in highway contracts: Multistep economic approach. *Journal of Construction Engineering and Management*, 134(12), pp. 953-962.
- Goldratt, E.M. and Cox, J.F. (1992). *The goal: a process of ongoing improvement*. Great Barrington, MA: North River Press.
- Gould, F. (2005.) *Managing the construction process: estimating, scheduling, and project control*. New Jersey: Pearson Education, Inc.
- Gounden, S.M. (2000.) *The impact of the affirmative procurement policy on affirmable business enterprises in the South African construction industry*. Thesis (Ph.D.). Pietermaritzburg: University of Natal.
- Great Britain. Office of Government Commerce (OGC). (2002). *Management of risk: guidance for practitioners*. London: Stationery Office.
- Green, D.S. (1994). Beyond value engineering: SMART value management for building projects. *International Journal of Project Management*, 12(1), pp.49-56.
- Green, S. (1989). Tendering: optimisation and rationality. *Construction Management and Economics*, 7(1), pp. 53-63.
- Griffith, A. and Watson, P. (2004). *Construction management principles and practice*. New York: Palgrave Macmillan.
- Groen, B. and Tan, K.D. (1977). Improved factor estimating with quantity and man-hour ratios. *Engineering and Process Economics*, 2, pp. 191-206.
- Gunaydin, H.M. and Dogan, S.Z. (2004). A neural network approach for early cost estimation of structural systems of buildings, *International Journal of Project Management*, 22, 595-602.
- Gunhan, S. and Arditi, D. (2005). Factors affecting international construction. *Journal of Engineering and Management*, 131(3), pp. 273-282.

- Gunhan, S. and Arditi, D. (2007). Avoiding change orders in public school construction. *Journal of Professional Issues in Engineering Education and Practice*, 133(1), pp. 67-73.
- Gunner, J. and Skitmore, M. (1999). Comparative analysis of pre-bid forecasting of building prices based on Singapore data. *Construction Management and Economics*. Vol.17, pp. 635-646.
- Gupta, J.L. and Sulaiman, M. (1996). Ethical orientation of managers in Malaysia. *Journal of Business Ethics*, 15(7), pp. 735-748.
- Guth, S.R. (2009). *Project procurement management: a guide to structured procurement*. Alexandria, VA: Guth Ventures LLC.
- Hackney, J.W. (1985) Applied contingency analysis. *Transactions of the American Association of Cost Engineers*, B(2), pp. 1-4.
- Halpin, D.W. 1985. *Financial and cost concepts for construction management*. New York: Wiley.
- Hamburger, D. (1994). Upper management leadership role in the contingency planning and control process. *PMI Annual Seminar and Symposium*, 17-19 October, Vancouver. PMI
- Hamm, R.M. (1991). Selection of verbal probabilities: a selection for some problems of verbal probability expression. *Organisational Behaviour & Human Decision Processes*, 48(2), pp. 193-223.
- Hammer, M. (2002). Process management and the future of Six Sigma. *Sloan Management Review*, 43(2), pp. 26-32.
- Hammond, J.S., Keeney, R.L. and Raiffa, H. (1998). The hidden traps in decision making. *Harvard Business Review*, September/October, pp. 47-58.
- Hampson, K.D., Peters, R.J., Walker, D.H.T., Tucker, S.N., Ambrose, M. and Mohamed, S. (2001). *Case study of the Action Peninsula Development*. Gold Coast, Australia: Department of Industry, Science and Resources.
- Han, S. H., Kim, D. Y., and Kim, H., (2008) Two-staged Early Cost Estimation for Highway Construction Projects, Report (2008), Civil and Environmental Engineering, Yonsei university, Seoul, Korea

- Hanna, A.S., Russell, J.S., Nordheim, E.V. and Bruggink, M.J. (1999). Impact of changes orders on labour efficiency for electrical construction. *Journal of Construction Engineering and Management ASCE*, 125(4), pp. 224-232.
- Hansen, B.E (1994). Autoregressive conditional density estimation. *International Economic review*, 35(3), pp. 705-730
- Harris, F. and McCaffer, R. (2001). *Modern construction management*. Oxford: Blackwell Science.
- Harris, F. and McCaffer, R. (2006). *Modern Construction Management*, 6th edition, Blackwell Publishing.
- Hart. D.H. (2007) *Managing the Contingency Allowance*. The AIA. BP 13.04.05
- Hartman, F.T. (2000) *Don't park your brain outside*. Upper Darby PA: PMI
- Hartman, F.T. (2000). *Don't park your brain outside*. Upper Darby, PA: Project Management Institute.
- Harun, H. and Torrance, J.V.T. (2006). Drivers of change: new challenges for the quantity surveyors. In: *Proceedings of the International Conference of Construction Industry 2006: toward innovative approach in construction and property development*, Kuala Lumpur, Malaysia, 12-24 June 2006. Malaysia: Universiti Teknologi Malaysia.
- Harvard, T. (2002). *Contemporary property development*. London: RIBA Enterprises.
- Hassal, T., Dunlop, A. and Lewis, S. (1996). Internal audit education: exploring professional competence. *Managerial Auditing Journal*, 11(5), pp. 28-36.
- Hassim, A.A., Kajewski, S and Trigunarsyah, B. (2010). Factors contributing to ethical issues in project procurement planning: a case study in Malaysia. In: 8th International Conference on Construction and Real Estate Management, 1-3 December, Brisbane, Queensland
- Hatem, D.J. & Ponte, D.M. 2009. Minimizing risks associated with construction cost estimates. [online]. Available from: <<http://asceinsurance.com/Portals/dnn.asceinsurance.com/forms/pl/articles/ASCE-PL-EstimateRisks-Article-F.pdf>> [Accessed 19 June 2012]

- Hayles, C. 2004 The role of value management in the construction of sustainable communities. *The Value Manager*, 10(2), pp. 15-19.
- Hegazy, T. and Ayed, A. (1998). Neural network model for parametric cost estimation of highway projects. *Journal of Construction Engineering and Management*, 124(3), pp. 210-218.
- Hegazy, T. and Moselhi, O. (1995). Elements of cost estimation: a survey of Canada and United States. *Cost Engineering*, 37(5), pp. 27-31.
- Heikkila, J. (2002). From supply chain to demand chain management: efficiency and customer satisfaction. *Journal of Operations Management*, 20(6), pp. 747-767.
- Heineck, L.F.M. (1986). *Orçamentos e programação de custos na Indústria da Construção Civil*. Porto Alegre: PPGEC/UFRGS.
- Heinze, K. (1996). *Cost management of capital projects*. New York: Dekker.
- Hemuka N. (2002). Ethical Behaviour and the Practice of Real Estate Surveying and Valuation in Nigeria.
- Hendrickson, C. & Au, T. (1989). *Project management for construction: fundamental concepts for owners, engineers, architects, and builders*. London: Prentice Hall.
- Hervet, L. (2011). Contingency risk model: a Black and Veatch business excellence review, Palisade@risk Conference by the AACE
- Hester, W.T., Kuprenas, J.A. and Chang, T.C. (1991). *Construction changes and change orders, Source document 66*. Austin, TX: Construction Industry Institute.
- Hill, R.C. and Bowen, P.A. (1997). Sustainable construction: principles and a framework for attainment. *Construction Management and Economics*, 15(3), pp. 223-239.
- Hillson, D. (1999). Developing effective risk responses. In: *Proceedings of the 30th Annual project Management Institute 1999 Seminars and Symposium, Philadelphia, Pennsylvania, 10-16 October*. Philadelphia, PA: PMI.

- Hillson, D.A. and Hulett, D.T. (2004) Assessing risk probability: Alternative approaches. Proceedings of PMI Global Congress 2004 EMEA, Prague, Czech Republic.
- Hillson, D.A. and Murray-Webster, R.E.(2004). *Understanding and managing risk attitude*. Aldershot, UK: Gower
- Hillson, D.A. (2003) *Effective opportunity management for projects: Exploiting positive risk*. New York, NY, USA: MarchelDekker
- Hillson, D.A. (2004) *Interpretation of probability-related terms. Risk Doctor Research Paper*.
- Hinze, J., Selstead, G. ad Mahoney, J.P. (1992). *Cost overruns on State of Washington construction contracts. Transportation Research Record 1351*. Washington, DC: Transportation Research Board.
- HM Treasury. (1993). *CUP Guidance: No.41 – managing risk and contingency for works projects*. London: Central Unit on Procurement.
- Ho, M.F.C. and Ng, C.W.V. (2003). Quantity surveyors' background and training, and their ethical concepts, conceptions and interests considerations. *Construction Management and Economics*, 21(1), pp. 43-67.
- Hogg, K. (2003). The role of quantity surveying profession in accommodating client risk. *Journal of Financial Management of Property and Construction*, 8(1), pp. 49-56.
- Hollmann, J. K.,(2006) Editor, Total Cost Management Framework: An Integrated Approach to Portfolio, Program and Project Management, AACE International, Morgantown,WV.
- Hollmann, J. (2009). Recommended Practice for Risk Analysis and cost Contingency Estimation, Association for the Advancement of Cost Engineering (AACE¹), Working Manual.
- Holm, L., Schaufelberger J.E., Griffin, D. and Cole, T. (2005). *Construction cost estimating: process and practice*. Upper Saddle River, NJ: Pearson Prentice Hall.
- Holm, L., Schaufelberger, J.E., Griffin, D., and Cole, T. (2005). Construction cost estimating – process and practice. Pearson Prentice Hall, pp.312-318.

- Holmes, L. and Joyce, P. (1993). Rescuing the useful concept of managerial competence: from outcomes back to process. *Personnel Review*, 22(6), pp. 37-52.
- Hong Kong Ethics Department Center (HKEDC). (1996). *Ethics from professionals (Architecture, Engineering and Surveying): a resource portfolio for Hong Kong universities*. Hong Kong : HKEDC.
- Horgren, C.T., Forster, G. and Sikant, M.D. (1990). *Cost accounting: a managerial emphasis*. 7th edition. Englewood Cliffs, NJ: Prentice-Hall.
- Howel, G., Miles, R., Fehling, C. and Ballard, G. (1996). Beyond partnering: towards a new approach to project management. In: *Proceedings of the Fourth International Conference on Lean Construction*, University of Birmingham, UK, 25th – 27th August. Edgebaston, Birmingham: University of Birmingham, School of Civil Engineering.
- Howell, G. and Ballard, G. (1996). Can project controls do its job? In: *Annual meeting of the International Group for Lean Construction*, 4th, 1996. Edgebaston, Birmingham: University of Birmingham, School of Civil Engineering.
- Hudson, J. (1999) Briefing and Design: The Role of Creativity. In: Baldry, D. And Ruddock, L. (eds.). *Proceedings of the RICS Construction and Building Research Conference (COBRA 1999), The Challenge of Change: Construction and Building for the New Millennium*, University of Salford, Salford, 1-2 September 1999, 1, 284-289.
- Ibrahim, A.D. (2003). *Cost implications of architectural design variables*. Unpublished thesis (Master's in Construction Engineering and Management). Dhahran, Saudi Arabia: King Fahd University of Petroleum and Minerals.
- Imbeah, W. and Guikema, S. (2009). Managing construction projects using the advanced programmatic risk analysis and management model. *Journal of Construction Engineering and Management*, 135(8), pp. 772-781.
- Institute of Risk Management (IRM) (2002) A Risk Management Standard. London. UK: AIRMIC/ALARM/IRM

- Institution of Civil Engineers (ICE) and Faculty & Institute of Actuaries, (1998). Risk Analysis & Management for Projects (RAMP), pub. Thomas Telford 1998, ISBN 0-7277-2697-8
- Ireland, V. (1983). *The role of managerial actions in the cost, time and quality performance of high rise commercial building projects*. Thesis (PhD). Sydney: University of Sydney.
- Jabalameili, M.S., Ghavamifar, K. and Abaei, M. (2004). The place of the value engineering in project management; Tehran: State Management and Planning, organization Press.
- Jahren, C. and Ashe, A.M. (1990). Predictors of cost-overrun rates. *Journal of Construction Engineering and Management*, 116(3), pp. 548-552.
- Janis, I. (1982). *Groupthink: psychological studies of policy decisions and fiascos*. Boston, MA: Houghton Mifflin
- Jelen, F.C. and Black, J.H. (1983). *Cost and optimization engineering*, 2nd edition. New York: McGraw-Hill.
- Johnson, H.T. and Kaplan, R.S. (1987) *Relevance lost: the rise and fall of management accounting*. Boston, MA: Harvard Business School.
- Joint Contract Tribunal, (1980). Conditions of contract. JCT. London
- Jones, L.R. & Euske, K.J. (1991). Strategic misrepresentation in budgeting. *Journal of Public Administration Research and Theory*, 1(4), pp. 437-460.
- Kahneman, D. and Tversky, A. (1979). Intuitive prediction: biases and corrective procedures. In: Makridakis, S. & Wheelwright, S.C. (eds). *Studies in the management sciences: forecasting*, Vol.12. Amsterdam: North-Holland.
- Kahneman, D. (1994). New challenges to the rationality assumption. *Journal of Institutional and Theoretical Economic Studies*, 150, pp. 18-36.
- Kahneman, D. And Lovallo, D. (1993) Timid choices and bold forecasts: a cognitive perspective on risk taking. *Manage. Sci.*, 39(1).
- Kahneman, D., Slovic, P. and Tversky, A. (eds.) (1986) *Judgement under uncertainty: Heuristics and biases*. Cambridge, UK: Cambridge University Press

- Kaliba, C., Muya, M. and Mumba, K. (2009). Cost escalation and schedule delays in road construction projects in Zambia. *International Journal of Project Management*, 27(5), pp. 522-531.
- Kamara, J.M., Anumba, C.J. and Evbuomwan, N.F.O. (2000) Process Model for Client Requirements Processing in Construction. *Business Process Management Journal*, 6(3) 251-279
- Kaming, P.F., Olomolaiye, P.O., Holt, G.D. and Harris, F.C. (1997). Factors influencing construction time and cost overruns on high-rise projects in Indonesia. *Construction Management and Economics*, 15(1), pp. 83-94.
- Kaplan, R.S. and Cooper, R. (1998). *Cost and effect: using integrated cost system to drive profitability and performance*. Boston, MA: Harvard Business School Press.
- Karande, K., Shankarmahesh, M.N., Rao, C.P. and Rashid, Z.M. (2000). Perceived moral intensity, ethical perception and ethical intention of American and Malaysian managers: a comparative study. *International Business Review*, 9(1), pp. 37-59.
- Kats, G. and Alevantis, L . (2003). *The costs and financial benefits of green buildings: a report to California's sustainable building task force*. [online]. Available from: <<http://www.usgbc.org/resources/costs-and-financial-benefits-green-buildings-report-california%E2%80%99s-sustainable-building-task>>[Accessed 15 May 2012]
- Keeney, R. and von Winterfeldt, D. (1989) On the uses of expert judgement on complex technical problems. *IEEE Transactions on Engineering Management*, 36(2), 83-86
- Kelly, J. and Male, S. (2006). Who is the Customer/Stakeholder of a Construction Project and how is their Value Criteria Measured. In: SAVE International Conference Proceedings. 9 June 2006.
- Kelly, J., Male, S. and Graham, D. (2004). *Value management of construction projects*. Oxford: Blackwell.
- Kelly, J.R. and Male, S.P. (1993). *Value management in design and construction: the economic management of projects*. London: Spon.

- Kenley, R.(2003). *Financing construction: cash flows and cash farming*. London: Spon.
- Kern, A.P. and Formoso, C.T. (2004) Guidelines for improving cost mangement in fast, complex and uncertain construction projects. In: Bertelsen, S. and Formos, C.T. (eds.) Proceedings of the 12th Conference of the international group of lean construction, 3-5 August, Helsinki, Denmark, pp. Online
- Kibert, C. J. (2005). *Sustainable construction: green building design and delivery*. Hoboken, NJ: Wiley & Sons.
- Kim, G.H., An, S.N. and Kang, K.I. (2004). Comparison of Construction Cost Estimating Models Based on Regression Analysis, Neutral Networks, and Case-Based Reasoning, *Building and Environment*, 39 1235-1242.
- Kim, G.H., Seo, D.S., and Kang, K.I. (2005) Hybrid models of neural networks and genetic algorithms for predicting preliminary cost estimates. *Journal of Computing in Civil Engineering*, 19(2), pp. 208-211.
- Kim, Y. and Ballard, G. (2001). Earned value method and customer earned value. *Journal of Construction Research*, 3(1), p.55-66. March.
- Kim, Y. (2002). *The implications of a new production paradigm for project cost control*. Thesis (PhD). Berkeley, CA: University of California.
- Klumpar, I.V. (1990). Upgrading capital estimating factors and correlations. In: *Transactions of the 34th AACE Annual Meeting, American Association of Cost Engineers*, Boston, MA, 24-27 June 1990. Morgantown, WV: The Association, pp. K1.1-K3.5.
- Knight, K. and Fayak, A.R. (2002). Use of fuzzy logic for predicting design cost overruns on building projects. *Journal of Construction Engineering and Management*, 128(6), pp. 503-512.
- Knipe, A., Van der Waldt, G., Van Niekerk, D., Burger, D. and Nell, K. (2002). *Project management for success*. Cape Town: Heinemann.
- Koleola, O. and Henry, O. (2008). Factors affecting the accuracy of a pre-tender cost estimate in Nigeria. *Journal of Cost Engineering*, 50(9), pp. 32-35.
- Koskela, L. (2000). *An exploration towards a production theory and its application to construction*. Thesis (DT). Helsinki: Helsinki University of Technology.

- Koushki, P.A. and Kartam, N. (2004). Impact of construction materials on project time and cost in Kuwait. *Engineering, Construction and Architectural Management*, 11(2), pp. 126-132.
- Koushki, P.A., Al-Rashid, K. and Kartam, N. (2005). Delay and cost increases in the construction of private residential projects in Kuwait. *Journal of Construction Management and Economics*, 23(3), pp. 285-294.
- Kubal, M (1994) *Engineering Quality in Construction*, 1st edition, McGraw-Hill, New York.
- Kujawski, E., Alvaro, M.L. and Edwards, W.R. (2004). Incorporating psychological influences in probabilistic cost analysis. *Systems Engineering*, 7(3), pp. 195-216.
- Kumaraswamy, M. and Dissanayaka, S.M. (1998). Linking procurement systems to project priorities. *Building Research and Information*, 26(4), pp. 223-238.
- Kumaraswamy, M. and Dulaimi, M. (2002). Empowering innovative improvements through creative construction procurement. *Engineering Construction and Architectural Management*, 8(5-6), pp. 325-334.
- Kwakye, A.A. (1994). *Understanding tendering and estimating*. Hampshire, England. Gower Publishing Limited.
- Labuschagne, J. (1985). *Staatskontrakte ter verkryging van goedere, diense en werke* Thesis. (LLD). Pretoria, South Africa: University of South Africa.
- Latham, M. (1994), "Constructing the team", Final report on joint review of procurement and contractual arrangement in the UK Construction Industry. HMSO, London, UK.
- Latham, M. (1993). *Trust and money: interim report of the joint government/industry review of the procurement and contractual arrangements in the United Kingdom Construction Industry*. London: HMSO.
- Leung, M. (2003). Developing a stress management model for construction estimators. In: Fellows, R. & Tjihuis, W. (eds). *CIB TG 23 International Conference: professionalism in construction: culture of high performance*, Hong Kong, 26-27 October 2003.

- Leveson, R. (1996). Can professionals be multi-skilled? *People Management*, 2(17), pp. 36, August.
- Levine, H.A. (1995). Risk management for dummies: managing schedule cost and technical risks and contingency. *PM Network*, October, 30-32.
- Li, H., Cheng, E.W.L. and Love, P.E.D. (2000.) Partnering research in construction. *Engineering Construction and Architectural Management*, 7(1), pp. 76-92.
- Lichtenstein, S. and Newman, J.R. (1967) Empirical scaling of common verbal phrases associated with numerical probabilities. *Psychonomic Science*, 9(1), 563-564
- Lim, h. And Ling, F.Y.Y (2002). Model for predicting clients' contribution to project success. *Journal of Engineering Construction and Architectural Management*, 9 (5-6),p.p 388-395
- Lindahl, G. & Ryd, N. 2007. Clients' goals and the construction project management process. *Facilities*, 25 (3/4), pp. 147-156.
- Ling, Y.Y. and Boo, J.H.S. (2001). Improving the accuracy of approximate estimates of building estimates. *Building Research and Information*, Vol. 29, No. 4, pp.312-318.
- Lingard, H. and Rowlinson, S.M. (2006). *Occupational health and safety in construction project management*. London: Taylor & Francis.
- Liu, A.M.M (1994). From act to outcome- a cognitive model of construction procurement. In proceedings of the CIB W-92 Procurement Symposium, Department of Surveying, The Univeristy of Hong Kong, 4th-7th December, Hong Kong,pp169-178.
- Liu, L. and Zhu, K. (2007). Improving cost estimates of construction projects using phased cost factors. *Journal of Construction Engineering and Management*, 133(1), pp. 91-95.
- London, K. and Everingham, P. (2006). Ethical behaviour in the construction procurement process. [online]. Available from: <http://www.construction-innovation.info/images/pdfs/Research_library/ResearchLibraryA/Project_Reports/Ethical_Behaviour_in_the_Construction_Procurement_Process.pdf> [Accessed 12 March 2012]

- Long, N.D., Ogunlana, S., Quang, T. and Lam, K.C. (2004). Large construction projects in developing countries: a case study from Vietnam. *International Journal of Project Management*, 22(7), pp. 553-561.
- Loo, R. (2002). Tackling ethical dilemmas in project management using vignettes. *International Journal of Project Management*, 29(7), pp. 489-495.
- Lopes, L.L. (1987). Between hope and fear: the psychology of risk. *Advances in Experimental Social Psychology*, 20, pp. 255-295.
- Lorance, R.B. & Wendling, R.V. (2001). Basic techniques for analysing and presenting cost risk analysis. *Cost Engineering*, 43(6), pp. 25-31.
- Lorance, R.B. and Wendling, R.V. (1999), *Basic techniques for analyzing and presenting cost risk analysis*, AACE Transactions, Risk. 01. 1-7
- Lovallo D. and Kahneman, D. (2003). Delusions of success: how optimism undermines executives' decisions. *Harvard Business Review*, 81(7), pp. 56.
- Love, P.E.D. (1996). Fast building: An Australian perspective. In Proceedings of CIB W-92 Procurement Systems Symposium, North Meets South, Developing Ideas, 14-17th January, Durban, South Africa, pp.329-343.
- Love, P.E.D. and Li, H. (2000) Quantifying the causes and costs of rework in construction. *Construction Management and Economics*, 18(4), 479-490.
- Love, P.E.D., Edwards, D.J., and Irani, Z. (2012). "Moving beyond optimism bias and strategic misrepresentation: *An explanation for social infrastructure project cost overruns.*" *IEEE Trans. Eng. Manage.* 59(4), 560-571.
- Love, P.E.D., Edwards, D.J., Watson, H. and Walker, D.H.T. (2009), "Project pathogens: The anatomy of omission errors in construction and resource engineering projects:", *IEE Transactions on Engineering Management*, 56(3), 425-435.
- Love, P.E.D., Irani, Z. and Edwards, D.J. (2004). A rework reduction model for construction projects. *IEEE Transactions on Engineering Management*, 51(4), pp. 426-440.
- Love, P.E.D., Skitmore, R.M. and Earl, G. (1998). Selecting a suitable procurement method for a building project. *Construction Management and Economics*, 16(2), pp. 221-223.

- Lowe, D.J., Emsley, M.W. and Harding, A. (2006). Predicting construction cost using multiple regression techniques. *Journal of Construction Engineering and Management*, 132(7), pp. 750-758.
- Lozon, J.P. (2008.) *Evaluating value improving practices for large scale projects*. Thesis (Ph). Alberta, Canada University of Calgary, Department of Civil Engineering.
- Luu, D.T., Ng, S.T. and Chen, S.E.(2003a). Parameters governing the selection of procurement system – an empirical survey. *Engineering, Construction and Architectural Management*, 10(3), pp. 209-218.
- Luu, D.T., Ng, S.T. and Chen, S.E. (2003b). A case-based procurement advisory system for construction. *Advances in Software Engineering*, 34(7), pp.429-438.
- Luu, D.T., Ng, S.T. & Chen, S.E. 2005. Formulating procurement selection criteria through case-based reasoning approach. *ASCE Journal of Computing in Civil Engineering*, 19(3), pp. 269-276.
- Mackie, P. and Preston, J. (1998) Twenty-one sources of error and bias in transport project appraisal. *Transp. Policy*, 5(1), 1-7.
- Mahamid, I. and Amund, A. (2010). Analysis of cost diverge in road construction projects. In: *Proceedings of the 2010 Annual Conference of the Canadian Society for Civil Engineering*, 9-12 June 2010, Winnipeg, Manitoba, Canada.
- Mak, S. and Picken, D. (2000). Using risk analysis to determine construction project contingencies. *ASCE Journal of Construction Engineering and Management*, 126(2), pp. 130-1377.
- Mak, S., Wong, J. and Picken, D. (1998). The effect on contingency allowances of using risk analysis in capital cost estimating: a Hong Kong case study. *Construction Management and Economics*, 16, 615-619.
- Maldonado, J. (1990). *Strategic planning: an approach to improving airport planning under uncertainty*. Unpublished thesis (MS). Cambridge, MA: Massachusetts Institute of Technology.

- Male, S. and Kelly, J. (1998). *Value management: the value management benchmark: research results of an international benchmarking study*. London: Thomas Telford Publishing.
- Male, S. (1990). Professional authority, power and emerging forms of 'profession' in quantity surveying. *Construction Management and Economics*, 8(2), p.191-204.
- Mann, T. (1992). *Building economics for architects*. Hoboken, NJ: Wiley & Sons.
- Manoliadis, O., Tsolas, T. and Nakou, A. (2006.) Sustainable construction and drivers of change in Greece: a Delphi study. *Construction Management and Economics*, 24(2), pp. 113-120.
- Mansfield, N.R., Ugwu, O.O. and Doran, T. (1994). Causes of delay and cost overruns in Nigeria construction projects. *International Journal of Project Management*, 12(4), pp. 254-60.
- Manz, C.C., Anand, V., Joshi, M. and Manz, K.P. (2008). Emerging paradoxes in executive leadership: a theoretical interpretation of the tensions between corruption and virtuous values. *The Leadership Quarterly*, 19(3), pp. 385-392.
- Maqsood, T., Finegan, A. and Walker, D. (2006). Applying project histories and project learning through knowledge management in an Australian construction company. *The Learning Organization Journal*, 13(1), pp. 80-95..
- Marjolein A.M.C. (2007). Vos JFJ. Investigating the use of the stakeholder notion in project management literature, a meta-analysis. *Project Management journal*.
- Marjuki, M. (2006). *Computerized building cost estimating system*. Unpublished thesis (MSc). Malaysia: University Teknologi Malaysia.
- Martin, J.M.F. and Stehmann, O.(1991). Product market integration versus regional cohesion in the community. *European Law Review*, 16(3), pp. 216-243.
- Maskell, B. and Baggaley, B. (2003). *Lean management accounting*. [online]. Available from <www.maskell.com> [Accessed 22 August 2012]

- Masterman, J. (1992). *An introduction to building procurement systems*. New York: Spon.
- Masterman, J.W.E. (1997). *An introduction to building procurement systems*. New York: Spon.
- Masterman, J.W.E. (2002). *Building procurement systems: an introduction*. New York: Spon.
- Matzdorf, F., Green, M., Megginson, D., Dale, M. and Kennie, T. (1997). *Learning to succeed*. London: Royal Institution of Chartered Surveyors.
- Mbachu, J. and Nkado, R. (2006). Conceptual framework for assessment of client needs and satisfaction in the building development process. *Construction Management and Economics*, 24(1), pp. 31-44.
- Mbamali, I., Aiyetan, A.O. and Kehinde, J.O. (2005). Building design for build ability: an investigation into the current practice in Nigeria. *Building and Environment*, 40(9), pp. 1267-1274.
- McCaffer, R., Mc Caffrey, M.J. and Thorpe, A. (1984). Predicting the tender price of buildings in the early design stage: method and validation. *Journal of Operational Research Society*, 35(5), pp. 415-424.
- McDevitt, R., Giaponi, C. and Tromley, C. (2007). A model of ethical decision making: the integration of process and content. *Journal of Business Ethics* 73(2), pp. 219-229.
- McDonald , M. (2002). Review of Large Public Procurement in the UK. *Guidance report prepared for the HM Treasury, London, UK*
- McDonald, G.M. and Zepp, R.A. (1988). Ethical perceptions of Hong Kong Chinese business managers. *Journal of Business Ethics*, 7(11), pp. 835-845.
- McMillan, J. (1992). *Games, strategies and managers*. New York: Oxford University Press.
- McNamara, C. (2008). *Problem-solving and decision-making*. [online]. Available from: <http://managementhelp.org/personalproductivity/problem-solving.htm> > [Accessed 18 February 2013]
- Mehta, S. (2003). MCI: is being good good enough? *Fortune*, 148(9), p. 117-124

- Merewitz, L. (1973). *Cost overruns in public works*. Berkeley, CA: University of California.
- Merrow, E. W. and Schroeder (1991). Understanding the cost and schedule of hydroelectric projects. *AACE International Transactions*, pp. 1.3.1-7.
- Merrow, E.W. and Yarossi, M.E. (1990). Assessing Project cost and schedule risk, *AACE Transactions*, H.6.2-7
- Meyer, T. and Semark, P. (1996). A framework for the use of competencies for achieving competitive advantage. *South African Journal of Business Management*, 27(4), pp. 96-103.
- Mezher, T.M. and Tawil, W. (1998). Cause of delays in the construction industry in Lebanon. Engineering. *Construction and Architectural Management*, 5(3), pp. 252-260.
- Mierzejewski, E.A. (1995). *A new strategic urban transportation planning process*. Tampa, FL: University of South Florida, Center for Urban Transportation Research.
- Minister of Finance. (1997). "Message ,"In Ministry of Finance and Public Works, green paper on Public Sector Procurement Reform in South Africa.(Published in Government Gazette, No 17928. April 14)
- Mkhize, Z.L. (2004). *Paper presented at Supply Chain Management Conference: Transforming Government Procurement System, November 22-23, Durban, South Africa.* [online] Available from: <<http://www.kznded.gov.za/Portals/.../SupplyChainManagementConference.doc>> [Accessed 5 July 2012]
- Mochtar, K. and Arditi, D.(2000). Pricing strategy in the US construction industry. *Construction Management and Economics*, 19(4), pp. 405-415.
- Mohammad, N., Che Ani, A.I., Rakmat, R.A.O.K. and Yusof, M.A. (2010) "Investigation on the Causes of Variation Orders in the Construction of Building Project – A Study in the State of Selangor, Malaysia", *Journal of Building Performance*, vol. 1, no.1, pp.73-82.

- Mok, C.K., Rao Tummala, V.M., and Leung, H.M. (1997). Practices barriers and benefits of risk management process in building services cost estimation. *Construction Management and Economics*. 15, 161-175.
- Mole, G., Plant, R. and Salaman, G. (1993). Developing executive competencies: learning to confront, confronting to learn. *Journal of European Industrial Training*, 17(2), pp. 3-7.
- Mole, T. (1991). Building Maintenance policy: Nebulous nevertheless necessary. In: Venmore-Rowland, P., Brandon, P., & Mole, T. Investment, Procurement and Performance in Construction. Proceedings of the First National RICS Research Conference held at Barbican Centre, 10-11 January. London: E & FN SPON
- Molenaar, K.R. and Wilson, C.R. (2009). A risk based approach to contingency estimation in highway project development. In: American Society of Civil Engineers (ed.). *Construction Research Congress 2009*, pp. 786-795.
- Molenaar, K.R. (2005). Programmatic cost risk analysis for highway megaprojects. *ASCE Journal of Construction Engineering and Management*, 131(3), pp. 343-53
- Molenaar, K.R. (2007). *Risk analysis tools and management practice to control transportation project cost: cost estimating and cost management in the planning process capacity building workshop, Minneapolis, 16 November 2007*. [online]. Available from: <http://www.cts.umn.edu/events/costestimating/2007-2008/documents/molenaar2007.pdf>. [Accessed 5 May 2012]
- Moore, P.G. (1983). *The business of risk*. Cambridge UK: Cambridge University Press.
- Morris, P. E. (1998). Legal regulation of contract compliance: an Anglo-American comparison. *Anglo-American Law Review*, 19(2), pp. 87-144.
- Morris, P.W.G. and Hough, G.H. (1987). *The anatomy of major projects: a study of the reality of project management*. New York: John Wiley & Sons.
- Morris, S. (1990). Cost and time overruns in public sector projects. *Economic and Political Weekly*, Xxv(47), pp. M154-M168.

- Morrison, N. (1984). The accuracy of quantity surveyors cost estimating. *Construction Management and Economics*, 2(1), pp. 57-75.
- Mortledge, R., Smith, A. and Kashiwagi, D.T.(2006). *Building procurement*. Oxford: Blackwell.
- Morton, R. and Jaggard, D. (1995). *Design and the economics of building*. London: Spon.
- Moselhi, O. (1997). Risk assessment and contingency estimating. *Transactions of the American Association of Cost Engineers*, 41, pp. A.06.1-A.
- Moshini, R.A. and Botros, A.F. (1990). PASCON: an expert system to evaluate alternative project procurement processes. In: Ireland, V. (ed.). *CIB 90: building economics and construction management*. Sydney: University of Technology, pp. 525-537.
- Mullins, D.R. (2003). *Accountability and coordination in a decentralised context: institutional, fiscal and governance issues*. Washington: DC. American University.
- Nahapiet, J. and Nahapiet, H. (1985). *The management of construction projects: case studies from the USA and UK*. Ascot: Chartered Institute of Building.
- Naoum, S.G. (1991). *Procurement systems and project performance: Occasional Paper 45*. London: Chartered Institute of Building.
- Napier, Z. and Liu, L. (2008). *The predictive validity and performance drivers of risk-based estimating: case studies of Australian water infrastructure projects.: proceedings of Project Management Institute Research Conference*. CD-ROM. Warsaw, Poland, [n.p.].
- Nassar, K. (2002). Cost contingency analysis for construction projects using spreadsheets. *Cost Engineering*, 44(9), pp. 26-35.
- National Audit Office. (2003). PFI: Construction performance (Report by the Comptroller and Auditor General HC 371 Session 2002-2003). London: Author.
- National Economic Development Office (NEDO). (1985). *Think about building: a successful business customer's guide to using the construction industry*. London: National Economic Development Agency.

- Navon, R. (1995). Resource-based model for automatic cash-flow forecasting. *Construction Management and Economics*, 13(6), pp. 501-510.
- Neale, H. and Neale, D. (1989). *Construction planning*. London: Thomas Telford.
- Nel, N. (1992). *Think tall: real estate has created more wealth than gold, diamonds or any other investment*. Pretoria: Executive Living.
- Newcombe, R. (1994). 'Procurement paths – a power paradigm' in S.M. Rowlinson (ed.) *East meets west: proceedings of CIB publication 175*, 243-50.
- Newman, O. (1996). *Creating defensible space, us department of housing and urban development*. Washington, DC: Office of Policy Development and Research.
- New South Wales Department of Commerce (2006). Procurement Method Selection Guidelines. July, <http://www.commerce.nsw.gov.au/Home.htm> [accessed 20 November 2013]
- Newton, S. (1991). An agenda for cost modelling research. *Construction Management and Economics*, 9(2), pp. 97-112.
- Newton, S. (1992). Methods of analyzing risk exposure in the cost estimates of high quality offices. *Construction Management and Economics*, 10(5), pp. 431-449.
- Nicholas, J.M. (2001). *Project management for business and technology: principles and practice*. 2nd edition. Upper Saddle River, NJ: Prentice-Hall.
- Nickols, F. (2010). *Change management 101: a primer*. [online]. Available from: <http://www.nickols.us/change.pdf>. [Accessed 10 June 2012]
- Nigerian Institute of Quantity Surveyors, (1988). Standard method of measurement of NIQS Lagos.
- Nkado, R.W. (2000). Competencies required by quantity surveyors in South Africa. In: Akintoye, A. (ed.). *16th Annual ARCOM Conference*, Glasgow Caledonian University, 6-8 September 2000. pp. 11-20.
- Ntamere, C.C. (1995) *Project Management: Theory and Practice*. African-Feb Publishers Ltd. Onitsha.
- Ntuen, C.A. and Malilik, A.K. (1987). Applying artificial intelligence to project cost estimating. *Cost Engineering*, 29(5), pp. 9-13.

- Nwachukwu C.C. (2008). The Analysis of Factors that Constraint Project Management Success of Public and Private Sector Construction in Nigeria, Ph.D Thesis, FUTO
- Nwachukwu,C.C and Emoh, F.I (2010) A system approach in analyzing material constraining factors to Factors to construction project management success in Nigeria. IJCRB Vol 2. No 5.pp 90-104
- Nwachukwu, C.C and Emoh F.I (2011). Building construction project management success as a critical issue in real estate development and investment. American Journal of Social and Management Sciences. 2(1),pp56-75
- Nwachukwu C.C., Emoh F.I. and Egolum C.C (2010). Equating Cost Constraint Factors to Construction Project Management Success in Nigeria (an analytical approach). UNIZIK Journal of Environmental Sciences, Vol 1, No 1 pp18.
- Nyaw, M and Ng, I (1994). A comparative analysis of ethical beliefs : a four country study. *Journal of Business Ethics*, 13, 543-555
- O'Brien, J.J. (1994). *Preconstruction estimating budget through bid*. New York: McGraw-Hill.
- O'Brien, J.J. (1998). *Construction change orders*. New York: McGraw-Hill.
- O'Leary, A.F. (1992). *Construction administration in architectural practice*. New York: McGraw-Hill.
- Oberlender, G. (1993). *Project management for engineering and construction*, McGraw-Hill, New York.
- Oberlender, G. D. and Trost, M. (2001). Predicting accuracy early cost estimates based on estimate quality. *Journal of Construction Engineering and Management*, 127(3), pp. 173-182.
- Odeck, J. & Skjeseth. T. (1995). Assessing Norwegian toll roads. *Transportation quarterly / Eno Foundation for Transportation*, 49(2), pp. 89-98.
- Odeck. J. (2004) Cost overruns in road construction – what are their sizes and determinants. *Transp. Pol.*, 11(1), 43-53.
- Odeh, A.M. and Battaineh, H.T. (2002). Causes of construction delay: traditional contracts. *International Journal of Project Management*, 20(1), pp. 67-73.

- Odusami, K.T., and Onukwube, H.N. (2008). Factors affecting accuracy of pre-tender cost estimate in Nigeria, *The construction and building research conference of the Royal Institution of Chartered Surveyors, COBRA*.
- Ofori, G. and Toor, S.R. (2009). Research on cross-cultural leadership and management in construction: a review and directions for future research. *Construction Management and Economics*, 27(2), pp. 119-133.
- Ofori, G. (2003). Frameworks for analyzing international construction. *Construction Management Economics*, 21(4), pp. 379-391.
- OGC (2003) Achieving excellence in construction-Procurement guide 06: Procurement and Contract Strategies, Office of Government Commerce,UK,London.
- Ogunsemi, D.R. (2007). Predicting the final cost of Construction Projects in Nigeria. *The Quantity Surveyors*, 54(4), pp. 3-6.
- Okpala, D.C. and Aiekwu, A.N. (1988). Causes of high costs of construction in Nigeria. *Journal of Construction Engineering and Management*, 114 (2), pp. 233-244.
- Olander, S. and Landin, A. (2008). A comparative study of factors affecting the external stakeholder management process. *Construction Management and Economics*, 26 (6), pp. 553-561.
- Olander, S. (2007) Stakeholder impact analysis in construction project management. *Construction Management and Economics*, 25(3), 277-287.
- Olusegun, A.E. (2010) Adjustments of Prime cost and Provisional Sums on Building Project in Nigeria: Causes, Effects and Solutions. *Journal of Applied Science Research*, 6(8): 1212-1214.
- Ostrena, M. R and Ozan, T.R. (1992). Guia da Ernst and Young para gestão total dos custos. 13 ed. Rio de Janeiro: Record.
- Oyedele, L.O. and Tham, K.W. (2007). Client's assessment of architects' performance in building delivery process: evidence from Nigeria. *Building and Environment*, 42(5), pp. 2090-2099.

- Padilla, A., Hogan, R. and Kaiser, R.B. (2007). The toxic triangle: destructive leaders, susceptible followers, and conducive environments. *The Leadership Quarterly*, 18(3), pp. 176-194.
- Park, H., Han, S. and Russell, J. (2005). Cash flow prediction model for general contractors using moving weights of cost categories. *Journal of Management in Engineering*, 21(4), pp.164-172.
- Parsons, E.L. (1999). *Waste management project contingency analysis*. Morgantown, WVA: U.S. Department of Energy, Federal Energy Technology Center.
- Patrascu, A. (1988). *Construction cost engineering handbook*. New York: Dekker.
- Peer, S. 1982. Application of cost-flow forecasting models. *Journal of the Construction Division*, 108(2), pp. 226-232, June.
- Perminova, O., Gustafsson, M., and Wikstrom, K. (2008). Defining Uncertainty in projects- a new perspective, *Journal of Project Management*, 26, 73-78.
- Phillip, O.F (2001). *Construction analysis and scheduling*. Prentice Hall. NJ. 2001
- Pickrell, D.H. (1990). *Urban rail transit projects: forecast versus actual ridership and costs*. Cambridge, MA: U.S. Department of Transport.
- Pinto, J.K. (1998). *Project management handbook*. San Francisco, CA: Project Management Institute.
- Pinto, J.K., and Slevin, D.P. (1989). Critical success factors in R & D projects. *Research Technology Management*, 32(1), pp. 31-35.
- Ploss, G.W. (1990). Cost manufacturing: dawn of a new era. *Production Planning and Control*, 1(1), pp. 61-68.
- PMBOK, (2004) "A Guide to the Project Management Body of Knowledge (PMBok)" 2004 Edition, The Project Management Institute, USA. 2004.
- Pohl, G. and Mihaljek, D. (1992) Project evaluation and uncertainty in practice: a statistical analysis of rate-of-return divergences of 1015 World Bank Projects. *World Bank Economic Review*, 6(2), 253-277.
- Ponpeng, J. and Liston, J.(2003). Contractor ability criteria: A review from the Thai construction industry. *Journal of Construction Management and Economics*, 21(3), pp. 267-282.

- Poon, J. (2004a). Factors influencing ethical decision making for surveyors. In: *Proceedings of the Construction and Building Research Conference (COBRA)*, Leeds Metropolitan University, Leeds, UK 7-8 September
- Poon, J. (2004b). The study of ethical behaviour of surveyors. In: *Proceedings of the Construction and Building Research Conference (COBRA)*, Leeds Metropolitan University, Leeds, UK 7-8 September
- Preece, C.N., Moodley, K. and Smith, P. (2003). *Construction business development: meeting new challenges, seeking opportunity*. London: Butterworth Heinemann.
- Preiser, W.F.E. (1995). Post-occupancy evaluation: how to make buildings work better? *Facilities*, 13(11), pp. 19-28.
- PMI (Project Management Institute). (2000). *A guide to the project management body of knowledge*. Newton Square, PA: PMI.
- PMI (Project Management Institute). (2004). *A guide to the project management body of knowledge*. 3rd edition. Newton Square, PA: PMI.
- PMI (Project Management Institute). (2008). *A guide to the project management body of knowledge (PMBOK Guide)*. 4th edition. Newton Square, PA: PMI.
- Prokesch, S.E. (1997). Unleashing the power of learning: an interview with British Petroleum's John Browne. *Harvard Business Review*, 75(5), pp. 146,
- Querns, W.R. (1989). What is contingency anyway? *AACE International Transactions*, pp. B.9.1-4.
- Rad, P.F. (2002). *Project estimating and cost management*. Vienna, VA: Management Concepts.
- Raftery, J., Pasadilla, B., Chiang, Y.H., Hui, E.C.M. and Tang, B.S. (1998). Globalization and construction industry development: implications of recent developments in the construction sector in Asia. *Construction Management and Economics*, 16(6), pp. 729-737.
- Rahman, H.A., Karim, S.B.A., Danuri, M.S.M., Berawi, M.A. and Yap, X.W. (2007). Does professional ethic affects construction quality? In: *Quantity Surveying International Conference*, Kuala Lumpur, Malaysia, 4-5 September 2007. Kuala Lumpur, Malaysia.

- Ramabodu, M.S., and Verster, J.J.P. (2010). Factors contributing to cost overruns of construction projects. In: *Proceeding of the 5th Built Environment Conference*, Durban, South Africa, 18-20 July 2010, pp. 131-143.
- Rameezdeen, R. (2007). Image of the construction industry. In: Sexton, M., Kähkönen, K. & Lu, S. (eds). *CIB priority theme: revaluing construction, a W065 organization and management of construction perspective*, CIB Publication 313, pp. 76-87.
- Ramus, J.W. (1981) *Contract Practice for Quantity Surveyors*. Heinemann: London.
- Ranasinghe, M. (1994). Contingency allocation and management for building projects. *Construction Management and Economics*, 12(3), pp. 233-243.
- Randolph, D.A., Rajandra, K. and Campfield, J.J. (1987). Using risk management techniques to control construction costs. *Journal of Construction Engineering and Management*, 3(4), pp. 314-324.
- Revell, J. (2003). The fires that won't go out. *Fortune*, 148(8), p. 139.
- Republic of South Africa. 1998. Commissions of Inquiry Act 11 Of 1998. Pretoria: Government Printer.
- Republic of South Africa. 2000. Preferential Procurement policy Framework Act 5 of 2000. Pretoria: Government Printer.
- Republic of South Africa. 1999. Public Finance Management Act 29 of 1999. Pretoria: Government Printer.
- Republic of South Africa. Treasury. 2004. Supply Chain Management : A Guide for Accounting Officers Authorities. Pretoria: Government Printer.
- RIBA (2000), *The Architect's Plan of Work*, Royal Institute of British Architects, London.
- Ritz, G. (1994). *Total construction project management*. New York: McGraw-Hill.
- Road Costs Knowledge System (ROCKS). (2002). *Transport Unit-TUDTR*. [online]. Available from: <http://www.worldbank.org/transport/roads/rd_tools/rocks_main.html>. [Accessed 4 August 2010].

- Root, D. (2001). *The Influence of professional and occupational cultures on project relationships mediated through standard forms and conditions of contract*. Unpublished thesis (PhD). Bath: University of Bath.
- Root, D., Fernie, S. and Baldwin, A. (1999). The languages of product and services: barriers to the integration of construction and design. In: *Proceedings of the 15th ARCOM Conference*, Liverpool John Moores University, Liverpool, Vol.1, pp. 181-190.
- Rose, A. (1982). An organized approach to parametric estimating. Transactions of the seventh International Cost Engineering Congress. London, England
- Rowe, J.F. (2006). A construction cost contingency tracking system (CTS). *Cost Engineering*, 48(2), pp. 31-37.
- Rowland, M. (1981). *The causes and effects of change orders on the construction proces*. Thesis (MS in CE). Georgia, ATL: Georgia Institute of Technology.
- Rowlinson, S. (1999). Selection criteria. In: *Procurement Systems: A Guide to Best Practice* (eds S. Rowlinson & P. McDermott), pp. 276-299. E and F.N. Spon, London.
- Royal Institution of Chartered Surveyors (RICS). (1971). *The future role of the quantity surveyor*. London: Royal Institution of Chartered Surveyors.
- Royal Institution of Chartered Surveyors (RICS). (1998). *The APC requirements and competencies*. London: Royal Institution of Chartered Surveyors.
- Risk Management Standards Australia (1999). *Risk management: AS/NZS 4360*. Strathfield, NSW: Standards Association of Australia.
- Ryan, J. (2004). *Predicted and actual ridership for recent new starts project (P04-1165): Presentation at the 83rd Annual TRB Meeting*, 13 January 2004, Session 501. Washington, DC: National Research Council.
- SAVE International (1997). U.S. Government Value Engineering Requirement, <http://www.value-eng.com/aboutgov.html>, [accessed 12 August 2013]
- Sanders, S.R., Maxwell, R.R., and Glagola, C.R. (1992). Preliminary estimating models for infrastructure projects. *Cost Engineering*, 34(8), pp. 7-13.

- Schaubroeck, J., Walumbwa, F.O., Ganster, D.C. and Kepes, S. (2007). Destructive leader traits and the neutralizing influence of an “enriched” job. *The Leadership Quarterly*, 18(3), pp. 236-251.
- Schermerhorn, J.R., Hunt, J.G. and Osborn, R.N. (2003). *Organizational behaviour*. 8th edition. New York: Wiley.
- Schexnayder, C.J. & Mayo, Richard E. (2003). *Construction management fundamentals*. Boston, MA: McGraw-Hill Higher Education.
- Schottlander, D.E. (2006). How accurate are your estimates? *AACE International Transactions EST.17:EST.17.1-17.6*.
- Seeley, I.H. (1984) *Quantity Surveying Practice*. MacMillan: England
- Seeley, I.H. (1976). *Building economics*. London: Macmillan Press.
- Seeley, I.H. (1983). *Building economics: appraisal and control of building design cost and efficiency*. 3rd edition. London: MacMillan Press.
- Semple, C., Harman, F.T. and Jergeas, G. (1994). Construction claims and disputes: Causes and cost/time overruns. *Journal of Construction Engineering and Management*, 120(4), pp. 785-795.
- Serpell, A.F. (2005). Improving conceptual cost estimating performance. *AACE International Transactions*, pp. EST.13:EST.13.1–13.6.
- Shaheen, A.A., Fayek, A.R. and AbouRizk, S.M. (2007). Fuzzy numbers in cost range estimating. *Journal of Construction Engineering and Management*, 133(4), pp. 325-334.
- Sharp, D., Mashigo, P., and Burton, P. (1999). *Assessment of Public Sector Procurement to Small, Medium and Micro-enterprises*. Pretoria, South Africa: Ntsika Enterprise Promotion Agency.
- Shash, A. A. and Ibrahim, A.D. (2005). Survey of procedures adopted by A/E firms in accounting for design variables in early cost estimates. *Journal of King Saud University*, 18(1), pp. 1-17.
- Shash, A.A. and Al-Khaldi, Z. (1992). The production of accurate construction cost estimates in Saudi Arabia. *Cost Engineering*, 34(8), pp. 15-24.
- Shash, A.A. (1993). Factors considered in tendering decisions by top UK contractors. *Construction Management and Economics*, 11(2), pp.111-118.

- Shen, Q., Chung, H.J. and Hui, P. (2004). A framework for identification and representation of client requirements in the briefing process. *Construction Management and Economics*, 22(2), pp. 213-221.
- Shezi, S. (1998). *Public Sector Procurement as an Instrument of Government Policy. Paper presented at the 9th International Public Procurement Association Conference, June 8, Copenhagen, Sweden.* [Online]. Available from <www.info.gov.za/speeches/1998/990514123p1010.htm> [Accessed 28 July 2004].
- Sidwell, A.C. (1982). *A critical study of project team organisational forms within the building process.* Thesis (Ph.D). Birmingham: The University of Aston in Birmingham, Department of Construction and Environmental Health.
- Sidwell, A.C., Kennedy, R., and Budiawan, D. (2001). Literature Review Value Alignment Process for Project Delivery. Research Program C, Construction Project Delivery Strategies, Report 2001-003-C-04, Cooperative Research Centre for Construction, Queensland University of Technology, Brisbane, Australia.
- Simon. P., Hillson. D., and Newland. K. (1997) (eds). *Project Risk Analysis and Management (PRAM) Guide*, APM Group, High Wycombe, Bucks UK, ISBN 0-9531590-0-0
- Singh, J.S. Lauenroth, W.K., Hunt, H.W. and Swift, D.M. (1984). Bias and random errors in estimators of net root production: a simulation approach. *Ecology*, 65(6), pp. 176-1764.
- Skitmore R.M. and Wilcock, J. (1994). Estimating processes of smaller builders. *Construction Management and Economics*, 12(2), pp. 139-154.
- Skitmore, M. And Picken, D. (2000). The accuracy of pre-tender building price forecasts: an analysis of USA data. *Australian Institute of Quantity Surveyors Refereed Journal*. Vol.4, No.1, pp.33-39.
- Skitmore, M., Stradling, S., Tuohy, A. and Mkwezalamba, H. (1990). *The accuracy of construction price forecasts: a study of quantity surveyors' performance in early stage estimating.* Salford: University of Salford.

- Skitmore, R.M., and Marsden, D.E. (1998). Which procurement system? Towards a universal procurement selection technique. *Construction Management and Economics*, 6, pp.71-89.
- Slevin, D.P. and Pinto, J.K. (1986). The project implementation profile: new tool for project managers. *Project Management Journal*, 17(4), pp. 57-70.
- Slevin, D.P. and Pinto, J.K. (1997) Balancing Strategy and Tactics in Project Implementation. *Sloan Management Review*, 29(6), pp. 33-41.
- Slovic, P. (1987). Perception of risk. *Science*, 236(4799), pp. 280-285
- Smith, A.J. (1995). *Estimating, tendering and bidding for construction*. London: Macmillan.
- Smith, J. and Wyatt, R. (1998). Criteria for Strategic Decision Making at the Pre-Briefing Stage, In: Hughes, W. (ed.). *Proceedings of the 14th Annual Conference of the Association of Research in Construction Management (ARCOM)*, Reading University, Reading, 9-11 September 1998, pp. 300-309.
- Smith, N.J. (1999). *Management Risk in Construction Projects*. Blackwell Science Ltd, Editorial Offices.
- Sodikov, J. (2005). Cost estimation of highway projects in developing countries: artificial neural network approach. *Journal of the Eastern Asia Society for Transportation Studies*, 6, pp. 1036 – 1047.
- Songer, A., Chinowsky, P. and Butler, C. (2006). Emotional intelligence and leadership behaviour in construction executives. In: *Proceedings of the 2nd Specialty Conference on Leadership and Management in Construction*, Grand Bahama Island, Bahamas, 4-6 May. Louisville, CO: PM Publishing, pp. 248-258.
- Songer, A.D., and Molenaar, K.R. (1997). "Appropriate Project Characteristics for Public Sector Design-Build Projects," *ASCE Journal of Construction Engineering and Management*, March, 1997, Vol. 123, No.1
- Sonmez, R., Ergin, A. and Birgonul, T. (2007). Quantitative methodology for determination of cost contingency in international projects. *Journal of Management in Engineering*, 23(1), pp. 35-39.

- Spencer, N. and Winch, G. (2002). *How buildings add value for clients*. London: Thomas Telford Ltd.
- Stallworthy, E.A. 1980. Development in project cost control. *The Cost Engineer*, 19(2), pp. 6-10.
- Standards Australia.(1999). Risk Management. AS/NZS 4360: 1999
- Stansbury, N. (2005). *Exposing the foundations of corruption in construction: global corruption report*. [online]. Available from: <www.transparency.org/publications/gcr/gcr_2005> [Accessed 18 February 2013]
- Stewart, J. and Hamlin, B. (1992). Competency-based qualifications: the case for established methodologies. *Journal of European Industrial Training*, 16(10), pp. 9-16.
- Stewart, R.D. (1991). *Cost estimating*. 2nd edition. New York: Wiley & Sons.
- Stoker, D.J. (1981). Steekproefopneming in die praktyk. Pretoria: Universiteit van Pretoria.
- Sutherland, J. (1999). Project cost estimating for major renovation projects. AACE International Transactions, 43rd Annual Meeting, pp EST 05.1-EST.05.7.
- Swedish Construction Clients Forum. (2006). *The role and mission of the construction client*. Stockholm: Byggherrarna.
- Swedish Planning and Building, Act PBL (1995) Plan- och bygglag (1987:10)9 kap. Byggnadsarbeten, tillsyn och kontroll & 1 Lag 1995:1197. "Svenk författningssamling. Stockholm": Miljödepartementet.
- Tah, J.H.M., Thorpe, A. and McCaffer, R. (1994). A survey of indirect cost estimating in practice. *Construction Management and Economics*, 12(1), 31-36.
- Thompson, P.A. and Perry, J.G. (1992). *Engineering construction risks: a guide to project risk analysis and risk management*. London: Tomas Telford.
- Tian, Q. (2008). Perception of business bribery in China: the impact of moral philosophy. *Journal of Business Ethics*, 80(3), pp. 437-445.
- Toor. S.R and Ofori, G (2007). Ethics and authenticity of leadership in the construction industry in T.C. Haupt and R. Milford (eds.), proceedings of CIB

- World Building Congress on 'Construction for development' 14-18 May, Cape Town, South Africa.
- Toor, S. and Ogunlana, S.O. (2008). Problems causing delays in major construction projects in Thailand. *Construction Management and Economics*, 26(4), pp. 395-408.
- Toor, S.R. and Ofori, G. (2008a). Leadership in the construction industry: agenda for authentic leadership. *International Journal of Project Management*, 26(6), pp. 620-630.
- Toor, S.R. and Ofori, G. (2008b). Developing construction Professionals of the 21st century. Renewal vision for leadership. *Journal of Professional Issues in Engineering Education and Practice*, 134(3), pp. 279-286.
- Touran, A. and Lopez, R. (2006). Modelling cost-escalation in large infrastructure project. *Journal of Construction Engineering and Management*, 132(8), pp. 853-860.
- Touran, A. (1992) Monte Carlo technique with correlated random variables. *Journal of Construction Engineering and Management*, 118(2), pp. 258-272.
- Touran, A. (2003). Probabilistic model for cost contingency. *Journal of Construction Engineering and Management*, 129(3), pp. 280-284.
- Transparency International. (2006). *Preventing corruption on construction projects: risk assessment and proposed actions for funders*. Available from: www.transparency.org/content/download/2228/1048/file/2_TI-ACF_Report_Risk_Assessment_Funders.pdf [Accessed 24 March 2013]
- Trevino, L.K. and Brown, M.E. (2004). Managing to the ethical: debunking five business ethic myths. *Academy of Management Executive*, 18(2), pp. 69-81.
- Trost, S. M. and Oberlender, G.D. (2003). Predicting accuracy of early cost estimates using factor analysis and multivariate regression. *Journal of Construction Engineering and Management*, 129(2), pp. 198-204.
- Trueman, P. (2004). *Capital works decision-making using risk management techniques*. Unpublished manuscript.
- Trujillo, L., Quinet, E. and Estache, A. (2002). Dealing with demand forecasting games in transport privatization. *Transport Policy*, 9(4), pp. 325-334.

- Tucker, S.N. (1984). *Building cash flows and life cycle costing. High-rise construction: Techniques and management for the 1990's. Conference papers, CIB84*. Singapore: Singapore University Press.
- Tummala, V.M.R., Leung, H.M., Mok, C.K., Burchett, J.F. and Leung, Y.H. (1997). Practices, barriers and benefits of using risk management approaches in selected Hong Kong industries. *International Journal of Project Management*, 15(5), pp. 297-312.
- Turner, J. R. (1993). *The handbook of Project-based Management*. McGraw-Hill.
- Turpin, C. (1989). *Government procurement and contracts*. London: Longman.
- Tversky, A. and Kahneman, D. (1974) Judgement under uncertainty: Heuristics and biases. *Sciences*, 185, 1124-1131
- Uman, D. (1990.) Is a standard needed for estimating building design and construction costs? *Cost Engineering*, 32(8), pp. 7-10.
- Van Reil, C. (1997). *Communication management*. 4th edition. New York: John Wiley.
- Vee, C. and Skitmore, M. (2003). Professional ethics in the construction industry. *Engineering Construction and Architectural Management*, 10(2), pp. 117-27.
- Veenedaal, J.A. (1998) Analysing the Impact of Change Orders on a Schedule. *Cost Engineering*, 40(9), 33039.
- Vennström, A. (2008). *The construction client as a change agent: contextual support and obstacles*. Thesis (PhD). Lulea: Lulea University of Technology.
- Vergara, A.J. and Boyer, L.T. (1974). Probabilistic approach to estimating and cost control, *Journal of the Construction Division*, 100(4), pp. 543-552.
- Verster, J.J.P. and Berry, F.H. (2005). The property development challenge: creating wealth through regional and rural projects. *Acta Structilia*, 12(1), pp. 20-40, June.
- Wachs, M. (1990). Ethics and advocacy in forecasting for public policy. *Business and Professional Ethics Journal*, 9(2), pp. 141-157.
- Walker, D.H.T. and Rowlinson, S. (2008). *Procurement systems: a cross-industry project management perspective*. New York: Taylor & Francis.

- Walker, D.H.T. (1995). An investigation into construction time performance. *Construction Management and Economics*, 13(3), pp. 265-74.
- Walker, H., Lester, W.J. and Sean, L. (2006). Re-thinking the conceptualization of customer value and service quality within the service-profit chain. *Managing Service Quality*, 16(1), pp. 23-26.
- Walker, H.T.D. and Shen, J.Y. (2002). Project understanding, planning, flexibility of management action and construction time performance: two Australian case studies. *Construction Management and Economics*, 20(1), pp. 31-44.
- Wasserman, B. (2000). *Ethics and practice of architecture*. New York: McGraw-Hill.
- Watermeyer, R. (2000). The use of targeted procurement as an instrument of poverty alleviation and job creation in infrastructure projects. *Public Procurement Law Review*, 9(5), pp. 226-250.
- Wideman, R.M. (1992) *Project and program risk management: a guide to managing risks and opportunities*. Dexcel Hill Pa: PMI
- Wideman, R.M. (1995). *Cost control of capital projects and the project cost management system requirements*. Richmond, BC: BiTech.
- Willis, C.J., Ashworth, A. and Wills, J.A. (1994). *Practice and procedure for the quantity surveyor*. 10th edition. Oxford: Blackwell Science.
- Wilmot, C.G. and Cheng, G. (2003). Estimating future highway construction costs. *Journal Construction Engineering and Management*, 129(3), pp. 272-279.
- Xueqing, Z. (2005). Critical success factor for public-private partnership in infrastructure. *Journal of Construction Engineering and Management*, 131(1), pp. 3-14.
- Yakub, A. (2005). Keynote address. In: *Proceedings of the 22nd Biennial Quantity Surveyors' National Convention sustaining the profession: towards diversification*, Kuala Lumpur, Malaysia, 10-11 August 2005. Kuala Lumpur: University of Malaysia.
- Yakubu, O. and Sun, M. (2009). Cost and time control of construction projects: A survey of contractors and consultants in the UK. *Construction Information Quarterly*, 11(2), pp. 53-59.

- Yang, J.B. and Peng S. (2008). Development of a customer satisfaction evaluation model for construction project management. *Building and Environment*, 43(4), pp. 458-468.
- Yates, J.F. (ed.). (1992). *Risk-taking behaviour*. Chichester, UK: J Wiley
- Yeo K.T. (1990). Risks, classification of estimates and contingency management. *Journal of Management in Engineering*, 6(4), pp. 458-470.
- Yu, A.T.W., Shen, G.Q.P., Kelly, J. and Hunter, K. (2006). A How-To Guide to Value Briefing, The Hong Kong Polytechnic University.
- Yu, W., (2006). PIREM: a new model for conceptual cost estimation. *Construction Management and Economics*, 24(3), pp. 259-270.
- Yusuf, G.A., Mohamed, S.F., Yusof, Z.M and Misnan, M.S. Framework for Enhancing Cost Management of Building Services. International Congress on Interdisciplinary Business and Social Science. 65(2012)697-703.
- Zabid, A.R. M. and Alsagoff, S.K. (1993). Perceived ethical values of Malaysian managers. *Journal of Business Ethics*, 12(4), pp. 331-337.
- Zaimi, A.M. (1997). *Non-excusable delay in construction*. Thesis (PhD). Loughborough: Loughborough University.
- Zeitoun, A.A. and Oberlander, D.O.G. (1993). *Early warning signs of project changes. Document 91*. Austin, TX: Construction Industry Institute.
- Zeynalian, M., Trigunarsyah, B. and Ronagh, H.R. (2013). Modification of advanced programmatic risk analysis and management model for the whole project life cycle's risks. *Journal of Construction Engineering and Management*, 139(1), pp. 51-59.

APPENDIX A: Questionnaire

COST PLANNING FOR THE WHOLE LIFE OF PROPERTY DEVELOPMENT PROJECT

Please use **X** to mark the box that indicates your opinion regarding the answer most applicable to you

Notes: This questionnaire is for research purposes only.
The name of respondents will not be revealed without prior consent.

PART 1: PROFILE OF THE RESPONDENT

1.1 Sector

1.1.1	Private sector	
1.1.2	Provincial government	
1.1.3	National government	X
1.1.4	Local government	
1.1.5	Other (please specify)	

1.2 Industry

1.2.1	Architecture	
1.2.2	Quantity surveying	X
1.2.3	Engineering	
1.2.4	Project management	
1.2.5	Construction	
1.2.6	Other (please specify)	

1.3 Gender

1.3.1	Male	X
1.3.2	Female	

1.4 Highest Tertiary Qualification

1.4.1	Grade 12	
1.4.2	National diploma	
1.4.3	B.Tech	X
1.4.4	B.Sc.	
1.4.5	B.Sc. (Hons.)	
1.4.6	Masters	
1.4.7	Ph.D.	
1.4.8	Other (please specify)	

1.5 Professional Registration

1.5.1	Architectural	
1.5.2	Quantity surveying	
1.5.3	Engineering	
1.5.4	Project management	
1.5.5	Construction	
1.5.6	Other (please specify)	x

1.6 Please specify the name of your council.....

1.7 Years of experience in your field

1.7.1	0-3 years	
1.7.2	3-5 years	
1.7.3	5-10 years	X
1.7.4	≥ 10 years	

1.8 What position do you hold in your company

1.8.1	Director	
1.8.2	Quantity surveyor	
1.8.3	Project manager	
1.8.4	Engineer (please specify)	
1.8.5	Construction manager	
1.8.6	Estimator	
1.8.7	Other (please specify)Engineer Technician Control - QS.....	X

Please indicate your opinion related to the level of importance in respect of the listed statements, by using **X** to mark the box that indicates your opinion regarding the level or answer most applicable to you. Please answer all questions.

- The scale is as follows:**
1. Strongly disagree
 2. Disagree
 3. Neither agree nor disagree
 4. Agree
 5. Strongly agree

PART 2: FACTORS THAT CONTRIBUTE TO PROJECT FAILURES

2.1 The following factors may lead to project failure

		1	2	3	4	5
2.1.1	Quality			X		
2.1.2	Time		X			
2.1.3	Cost					X
2.1.4	Scope				X	
2.1.5	Other (please specify)					

2.2 The following statements are pressures that are imposed by clients to projects

		1	2	3	4	5
2.2.1	Unrealistic delivery time				X	
2.2.2	Complicated client brief					X
2.2.3	Political interest in blue chip projects			X		
2.2.4	Organisations involved in projects has increased				4	
2.2.5	Fixed budget			X		
2.2.6	Red tape by treasury				X	
2.2.7	Under staffed with technical personnel					X

2.3 The following aspects are some of the challenges faced by quantity surveyors in performing their duties

		1	2	3	4	5
2.3.1	Changes without revisions of drawings					X
2.3.2	Ability to keep expenditure within the allowed budget					X
2.3.3	Final account exceed the first estimate				X	
2.3.4	No consultation by the project manager / principle agent					X

PART 3: FACTORS AFFECTING ACCURACY OF PROJECT ESTIMATES

3.1 The important issues in project estimating are

		1	2	3	4	5
3.1.1	Measurements				X	
3.1.2	Pricing				X	
3.1.3	Information				X	
3.1.4	Other (please specify) ...Methods of Construction				x	

3.2 According to past experience this is how close the project estimate is to the tender amount, awarded to the contractor

		1	2	3	4	5
3.2.1	Less than 5%				x	
3.2.2	Less than 10%				x	
3.2.3	Less than 15%				x	
3.2.4	More by 5%					x
3.2.5	More by 10%					x
3.2.6	More by 15%					x
3.2.7	Other (please specify)					

3.3 The following programmes are the most preferred ones used by quantity surveyors to prepare Bill of Quantities

		1	2	3	4	5
3.3.1	WinQS				x	
3.3.2	Excell					x
3.3.3	QS-Plus			x		
3.3.4	CCS			x		
3.3.5	Other (please specify)					

3.4 Bill of Quantities are mostly issued to tenderers in the following manner

		1	2	3	4	5
3.4.1	Hard copy					x
3.4.2	Soft copy	x				
3.4.3	Other (please specify)					

3.5 The following estimating methods are used by cost planners to yield project success

		1	2	3	4	5
3.5.1	Area method					x
3.5.2	Storey enclosure method				x	
3.5.3	Elemental estimate		x			
3.5.4	Rough quantities	x				
3.5.5	Other (please specify)					

3.6 Does experience play a role in the accuracy of the estimate?

3.6.1	Yes					x
3.6.2	No					
3.6.3	If yes, please explainThe accuracy of the estimates is based on the know-how gained from a lot of experience, the more you know the more skilled and accurate you become – you will understand the construction methods better, you will acquire good skill on do’s and don’ts on market rates related matters.....					

3.7 The following are recommendations on how estimates can be improved

		1	2	3	4	5
3.7.1	Ability to check for errors				x	
3.7.2	Recognizing inflation factors					x
3.7.3	Pricing risk separately				x	
3.7.4	Experienced staff to do estimates				x	
3.7.5	Other (please specify)					

3.8 What is your ideal profile of an estimator?

		1	2	3	4	5
3.8.1	Someone who is able to work under pressured				x	
3.8.2	Interested in prices and financial viabilities					x
3.8.3	Inquisitive on market conditions				x	
3.8.4	Good level of accuracy				x	
3.8.5	Be able to pay attention to detail					x
3.8.6	Contemporary to construction developments				x	
3.8.7	Other (please specify)					

**3.9 The following factors has an influence in the accuracy of the estimate
(factor related to consultants and design parameters)**

		1	2	3	4	5
3.9.1	The experience and skill level of the estimator				x	
3.9.2	Project team's experience in the construction type				x	
3.9.3	Designer's experience level				x	
3.9.4	Number of estimating team members					x
3.9.5	Availability of all consultants of specialization in the project team				x	
3.9.6	Project team's capability to control the project				x	
3.9.7	Level of involvement of the project manager		x			
3.9.8	Quality of information and information flow requirements				x	
3.9.9	Data base of bids on similar project (Historical cost data)		x			
3.9.10	Completeness of cost information				x	
3.9.11	Accuracy of reliability of cost information				x	
3.9.12	Procedure for updating cost information					x
3.9.13	Utilization of checklists to ensure completeness and technical basis					x
3.9.14	Quality of the assumptions used in preparing the estimate				x	
3.9.15	Estimating method used				x	
3.9.16	Volume of estimator's workload during estimating					x
3.9.17	Time allowed for preparing the cost estimate			x		
3.9.18	Completeness of project documents				x	
3.9.19	Clear and detail drawings and specifications					x
3.9.20	Build ability of design				x	
3.9.21	Level of communication with client and other design team consultants				x	
3.9.7	Other (please specify)					

**3.10 The following factors has an influence in the accuracy of the estimate
(related to project characteristics)**

		1	2	3	4	5
3.10.1	Type of project (residential, commercial, industrial ...etc)					x
3.10.2	Type of structures				x	
3.10.3	Project size		x			
3.10.4	Project duration		x			
3.10.5	Location of project		x			
3.10.6	Site condition (topography etc)				x	
3.10.7	Site constraint (access etc)				x	
3.10.8	Project complexity				x	
3.10.9	Method of construction techniques					x
3.10.10	Impact of project schedule			x		
3.10.11	Other (please specify)					

PART 4: ALLOCATION OF CONTINGENCIES IN PROJECT ESTIMATES

4.1 What approach do you use to allocate contingency for project risk during estimating?

		1	2	3	4	5
4.1.1	Price and detail development contingencies			x		
4.1.2	Building contract contingencies				x	
4.1.2.5	Other (please specify)					

4.2 The following are factors you may take into account for contingency allowance

		1	2	3	4	5
4.2.1	Client risk items				x	
4.2.2	Insufficient information					x
4.2.3	Budgetary items				x	
4.2.4	Lack of details from drawings					x
4.2.5	Other (please specify)					

4.3 The following percentages are used in allocating contingencies to project estimates

		1	2	3	4	5
4.3.1	10% of the estimated amount					x
4.3.2	5% of the estimated amount				x	
4.3.3	2.5% of the estimated amount		x			
4.3.4	Other (please specify)					

PART 5: FACTORS INFLUENCING THE PERFORMANCE OF CONTRACTORS

5.1 The following factors contribute to poor performance by contractors in respect of cost and time

		1	2	3	4	5
5.1.1	Incompetent construction project managers				x	
5.1.2	Bad construction management					x
5.1.3	Insufficient control on site				x	
5.1.4	Lack of good planning					x
5.1.5	Miss communication				x	
5.1.6	Shortage of educated and skilled labourers				x	
5.1.7	Unrealistic programmes					x
5.1.8	Tight profit margins				x	
5.1.9	Working load of contractors					x
5.1.10	Natural causes				x	
5.1.11	Constructability of designs			x		

PART 6: FACTORS CONTRIBUTING TO COST OVER-RUNS OF PROJECTS

6.1 Do clients understand the word cost over-run in a project?

6.1.1	Yes	
6.1.2	No	x
6.1.3	Other (please specify)	

6.2 Do clients understand the role of the quantity surveyor in a project?

6.2.1	Yes	
6.2.2	No	x
6.2.3	Other (please specify)	

6.3 The critical factors contributing to cost over-runs are:

		1	2	3	4	5
6.3.1	Provisional Bills of Quantities				x	
6.3.2	Incomplete design at time of tender				x	
6.3.3	Delays in costing variation and additional works					x
6.3.4	Change in scope of work on site					x
6.3.5	Lack of cost planning and monitoring of funds				x	
6.3.6	Unexpected unmeasured conditions on site					x
6.3.7	Completeness of design and specifications during compilation of Bills of Quantities			x		
6.3.8	Other (please specify)					

6.4 Moderate critical factors contributing to cost over-runs are:

		1	2	3	4	5
6.4.1	Requirement to have a minimum cidb rating		x			
6.4.2	Good and effective communication between parties				x	
6.4.3	Ignoring items with abnormal rates during tender evaluation, especially items with provisional quantities					x
6.4.4	Lack of timeous cost reports during construction stage					x
6.4.5	Delays in issuing information to the contractor during construction stage				x	
6.4.6	Other (please specify)					

6.5 Less critical factors contributing to cost over-runs are:

		1	2	3	4	5
6.5.1	Omission and errors in the Bills of Quantities				X	
6.5.2	Clarity of drawings and documentation: Variation orders					X
6.5.3	Adjustment of prime cost				X	
6.5.4	Re-measurement / adjustment of provisional sums				X	
6.5.5	Distribution of state budget (financial year)				X	
6.5.6	Other (please specify)					

PART 7: FACTORS THAT MAY IMPROVE PROCUREMENT POLICIES

7.1 Procurement success guidelines for the delivery of projects are:

		1	2	3	4	5
7.1.1	Project team that has been selected on the basis of their competence				X	
7.1.2	Sufficiently skilled and resourced to deliver the project successfully					X
7.1.3	Responsibility and accountable for their services				X	
7.1.4	Has sufficient time been allowed for design estimating stage				X	
7.1.5	Effective communication with stakeholders				X	
7.1.6	Reasonable design & construction programme				X	
7.1.7	Careful selection of materials					X
7.1.8	Careful selection of a procurement method				X	
7.1.9	Other (please specify)					

7.2 Procurement policy considerations

In order to eliminate cost over-runs and irregularities in the award of tenders, the following criteria may be used:

		1	2	3	4	5
7.2.1	The lowest evaluated tender in price, based on prescribed criteria must be awarded					
7.2.2	Bid document must include evaluated and adjudication criteria					
7.2.3	Abnormally low tenders may be verified to ensure ability to perform					
7.2.4	The procuring entity may decide not to award the contract if there is no responsive tenderer					
7.2.5	Obvious errors in the tender document should be corrected before adjudication of tenders can proceed					
7.2.6	Tenderers must confirm to the essentials requirements of the notice or tender documentation					
7.2.7	Estimates must be known to tenderers before hand					
7.2.8	Tenderers must be allowed to make presentation on how they will carry out the project					
7.2.9	Presentation by contractor on project plan					
7.2.10	Presentation by contractor on cost plan for the duration of the project					
7.2.11	Presentation by contractor on his company's capability to complete the work before award can be done					
7.2.12	Appointment of validating agency to validation tender awards and appointment					

General comments:I believe this will improve the level of service delivery.

.....

THANK YOU!!!!



APPENDIX B: Case study of school projects

**UNIVERSITY OF THE FREE STATE
DEPARTMENT OF QUANTITY SURVEYING AND CONSTRUCTION
MANAGEMENT**

Dear colleague

Kindly assist by completing the attached survey form on **cost performance of school projects** that your company has completed in the past, also indicate in which year the school was initiated, completed and whether it is a primary, intermediate or secondary school. Kindly return the completed form by e-mail: ramabodums@ufs.ac.za or by fax to 051 – 4480952. Your contribution is seen as most valuable and will be highly appreciated.

Personal data:.....

Degree:.....

Position:.....

Time in business: Years:.....

COMPLETE THIS FORM FOR SCHOOL PROJECTS COMPLETED BY YOUR FIRM IN THE PAST

COST RELATED ITEMS

TIME RELATED ITEMS

COST RELATED ITEMS									TIME RELATED ITEMS		
Project name (Year of construction)	QS estimate (Excl fees)	Tender amount (Excl VAT)	Final account (Excl VAT)	Original P&G	Adjustment of P&G in final account	Original prov. sums	Adjustment of prov. Sums in final account	Contingen- cies in QS estimate	Duration of project to practical completion	Extension of time awarded (in months)	Reasons for extension
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											
9.											
10.											