

•
•
•
•
•
•
•
•

94 Parkmead Avenue, Centenary
Park, Phoenix,
Durban
4068
Email: ssaroop@kv3.co.za
Tel no: (031) 2758500 / 0837661281

SATC 2008: STUDENT ESSAY COMPETITION



Shian Saroop Research Project: The Infrastructure Cost Model

DURBAN UNIVERSITY OF TECHNOLOGY
DEPARTMENT OF CIVIL ENGINEERING

SUPERVISOR
DR DHIREN ALLOPI

⋮

TABLE OF CONTENTS

SATC 2008: STUDENT ESSAY COMPETITION- Research Project

Contents	Pages
1. RESEARCH PROJECT DESCRIPTION	3
1.1 Abstract	3
1.2 Objectives	3
1.3 The Principles of the Proposed Cost Model.....	3
1.4 Methodology: The Infrastructure Cost Planning Model	3
1.5. The Research Contribution to Infrastructure Projects.....	4
1.6 The Research Contribution to accountability, sustainable service delivery and affordability..	4
1.7 The model assists consultants and clients in the following ways	5
1.8 The scope for further research work	5
2. EXECUTIVE SUMMARY	5
3. POSTER PAPER	8
4. BRIEF PROFILE OF SHIAN SAROOP	9
4.1 Brief profile	9
4.2 Educational Achievement	9
4.3 Awards received	9
4.4 Contributions to Engineering Research	
4.4.1 Technical papers presented and Journal Publications	9

1. RESEARCH PROJECT DESCRIPTION

1.1 Abstract

Due to the South African civil engineering industry's rapid growth, cuts in the infrastructure budget, poor forecasting techniques and insufficient research methodology, the danger of cost overruns, wastage and proper control of the budget is increasing substantially.

One key issue is that of affordability. The enormous costs involved have forced Government to formulate ways of stretching its limited resources as far as possible.

This paper describes a methodological approach that can be used to enhance management's decision-making processes

This paper contributes to the underdeveloped area of cost planning and forecasting on infrastructure projects by maximising the opportunity for improving quality and reducing project costs at each stage in the design process.

In these days of ever-increasing costs the majority of clients, globally, are insisting on projects being designed and executed to give maximum value for money. The cost planning model and its outputs is a disciplined effort to produce fundamental decisions in shaping the project cost. This will place a heavy burden on the consultants to use client's money in the most efficient way possible.

1.2 Objectives

- To develop an inter-active decision making tool that compares a range of possible design alternatives and forecasts of the economic effects of the project upon the change of different variables or elements, at any stage in the design evolution.
- Its aim is to increase the volume of services available to the poor and to enhance the budget optimisation by reducing costs while retaining quality and standards.
- To incorporate cost planning techniques, value engineering, cost benefit analysis, life cycle analysis and construction economics on infrastructure projects and translate these into measurable outputs.

1.3 The Principles of the Proposed Cost Model

- Financial sustainability
- Effective and efficient economic resource use
- Accountability, transparency
- Value engineering
- Cost optimization

1.4 Methodology: The Infrastructure Cost Planning Model

It is globally acknowledged that the complexity of infrastructure planning and realisation is growing, both technically and financially. There is a growing need for co ordination of design and cost. Minimum cost has become a critical performance criteria for most engineers in the provisions of township infrastructure service schemes.

As shown in figure 1 and 2 design cost planning is particularly crucial as decisions made during the early stages of the development process carry more far reaching economic consequences than the relatively limited decisions which can be made later in the process.

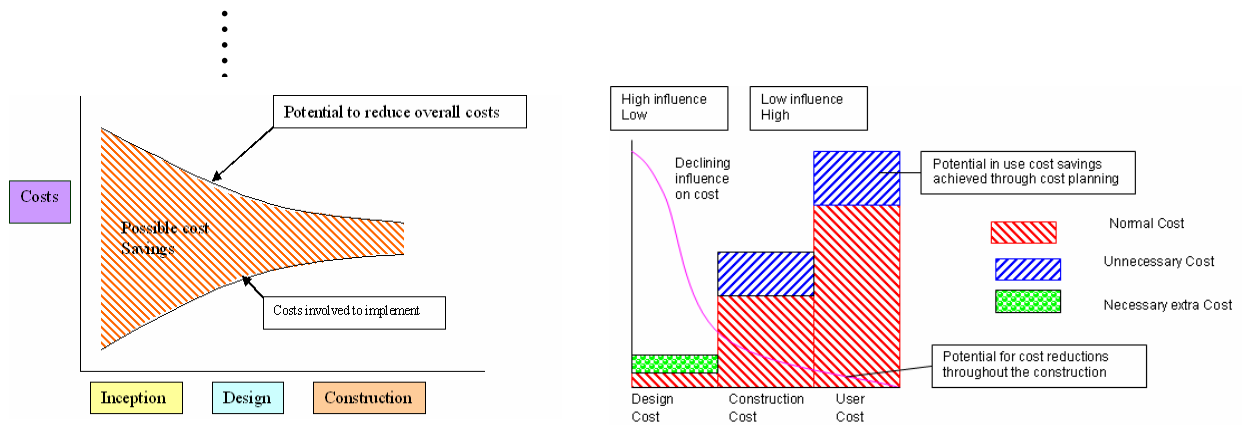


Fig 1: Opportunity to change a design Fig 2: The declining influence on cost (Ashworth, 1999)

In order to obtain financial discipline on infrastructure projects, a comprehensive reporting system was created at the design stage, in order to ensure projects are completed within budget and to the specified quality. These forms can help monitor and optimize design activities, track progress, and prevent potential overspending. The cost planning model attempts to relate the design to their cost, so that, while taking full account of quality, utility and appearance, the cost is planned to be within the economic limit of expenditure.

As one goes through the proposed model, it is intended to draw up some generic cost estimation from the various design scenarios and levels of services on infrastructure projects. The model helps to identify and cost elemental parts of design, which appear to be more or less expensive than they might have expected.

1.5 The Research Contribution to Infrastructure Projects

- Accelerated provisions for infrastructure services delivery through coordinated design efforts
- Alleviation of key deficiencies in current provisions for infrastructure services practice, namely inaccurate cost forecasts, cost overruns, etc
- Creating an environment towards stringent cost control of economical infrastructure design options
- Incorporating value engineering, cost benefit analysis, life cycle analysis, etc. on infrastructure projects.

1.6 The Research Contribution accountability, sustainable service delivery and affordability

The model creates opportunities to account of public expenditure and makes engineers account for one's decisions and actions enabling clients and consultants to have more control over the economic decisions taken. It pursues the provision of affordable infrastructure options in order to support the achievement of more sustainable and economical provision of services to the communities.

The model uses life-cycle costing and value engineering was recognized as being supportive of sustainable development, in particular when used in the conceptual planning and design phases, where decisions are made that substantially affect the ultimate performance of a project

This approach seeks to optimize the budget through the analysis of the costs of the different levels of infrastructure options, optimized decision making, therefore providing the required level of service at least cost.

1.7 The model assists consultants and clients in the following ways:

The model through its disciplined cost reporting will enable clients with the opportunity to respond to design decisions. Financial control will also be shifted from the consultant to the authorities. This approach is in line with the emphasis on assessing outputs and outcomes.

- To manage the planning and design as well as the correct pricing of infrastructure services with a clear and credible presentation of the cost of different options and their influence on the budget.
- To make informed cost-effective decisions.
- To enable executing authorities to have final power over most cost decisions of projects and will enhance real accountability to the authorities.
- It provides a graphical method of presenting their results allowing engineering and financial issues to be easily weighed up against one.

1.8 The scope for further research work

This entails the development of a software to facilitate the infrastructure cost model, enabling the decision maker to reduce the cost while retaining or improving quality, at any stage in the design evolution.

2. EXECUTIVE SUMMARY

Minimum cost has become a critical performance criteria for most engineers in the provisions of township infrastructure service schemes.

As projects become more complex and clients more exacting in their requirements, so it becomes necessary to improve and refine the cost control tools on infrastructure projects. This cost planning model makes cost effective decisions just one of the criteria relevant to the project planning.

It uses of cost planning techniques, value engineering, cost benefit analysis, life cycle analysis and construction economics on infrastructure projects.




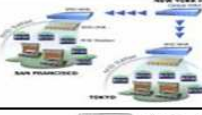
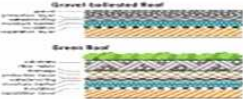
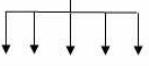
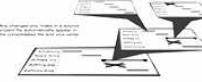

The infrastructure cost model shows how different levels of cost estimate can be prepared in parallel with design development and allows for the various components of the costs to be estimated at their own discrete level, depending on the level of design information available.

In order to maintain financial discipline of infrastructure projects, a comprehensive reporting system was created at the design stage, in order to ensure projects are completed within budget and to the specified quality. These forms can help monitor and optimize design activities, track progress, and prevent potential overspending.

Clients, consultants and government can evaluate the cost of decisions at planning stage, where costs are most affected, thus increasing the volume of services and enhancing service delivery. The development of the cost planning model is a strategy to reduce and optimize the use of the client's budget and to ensure that he gets value for money.

This, together with basic principles of cost planning, value engineering and construction economics will contribute to the concept of "affordable township infrastructure" and will result in a delivery system that becomes more efficient and effective.

THE COST PLANNING MODEL

		PROJECT REQUIREMENTS						
FORMS USED AT EACH STAGE	STANDARD FORM AT EACH STAGE	ROADS	SEWERS	STORM WATER	TOP STRUCTURES	WATER	STAGE 1 FEASIBILITY STAGE	DESCRIPTION OF EACH STAGE
* FORM 3 * FORM 6	* FORM 1 * FORM 2 * FORM 4 * FORM 5	unpaved treated unpaved gravel single seal double seal asphalt block paving concrete	pit latrine communal toilet vacuum truck cartage low cost septic tank bucket cartage aquaprivy Japanese vacuum truck cartage septic tank water borne sewerage	natural watercourse soakaways storage piped network open channel	roofs ceilings floors ext. walls int. walls foundation plumbing and drainage frame	communal well/ borehole water tanker communal storage with adjacent stand pipes public stand pipes individual water butt individual well/borehole on plot individual piped supply- single tap individual piped supply- multi tap		: ASSESEMENT OF OPTIONS : LEVELS OF SERVICE : APPROXIMATE ESTIMATE OF ALTERNATIVES : SCREENING OUT OF OPTIONS.
* FORM 8 * FORM 3	* FORM 7						STAGE 2 SCHEME DESIGN STAGE	PRELIMINARY DESIGN : EVALUATING DIFF. SCENARIOS : 'THE COST BRACKET' : COST LIMIT : QUANTITATIVE VARIABLES
* FORM 3 * FORM 8	* FORM 9 * FORM 10						STAGE 3 DETAILED DESIGN STAGE	DETAIL DESIGN : DETAILED DESIGN : QUALITATIVE VARIABLES : ELEMENTS
* FORM 3 * FORM 8	* FORM 11 * FORM 12						STAGE 4 BILL OF QUANTITIES STAGE	FULL DESIGN : DETAIL ELEMENT DESIGN : SPECIFICATION OF ELEMENTS : QUALITY OF SPECIFICATION

STANDARD FORMS

* FORM 1	: FEASIBILITY COST REPORT
* FORM 2	: COMPARATIVE COST PLAN
* FORM 3	: VALUE ANALYSIS FORM
* FORM 4	: LIFE-CYCLE COST ANALYSIS REPORT
* FORM 5	: BENEFIT COST ANALYSIS
* FORM 6	: COST TARGET/LIMIT FORM
* FORM 7	: ELEMENTAL COST ANALYSIS FORM
* FORM 8	: COST CHECK FORM
* FORM 9	: DETAILED COST ANALYSIS
* FORM 10	: DETAILED COST PLAN
* FORM 11	: SPECIFICATION AND DESIGN NOTES FORM
* FORM 12	: MATERIALS COST ANALYSIS

THE COST PLANNING MODEL: A SOLUTION TO COST EFFECTIVE DESIGN

SAROOP, S.H.

PROBLEM STATEMENT

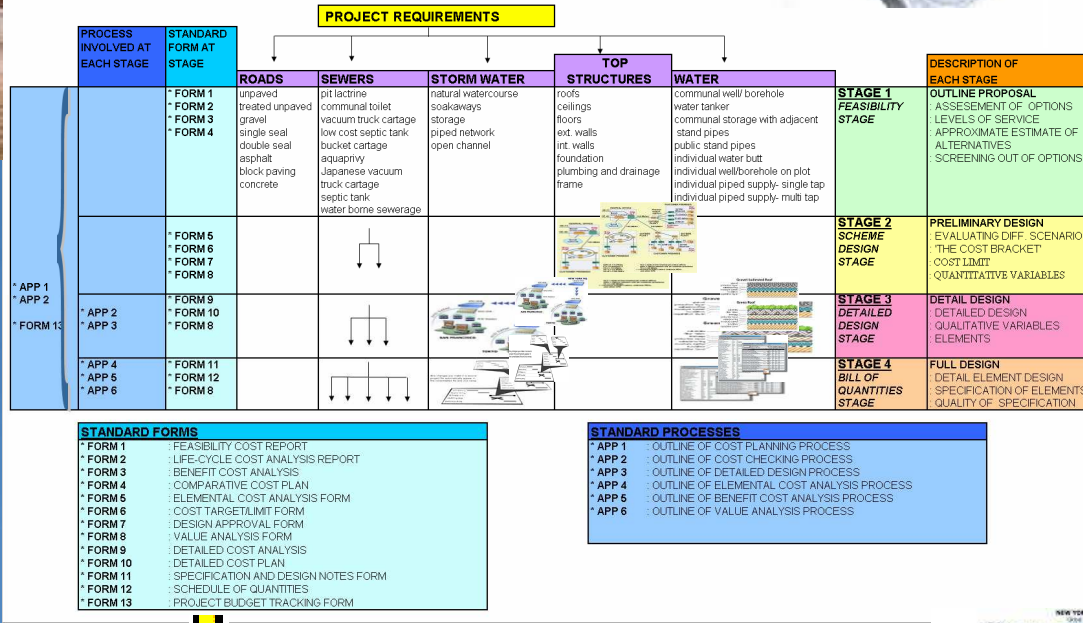
Minimum cost has become a critical performance criteria for most engineers in the provisions of infrastructure service schemes. Government needs to effectively monitor the design process from beginning to end instead of just allocating money to the provisions of infrastructure service schemes.

CHALLENGES

- housing and infrastructure industry's rapid growth
- cuts in the housing budget
- poor forecasting techniques
- the danger of cost overruns,
- wastage and proper control of infrastructure projects
- Insufficient alternative project options



THE COST PLANNING MODEL



OBJECTIVES

This model is designed to provide assistance to governments/local councils that are committed to implementing infrastructure projects, but are lacking the capacity and ability in making cost informed decisions.

It enables clients

- To assess the cost of various design options on infrastructure and housing projects.
- enable management to make informed cost-effective decisions.
- To compare a range of possible design alternatives and forecasts of the economic effects of the project upon the change of different variables or elements, at any stage in the design evolution.
- To increase the volume of services available to the poor and to enhance the budget optimisation by reducing costs while retaining quality and standards
- To enhancing service delivery.

COST REPORTS

The cost planning reports are a disciplined effort to produce fundamental decisions in shaping the project cost. It defines in a comprehensive, and verifiable manner, the essential characteristics of a deliverable. The standard forms form the foundation for an effective cost evaluation of the different design options on infrastructure projects.

BENEFITS

- Cost information can be provided more quickly, and changes in the design can be easily cost updated.
- Appropriately allocate budget in alignment with strategic plans and programmes.
- Manage planning and the design of projects.
- The tools used in the model provide a graphical method of presenting their results. - allows engineering, practical and financial issues to be easily weighed up against one another.
- The accurate pricing of infrastructure services with clear and credible presentation of options and of costs and their benefits;
- Ability to hear out options and give careful consideration to their arguments and act decisively.

INPUT

PROCESS

OUTPUT



APPLICATION OF THE COST MODEL

The model will assist consultants and clients in the following ways:

- To manage the planning and design of projects as well as the correct pricing of infrastructure services with a clear and credible presentation of the cost of different options and their influence on the budget
- Different levels of cost estimates can be prepared in parallel with design development. - allows for the various components of the costs to be estimated at their own discrete level, in the form of cost reports- depending on the level of design information available.
- Enables executing authorities to have final power over most cost decisions of projects - enhance real accountability to the authorities
- Enable authorities with the opportunity to respond to design decisions. Financial control is shifted from the consultant to the authorities.
- The goal for continuous improvement in the infrastructure sector can be achieved through the proposed framework. - basic principles of cost planning and construction economics can contribute to the concept of "affordable township infrastructure" - result in a delivery system that becomes more efficient and effective.

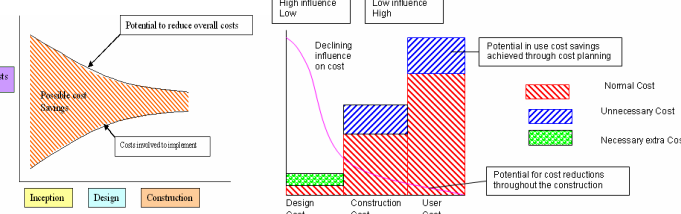
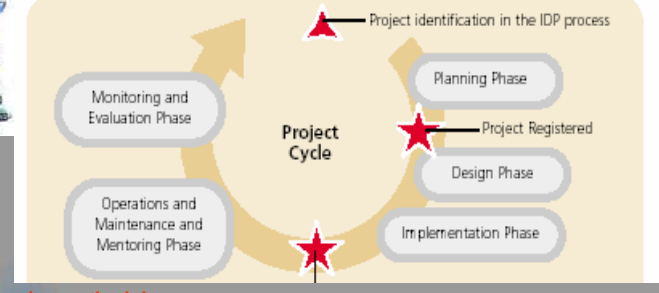
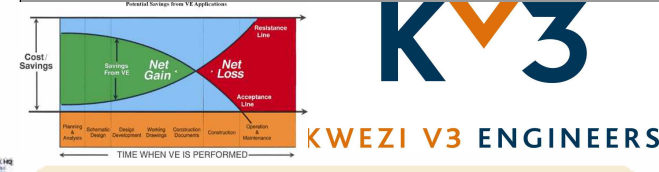


Figure a: Opportunity to change a design

Figure b: Declining influence on cost

- Design cost planning - crucial as decisions made during the early stages of the development process carry more far reaching economic consequences than the relatively limited decisions - made later in the process.
- The cost reduction potential curve shown in Figure a illustrates - most significant cost reductions are achieved - in the inception stage of the project. Once the project has reached the construction stage, the potential for achieving cost reductions is significantly lower.
- Figure a also illustrates the opportunity to revise or make changes to the design to the project.
- Figure b suggests that, as the project develops, the potential to reduce costs decrease rapidly during the design stage as well as the declining influence of cost.



The cost planning methodology

As projects become more complex and clients more exacting in their requirements- becomes necessary to improve and refine the cost control tools. Cost planning- a system of relating the design- to their cost, while taking full account of quality, utility and appearance- the cost is planned to be within the economic limit of expenditure. The cost model aim is to overcome the problem of poor design decisions being made and promotes financial optimisation on infrastructure projects. Annexure 1 illustrates the conceptual model for cost forecasting at the different stages of design as well as standard forms for the analysis of the various options. By a series of cost analysis, the various levels of services can be compared with each other. The economic studies carried out, allow for the least competitive alternatives to be eliminated. In this way, progressively fewer alternatives are developed to an increasing level of detail, until an optimum choice is made.

ASSESSING PROJECT ALTERNATIVES



Table 1: The output forms at each stage

Stage	Form No.	Form Name
FEASIBILITY STAGE	FORM 1	FEASIBILITY COST REPORT
	FORM 2	LIFE CYCLE COST ANALYSIS FORM
	FORM 3	BENEFIT COST ANALYSIS
	FORM 4	COMPARATIVE COST PLAN
SCHEME DESIGN STAGE	FORM 5	ELEMENTAL COST ANALYSIS
	FORM 6	COST TARGET FORM
	FORM 7	DESIGN REVIEW FORM
	FORM 8	VALUE ANALYSIS FORM
DETAILED DESIGN STAGE	FORM 9	DETAILED COST ANALYSIS
	FORM 10	DETAILED COST PLAN
BILL OF QUANTITIES STAGE	FORM 11	SPECIFICATION AND DESIGN NOTES FORM
	FORM 12	SCHEDULE OF QUANTITIES
	FORM 13	PROJECT BUDGET TRACKING FORM
	FORM 8	COST CHECK FORM (FINAL PRODUCTION)

SAROOP, S.H. and ALLOPI, D (Pr Tech (Eng))

Kwezi V3 Engineers (Pty) Ltd,
P O Box 299,
Westville,
3630,
Tel (031) 2758500
Fax (031) 2758555
E-mail : ssaroop@kv3.co.za

4. BRIEF PROFILE OF SHIAN SAROOP

4.1 BRIEF PROFILE

Mr. Shian Hemraj Saroop is a professional civil engineering technologist for Kwezi V3 Engineers in Durban. He is 28 years old and has gained a wide range of experience in Structural, Civil and Project Management whilst working for both contractors and consulting engineers. His experience covers a wide variety of infrastructure development namely: design of roads, sewer, storm water, water, and earthworks. He is currently a Project Director for a number of projects and is involved in project planning, project management, design, and construction management of them. He has a passion for designing multiple level platforms and modeling water and stormwater reticulations.

He holds two B Tech degrees and is completing an M-tech in civil engineering His field of specialization for his M tech encompasses cost planning of infrastructure services. His energies are increasingly channeled into the areas of sustainable infrastructure development, life cycle cost alternatives of infrastructure services and formulating strategies for the optimal use of the client's budget. He has presented a number of technical papers at various civil engineering conferences over the past 2 years. One of his major technical achievements for 2006 was when he received the award for the best paper presented at the 70th Institute of Municipal Engineering (IMESA) Conference 2006 in Soweto

4.2 EDUCATIONAL ACHIEVEMENT

N Dip. In Eng: Civil

B Tech in Eng: Civil (Project Management)

B Tech in Eng.: Civil (Urban Engineering)

M Tech in Eng.: Civil –currently completing

4.3 AWARDS RECEIVED

Award for the best paper presented at the 70th Institute of Municipal Engineering (IMESA) Conference 2006 in Soweto.

4.4 CONTRIBUTIONS TO ENGINEERING RESEARCH

4.4.1 TECHNICAL PAPERS PRESENTED AND JOURNAL PUBLICATIONS

- Journal of the Institution of Municipal Engineering of Southern Africa, Volume 30, 2005(ImNov Dec5 24)
- International Journal Publication–Municipal Engineer, Proceedings of the Institution of Civil Engineers, 2007 ICE- UK-MUEN-D-07-00013
- South African Transport Conference 2005+ 2006
- 3rd Post Graduate Conference on Construction Industry Development (CIDB), 2005
- Planning Africa- Cape town, 22-24 March 2006
- Project Management South Africa international conference 2006,
- CIOB Africa- First Built Environment Conference- June 2006
- XXXIII IAHS World Congress on Housing 2005
- First international African Conference on Gender, transport & development:
- 3rd Irf/Sarf regional conference for Africa
- 70th Institution of Municipal Engineering of Southern Africa (IMESA) conference 2006.- **RECEIVED THE AWARD FOR BEST PAPER PRESENTED**