MATCHING THE MAINTENANCE BUDGET WITH MARKET REALITY FOR A COMPETITIVE ADVANTAGE

S.W.J. VAN WYK

Mini-dissertation submitted in partial fulfilment of the requirements for the degree Master in Business Administration at the North West University

Supervisor: Dr. A. Smit

Co-supervisor: Mr. C.M. Norden

November 2004

Potchefstroom

ABSTRACT

This research report investigates whether a need exists for realistic maintenance budgets that are aligned with market reality, providing the business with a competitive advantage. To achieve this, a theoretical model has been developed to define the need for and the substance of a realistic maintenance budget.

Subsequently, this issue was investigated in the South African coal mining sector, as this sector is positioned in such a manner that the implementation and use of such a model can and should have a major impact on business competitiveness. The investigation took the form of data collection through means of an e-mailed questionnaire.

The data collected by means of the questionnaires were presented as findings, which also highlighted some important issues. These issues are discussed individually.

The research report concludes that a need for having a realistic maintenance budget that is aligned with market reality, giving the business a competitive advantage, does exist within the South African coal mining sector.

Finally, the integrated theoretical budgeting model, which was developed to assist the maintenance practitioner in compiling a realistic maintenance budget, which is aligned with the current market reality, will give any colliery (and for that matter any business) a competitive advantage when applied.

The research report ends with a proposed list of possible research opportunities that can be conducted as follow up studies to the research presented in this research report.

DECLARATION

I declare that this dissertation is my own unaided work. It is submitted in partial fulfilment of the requirements of the degree Master in Business Administration at the Potchefstroom Business School of the North West University. In addition, I hereby declare that this has not been submitted before for any other degree or examination at any other University.

Schalk Willem Jacobus van Wyk

5 November 2004

ACKNOWLEDGEMENTS

Firstly, I would like to give praise to my Lord and Saviour, Jesus Christ, who has blessed me with the ability and patience to complete this work.

In addition, I would like to thank my wife Lynette, my daughter Chanelle, and my son Schalk, for their patience, understanding and support throughout the preceding three years. They deserve much of the credit for this work, by allowing me to remain focussed on my studies and some times where they had to take second place.

I would also like to thank my company, Sasol Mining, and my superiors for allowing me the opportunity to study an MBA and supporting me in completing this work. In particular I would like to thank Abrie Eckard, Hermann Wenhold and Riaan Rademan for their support in this regard.

Thank you to my supervisor, Dr Anet Smit, and co-supervisor, Charl Norden, for their guidance throughout my research. Finally, I also thank the students in my MBA group at Secunda from whom I had learnt a great deal.

I thank you all.

TABLE OF CONTENTS

ABSTRACT ii

DECLARATION iii

ACKNOWLEDGEMENTS iv

TABLE OF CONTENTS v

LIST OF FIGURES viii

LIST OF TABLES x

GLOSSARY OF TERMS xi

LIST OF ABBREVIATIONS xiv

1. INTRODUCTION 1

1.1 Background *1*

1.2 Objective statement *3*

1.3 Defining the real issue to be researched *4*

2. AN INTEGRATED APPROACH TO MAINTENANCE BUDGETING 6

2.1 An investigation into the different approaches to budgeting *6*

2.1.1 The traditional budgeting approach 6

2.1.2 The activity-based budgeting approach 8

2.1.3 The zero-base budgeting approach 11

2.1.4 Using the quality function deployment approach 16

2.1.5 The target budgeting approach 20

2.1.6 The life-cycle costing approach 22

2.1.7 The rolling budgeting approach 26

2.2 Defining competitive advantage using realistic budgeting principles *27*

2.3 Integrating the different budgeting approaches into a theoretical model *30*

2.3.1 Goals 30

2.3.2 Strategies 31

2.3.3 Forces 32

2.3.4 Activities 32

2.3.5 Rolling budget (forecast) 35

2.4 Applying the integrated budgeting model to the maintenance budget *36*

2.5 Linking competitive advantage and maintenance budgeting *46*

3. EMPIRICAL RESEARCH IN THE SA COAL MINING SECTOR **50**

3.1 Defining the sample *51*
3.1.1 Evaluating the coal mining sector as a sample area 52

3.2 Determining the questions to be asked *55*
3.2.1 The sampling method 57
3.2.2 The questionnaire 58

4. THE RESULTS **61**

4.1 The number and distribution of respondents *61*
4.1.1 Sample size 61
4.1.2 Distribution of respondents 62

4.2 Background information *62*
4.2.1 Type of colliery represented 62
4.2.2 Annual production distribution of the collieries 63
4.2.3 Maintenance cost distribution 64
4.2.4 Distribution of time spent on the maintenance budget 64
4.2.5 Maintenance budget update frequency 65
4.2.6 Use of an enterprise management system (EMS) 66

4.3 Frustrations with traditional budgeting *66*
4.3.1 Constrain responsiveness and a barrier to change 66
4.3.2 Rarely strategically focused and often contradictory 67
4.3.3 Adds little value for the time to prepare 68
4.3.4 Focus on cost reduction rather than value creation 69
4.3.5 It strengthens vertical command-and-control 69
4.3.6 Budgeting follows a process of "horse trading" 70
4.3.7 Budgeting is a time consuming process 71
4.3.8 Budgets are developed and updated too infrequently 72
4.3.9 Excel spreadsheets are used as the primary software 72

4.4 Budgeting approaches in use at collieries *73*
4.4.1 The traditional budgeting approach 73
4.4.2 The activity based budgeting approach 74
4.4.3 The zero-based budgeting approach 75
4.4.4 The quality function deployment budgeting approach 75
4.4.5 The target budgeting approach 76
4.4.6 The life cycle costing approach 77
4.4.7 The rolling budgeting approach 78

4.5 Extent to which the theoretical model is used *79*
4.5.1 Goals 79
4.5.2 Strategies 79
4.5.3 Forces 80
4.5.4 Activities 80
4.5.5 Rolling budget (forecast) 85

4.6 Need for an integrated theoretical budgeting model *85*
4.6.1 The maintenance budget can influence competitiveness 85

4.6.2 Continuously updated budgets assist in becoming more cost effective 86
4.6.3 Need for a maintenance budgeting model 87

5. DISCUSSION, CONCLUSION & RECOMMENDATIONS 88

5.1 Representativeness of the data 88
5.2 Frustrations experienced with traditional budgeting 89
5.3 Budgeting approaches in use at the collieries 90
5.4 Use of an integrated budgeting model 91
5.5 Need for an integrated budgeting model 92
5.6 Conclusions 93
5.7 Recommendations 95
5.8 Future research areas 96

6. REFERENCES 97

7. APPENDICES 100

7.1 APPENDIX A: Data requirements table 100
7.2 APPENDIX B: The survey questionnaire 104
7.3 APPENDIX C: Introducing a self-administered questionnaire 110

LIST OF FIGURES

Figure 2-1: Closed Loop Model of the ABB-approach 9
Figure 2-2: Relationship between planning and budgeting 11
Figure 2-3: Formulating decision packages 13
Figure 2-4: Ranking process for decision packages 14
Figure 2-5: The management process 15
Figure 2-6: Conditional propositions 17
Figure 2-7: Bi-directional relationships 18
Figure 2-8: A QFD matrix 18
Figure 2-9: Decomposition process using three QFD matrices 18
Figure 2-10: Matrix showing expected effects and correlation coefficients 19
Figure 2-11: Fourth matrix's bi-directional relationship 20
Figure 2-12: LCC = Acquisition + Sustaining costs with time considerations 23
Figure 2-13: Acquisition cost tree 23
Figure 2-14: Sustaining cost tree 24
Figure 2-15: Process flow for LCC calculations 25
Figure 2-16: Closed-loop processes for management planning and control 29
Figure 2-17: An integrated theoretical budgeting model 31
Figure 2-18: Component failure Normal distribution 40
Figure 2-19: Optimal component replacement point 40
Figure 2-20: Component expected life improvement 41
Figure 2-21: Component expected repair/replacement cost improvement 42
Figure 2-22: Total expected maintenance cost reduction 43
Figure 2-23: Example of life cycle cost smoothing 47
Figure 2-24: Maintenance decisions based on lowest combined cost 48
Figure 4-1: Percentage of population of respondents 61
Figure 4-2: Type of colliery represented 63
Figure 4-3: Annual production distribution of the collieries 63
Figure 4-4: Maintenance cost distribution 64
Figure 4-5: Distribution of time spent on the maintenance budget annually 65
Figure 4-6: Maintenance budget update frequency 65
Figure 4-7: Use of an EMS 66

Figure 4-8: Constrain responsiveness and a barrier to change 67
Figure 4-9: Rarely strategically focused and often contradictory 68
Figure 4-10: Adds little value for the time to prepare 68
Figure 4-11: Focus on cost reduction rather than value creation 69
Figure 4-12: Strengthens vertical command-and-control 70
Figure 4-13: Budgeting follows a process of "horse trading" 71
Figure 4-14: Budgeting is a time consuming process 71
Figure 4-15: Budgets are developed and updated too infrequently 72
Figure 4-16: Excel spreadsheets are used as the primary software 73
Figure 4-17: Traditional budgeting approach 74
Figure 4-18: The activity based budgeting approach 74
Figure 4-19: The zero-based budgeting approach 75
Figure 4-20: The quality function deployment budgeting approach 76
Figure 4-21: The target budgeting approach 77
Figure 4-22: The life cycle costing approach 78
Figure 4-23: The rolling budgeting approach 78
Figure 4-24: A well-documented and implemented maintenance strategy exists 79
Figure 4-25: The budget is linked with the exchange rate and PPI 80
Figure 4-26: A cost breakdown structure is developed 81
Figure 4-27: Develop a list of expected component lives 82
Figure 4-28: Statistical software is used 83
Figure 4-29: Condition monitoring techniques are used 83
Figure 4-30: Scheduling software is used 84
Figure 4-31: Component repairs or replacements are scheduled 85
Figure 4-32: The maintenance budget can influence competitiveness 86
Figure 4-33: Continuously updated budgets assist in becoming more cost effective 86
Figure 4-34: Need for a maintenance budgeting model 87
Figure 5-1: Frustrations experienced with traditional budgeting 90
Figure 5-2: Budgeting approaches in use at collieries 91
Figure 5-3: Extent to which the model is in use 92
Figure 5-4: The need for an integrated budgeting model 93

LIST OF TABLES

Table 2-1: Extract from a cost breakdown structure 33
Table 2-2: Extract of the first three years of a 10-year maintenance plan 34
Table 2-3: Listing expected component lives 39
Table 2-4: Establish starting point for the scheduler 44
Table 2-5: Budgeted expenditure for the first period 44
Table 2-6: Allowance for changes in the external market environment 49
Table 3-1: Sample area requirements to be complied with 52
Table 3-2: Relevant order winners and qualifiers for coal 53
Table 3-3: Aspects of concern 54
Table 3-4: Issues and statements to be verified 56
Table 3-5: Population and required minimum sample size 57
Table 3-6: Actual sample sizes required 58
Table 3-7: Extract from the data requirements table in Appendix A 60
Table 4-1: Distribution of respondents per company 62

GLOSSARY OF TERMS

ABB-group – is the Consortium for Advanced Manufacturing-International, Cost Management Systems, Activity-Based Planning and Budgeting Group (Hansen *et al*, 2003:98).

Activity consumption rate - is the quantity of each activity that is required to produce one unit of demand (Hansen *et al*, 2003:99).

Asset management - completely aligns plant resources to achieve the business goals of the organisation at the lowest cost (Peterson, 2000:1).

Breakdown maintenance – means fixing an item when it is found to be failing or when it has failed (Moubray, 1997:171).

Budget – A detailed plan for the acquisition and use of financial and other resources over a specified time period (Garrison & Noreen, 2000:406).

Condition-based maintenance – are corrective or consequence-avoiding actions/tasks based on an assessment of the condition of an item (Moubray, 1997:145).

Decision packages – are discrete activities, functions, operations, or programs to be operated in the next fiscal year(s) (Pyhrr, 1973:6).

Decision unit – is a cost or budget centre for which decision packages are to be developed and analysed (Pyhrr, 1973:6).

Financial balance – equates the required rate of return with the demanded rate of return (Hansen *et al*, 2003:99).

Fixed-time-to maintenance (FTTM) – is work organised and conducted with forethought, and is frequently called scheduled maintenance (Edwards *et al*, 2000:428).

Just in time (JIT) – is a "uniquely Japanese" principle used to describe a manufacturing or other process in which materials arrive as close as possible to the time required (Masaaki, 1997:2).

Net present value (NPV) – discounts all cash flows to the present at the project's cost of capital and then sums those cash flows (Barringer, 2004:1).

Operational balance – equates the required quantities with the demanded quantities (Hansen *et al*, 2003:99).

Operationally optimum condition - refers to the required condition of the equipment/machinery to perform at the design intended productivity and maintenance and operational cost levels (Wireman, 1998:5).

Opportunity maintenance – are those unscheduled tasks that are performed in the non-use or off time of equipment/machinery and to make use of the "window of opportunity" without influencing the productivity of the equipment/machinery (Defined by the author of this research report).

Resource consumption rate – is the quantity of each resource that is required to perform one instance of each activity (Hansen *et al*, 2003:99).

Return on invested capital (ROIC) – is the ratio of net operating profit after taxes and amortisation (NOPATA) to total operating capital (Brigham & Ehrhardt, 2002:48).

Return on investment (ROI) – is the net operating income divided by average operating assets. It also equals margin multiplied by turnover (Garrison & Noreen, 2000:579).

Scheduled maintenance – are those tasks undertaken before a failure occurs in order to prevent the item from getting into a failed state (Moubray, 1997:145).

Total cost of ownership – considers costs most relevant to the acquisition, possession, use, maintain and subsequent disposition of a good or service, i.e. typically

the "cradle to grave" concept of a good or service (Ellram and Siferd, 1998:56).

Traditional planning and budgeting – is a periodic top-down process by which organisations tend to define their future operational expenditures and forecasted incomes (Neely *et al*, 2001:6).

Zero-based budget – is a method of budgeting in which managers are required to justify all costs as if the programs involved were being proposed for the first time (Garrison & Noreen, 2000:407).

LIST OF ABBREVIATIONS

ABB	- Activity-based budgeting
BEE	- Black economic empowerment
CMMS	- Computerised maintenance management system
EE	- Employment equity
EMS	- Enterprise management system
ERP	- Enterprise Resource Planning
FTTM	- Fixed-time-to maintenance
JIT	- Just in time
LCC	- Life cycle costing
LOB	- Life-of-business
MMIS	- Maintenance management information system
MPC	- Management planning and control
MTBF	- Mean time between failures
MTTR	- Mean time to repair
NPV	- Net present value
OEM	- Original equipment manufacturer
QFD	- Quality function deployment
RB	- Rolling budgeting
ROCC	- Return on cost of capital
ROI	- Return on investment
ROIC	- Return on invested capital
SACEA	- South African Colliery Engineers Association
SAMI	- Strategic Asset Management Inc.
TB	- Target budgeting
TCO	- Total cost of ownership
TPM	- Total productive maintenance
ZBB	- Zero-base budgeting

1. INTRODUCTION

1.1 Background

In today's rapid changing environment, the race to succeed is on, and highly competitive businesses thrive on change. The speed with which businesses adapt to change is a necessity and not a matter of choice anymore. Highly competitive businesses actually take the lead in setting the pace for change. It is thus imperative for a business to ensure aligned commitment of all its resources and their functions within the business. Each function should formulate strategies to ensure it adds value, through increased profits, to the bottom-line and that it assists the business to sustain its competitiveness.

The globalisation of the South African economy, especially since its re-admission into the international arena in 1994, brought about new challenges and pressures for organisational leadership. Within the South African coal mining industry, mines were used to compete only on the internal markets, but since 1994 South African coalmines had to start competing with international coalmines. Internal benchmarking was not good enough anymore and "world-class" benchmarking became the new focus, allowing the South African collieries to compete with world-class collieries.

Currently, South African coal mines (collieries) are highly mechanised, and based on experience the maintenance function of a colliery is also the function that controls about two thirds of the direct mining costs. Downturns in the economy inevitably result in financial scrutiny and budget cuts in every department. Maintenance engineering is no exception and is thus a very attractive first option for cost cuts. Maintenance labour cuts, stretched preventative maintenance cycles, and delayed equipment upgrades may reduce operating costs in the short term, but they can all have disastrous long-term consequences on production because when maintenance work is cancelled, machinery and equipment reliability is negatively influenced. Only certain maintenance work can be postponed on the short term, but never cancelled. It is thus imperative for the maintenance function to formulate a strategy to optimise the total maintenance

expenditure of the business. This maintenance strategy, expressed in financial terms, is called the maintenance budget.

The annual budgeting process is usually tedious and very time consuming if done correctly. Unfortunately, experience has shown that it's also a process that is not always followed through by all supervisors, engineers and managers with the necessary dedication it deserves, resulting in unrealistic budgets that are seldom achieved. The deviations could be one of a variety ranging from being well under spent to being well overspent. Reasons for the deviations could also vary from valid ones to invalid ones.

It therefore makes sense that a company implements a budgeting process that would enable them to produce realistic maintenance budgets that will give the company a competitive advantage. Subsequently the question should be asked, 'How?'

This research report investigates whether a need exists for realistic maintenance budgets that are aligned with market reality, providing the business with a competitive advantage. To achieve this, a theoretical model has been developed to define the need for and the substance of a realistic maintenance budget. This model also forms the basis for exploring the reasons why maintenance budgets are seen to be unrealistic. Measurements for this study are questionnaire responses from maintenance practitioners of coalmines within the South African coal mining sector. This sector was chosen because of the highly mechanised nature of collieries and the impact the South African maintenance practitioner may have on a colliery's unit cost of production within the South African market.

In this report the objective of the research is stated, the real issue is further defined in greater detail, and an academic and practitioner literature review on the different budgeting approaches is conducted and integrated into a theoretical model. This model is designed to assist the maintenance practitioner to develop a realistic maintenance budget, which will give the business a competitive advantage. A discussion regarding the research parameters, sampling method, and questionnaire development will follow thereafter. Then the research results are discussed from which conclusions and recommendations follow. Finally, areas for future research are proposed.

1.2 Objective statement

The purpose of this research report is twofold: firstly, to provide a theoretical model which will assist the maintenance practitioner in compiling a realistic maintenance budget which is aligned with the current market reality, giving the business a competitive advantage; and secondly, to determine whether a need exists for having a realistic maintenance budget that is aligned with market reality, giving the business a competitive advantage.

Based on experience and personal observation, the compilation of the annual maintenance budget is usually a very time consuming and stressful period in the life of maintenance practitioners. This is due to them being sent backwards and forwards by their departmental managers, having to cut out perceived "fat" from their budgets so that it becomes more "realistic" and aligned with the company's strategic objectives. This perception that maintenance practitioners build "fat" into their budgets comes from basing budgets on gut feel and "thumb sucking" and not having a scientific tool to help them budget realistically. This is also the reason for the research done. Needless to say that this iterative budgeting process (i.e. the backwards and forwards sending of maintenance practitioners to cut out "fat" from their budgets) not only wastes an enormous amount of time, but it also distracts the maintenance practitioners from focussing on their more important task, which is to ensure that machinery and equipment are maintained cost effectively. Normally after being sent backwards and forwards for a couple of times, the maintenance practitioner gets discouraged to such an extent that he/she rushes just to complete the maintenance budget and to get their managers "off their backs". This results in the inclusion of severe oversights into the maintenance budget. This is the very reason why many companies experience maintenance cost "surprises" during the budgeted financial year which do not equate to the prevailing market reality, forcing them to become uncompetitive.

In the next section, the real issue to be researched will be defined in more detail.

1.3 Defining the real issue to be researched

According to Garrison and Noreen (2000:402), in the traditional or incremental budgeting approach, the manager starts by using the previous year's budget as a baseline, adding to it (or subtracting from it) according to anticipated needs during the following financial year. This approach raises the concern that it could lead to drastic over- or understating of the maintenance budget and subsequent under- or overstating of planned profits of the business. Another concern of this approach is that the annual budgeting process is often a long and time-consuming process that is too slow and unresponsive for today's competitive and turbulent environment. Usually it is also affected by "gaming", company politics, and horse-trading tactics, all of which adds little value to the company's bottom line.

These concerns give rise to the question: *"What can be done to change the perceived status of the budget from something based on a thumb suck to something more scientific, and which is aligned with market reality giving the business a competitive advantage?"*

In an attempt to answer this question, the following specific issues will be discussed in this study:

- An investigation into the different approaches to budgeting.
- Defining competitive advantage using realistic budgeting principles.
- Integrating the different budgeting approaches into a theoretical model.
- Applying the integrated budgeting model to the maintenance budget.
- Linking competitive advantage and maintenance budgeting.
- Empirical research within the South African coal mining sector.
- Results obtained from the empirical research.
- Discussion, conclusion and recommendations of results obtained.
- Future research areas.

This research could look at all budgets, however, maintenance budgeting is very complex and it constitutes a significant part of the cash cost of physical asset intensive businesses. Thus, this research will focus on physical asset intensive businesses. It is also felt that limiting the investigation to maintenance budgets will set the boundaries for

a manageable piece of research. Because the maintenance budget is the most complex and largest cost contributor in physical asset intensive businesses, these principles should also be applicable to the other functional budgets of a business.

The following chapter will deal with a comprehensive literature review of the various approaches to budgeting, their integration into a theoretical model, its application to the maintenance budget, and linking competitive advantage and maintenance budgeting.

2. AN INTEGRATED APPROACH TO MAINTENANCE BUDGETING

2.1 An investigation into the different approaches to budgeting

The first phase of the research involved an extensive, although not exhaustive, review of available literature on the subject of budgeting. This sub-section draws on this material to explore the current frustrations and weaknesses maintenance practitioners experience with traditional budgeting. In addition, other budgeting approaches that are perceived to be "better" than the traditional budgeting approach, such as activity based budgeting (ABB), zero-base budgeting (ZBB), quality function deployment (QFD), target budgeting (TB), the life-cycle costing (LCC) approach, and the rolling budgeting (RB) approach, are also explored.

2.1.1 The traditional budgeting approach

According to Neely, Sutcliff and Heyns (2001:6), all the literature reviewed discussed the disadvantages and occasionally the benefits of the "traditional" planning and budgeting process, but a few actually defined it. "Traditional" planning and budgeting is thus defined as the periodic process by which organisations tend to define their future operational expenditures and forecasted incomes. In its "traditional" sense it is a top-down approach whereby the corporate head office distributes the various budget packages (consisting of various forms to be filled in and sales and operational forecasts to be completed) to the divisions and operating units. Once the required data has been entered these completed budget packages are returned "bottom-up" to the corporate head office. This is an iterative process until final agreement is achieved. The final budget is usually presented weeks or months after the initial budget packages were distributed and it consists of limits to operate within as well as targets to be achieved for the next financial year. This iterative process between top-down and bottom-up of the traditional budgeting approach has the following disadvantages:

2.1.1.1 Budgets are time-consuming to put together: -

The planning and budgeting process in many organisations is said to take up anything from 20% to 30% of management's time. (Neely *et al.*, 2001:6).

2.1.1.2 Budgets constrain responsiveness and are often a barrier to change: -

Traditional approaches to budgeting act as a barrier to continuous improvement and success due to the continuous focus within the organisation on how to beat the budget, rather than on how to maximise potential. (Hansen, Otley and Van der Stede, 2003:96).

2.1.1.3 Budgets are rarely strategically focused and often contradictory: -

Budgets tend to be internally driven with little focus on issues required to satisfy customers and to generate value over the longer term. (Neely *et al.*, 2001:6).

2.1.1.4 Budgets add little value, especially given the time required to prepare them: -

More than half the time spent on the budget by the financial department is consumed to put a budget together while only 27% of the time is spent on analysis. (Neely *et al.*, 2001:7).

2.1.1.5 Budgets focus on cost reduction rather than value creation: -

Neely *et al.* (2001:7) found that only 27% of companies integrate strategies with tactics and only 22% have forecasts which include corrective action plans.

2.1.1.6 Budgets strengthen vertical command-and-control: -

Senior management usually dictate the conditions for activity within the company and the budgeting process provides a mechanism to ensure that the conditions are adhered to, thus controlling employees rather than encouraging them. (Neely *et al.*, 2001:6).

2.1.1.7 Budgets do not reflect the emerging network structures that organisations are adopting: -

Budgets do not reflect value creation and customer service brought about by decentralising activities through alliances and partnerships; instead they promote centralised control within the confines of the individual company. (Hansen *et al.*, 2003:96).

2.1.1.8 Budgets encourage "gaming" and perverse behaviour: -

Usually when incentives are linked to budget requirements, individuals tend to minimise the level of commitment they have to make, and maximise their personal gain during the process of setting budget targets. When this mentality exists within an organisation, the drive to continuously improve is lost. (Neely *et al.*, 2001:6).

2.1.1.9 Budgets are developed and updated too infrequently, usually annually: -

Budgets typically have an annual time horizon and remain unchanged throughout the year, even though they are out of date at the end of the first month of the financial year. (Neely *et al.*, 2001:6).

2.1.1.10 Budgets are based on unsupported assumptions and guesswork: -

Usually senior management's contribution is that of arbitrarily cutting or increasing budgets by certain percentages with very limited justification of the assumptions it's based upon. (Neely *et al.*, 2001:6).

2.1.1.11 Budgets reinforce departmental barriers rather than encourage knowledge sharing: -

Everyone strives to achieve their own budgeted targets because there is little incentive to co-operate and share with others to achieve synergies. (Neely *et al.*, 2001:6).

2.1.1.12 Budgets make people feel undervalued: -

Traditional budgeting prevents empowerment and the opportunity for employees to contribute to the achievement of strategic objectives. Employees are often treated as costs to be minimised, rather than assets to be developed to their full potential. (Neely *et al.*, 2001:6).

2.1.2 The activity-based budgeting approach

Hansen *et al.* (2003:98) state that the activity-based budgeting (ABB) approach focuses on generating a budget from an activity-based model of the organisation, as against the traditional product-market, responsibility centre, or departmental focus. The essence of the ABB-approach to budgeting is the Closed Loop Model shown in Figure 2.1. (Hansen *et al.*, 2003:99). Unlike the traditional budgeting approach, the ABB-approach creates

an operationally feasible budget prior to generating the financial budget.

Stage 1, the operational loop, uses activity-based concepts to convert the estimated demand for products and services into activity requirements using activity consumption rates, and then translates activity requirements into resource requirements using resource consumption rates.

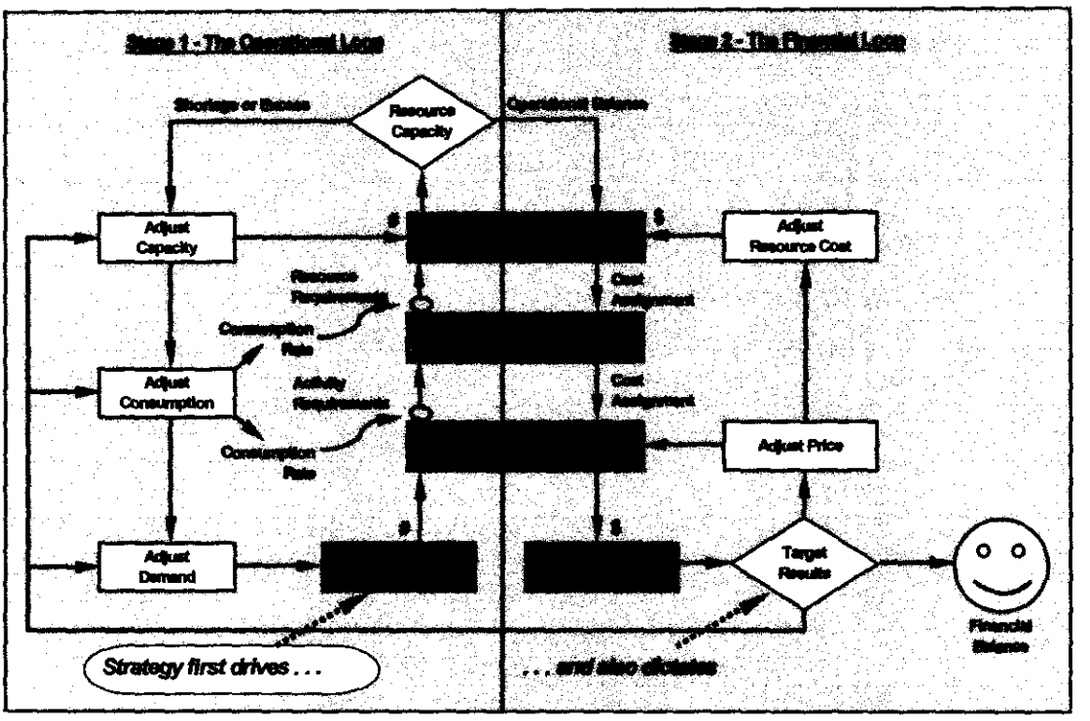


Figure 2-1: Closed Loop Model of the ABB-approach

***Source: Hansen** et al (2003:100)*

Once the activity and resource consumption rates are known, the ABB-approach works to achieve an operational balance between the resource requirements to meet the demand and the resources available (production capacity). Should an imbalance exist due to the initial plan, the organisation can adjust the demand quantity, resource capacity, resource consumption rates, or activity consumption rates. In contrast, with traditional budgeting the budget can only be balanced by changing the demand quantity or resources available (production capacity).

Stage 2, the financial loop, develops a financial plan based on the operational plan.

Financial balance is achieved when the financial plan meets a predetermined financial target. Once the demands, activities, and resources are known, it determines the cost of resources, traces them to activities, and then to products/services. Should the initial financial plan not balance, the ABB-approach allows adjustments of five possible elements to achieve the budget target: activity and resource consumption rates, resource capacity, resource cost, product/service demand quantity, and product/service price. Fewer possibilities are offered by the traditional budgeting approach because it does not collect information on activity and resource consumption rates.

The following potential benefits of the ABB-approach are listed by the ABB-group (Hansen *et al.*, 2003:99):

2.1.2.1 Avoids unnecessary financial calculations of infeasible operational plans: -

By first balancing the operational requirements, unnecessary calculations of the financial effect of operationally infeasible plans are avoided. Sources of imbalance, inefficiencies, and bottlenecks are highlighted.

2.1.2.2 Provides a more comprehensive set of tools for balancing capacity: -

Explicit analysis of resource capacity and the increased visibility of resource consumption allow organisations to identify capacity issues and make adjustments earlier in the budgeting process.

2.1.2.3 More easily communicated and understood budgeted information: -

Managers and operational employees can more easily understand and communicate budgeting information in operational rather than financial terms. ABB also help managers understand how to perform their jobs.

2.1.2.4 Reinforces a horizontal process view of the organisation: -

The process model facilitates the integration of budgets with other management initiatives, such as performance measurement systems focused on cause-effect or lead-lag relationships (e.g. balanced scorecards).

However, according to Neely *et al* (2001:10) ABB is still a time consuming approach, which still result in game playing and adding limited value after its first application. It is thus prudent to state that due to this, when ABB is used on its own as a budgeting

approach, will not be conducive to competitiveness within a fast changing environment.

2.1.3 The zero-base budgeting approach

Horngren, Foster, Datar, Black and Gray (1996:492) define zero-base budgeting (ZBB) as "budgeting from the ground up, as though the budget were being prepared for the first time. Therefore, every proposed expenditure comes under review."

Pyhrr (1973:2) states that many managers have suggested that ZBB be renamed to "zero-base planning" or "zero-base planning and budgeting" due to the process requiring effective planning. He further explains that planning and budgeting contrasts each other in the business process as follows:

- Planning identifies the desired ***output***.
- Budgeting identifies the required ***input***.
- Planning is more general than budgeting.

Figure 2.2 shows the relationship between planning and budgeting. (Pyhrr, 1973:3). Planning has to do with the establishing of plans and programs, the setting of goals and objectives, as well as the making of basic policy decisions. Budgeting, and to be more specific, ZBB, has to do with the detailed analysis of the many functions or activities that the business must perform to implement each program, evaluating all the alternatives within each activity to achieve the desired end result, and the identification of the trade-offs between goal achievement and associated costs.

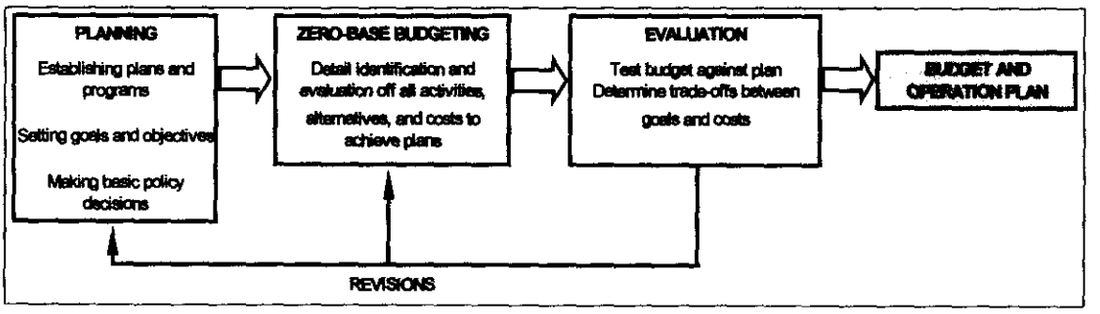


Figure 2-2: Relationship between planning and budgeting

Source: Pyhrr (1973:3)

According to Schick and Hatry (1982:86) ZBB encourages participation by operating managers in the budgeting process. Conventional budgeting may use large numbers of business personnel to assist with the preparation of budget materials for someone else's use, but ZBB requires operating managers to prepare budgets for their own use. The organisation of budgeting around decision units rather than larger administrative units draws more managers into the process, which also does not demand analysis beyond normal managerial skills.

The following major planning, analytical and decision-making processes are required to be engaged by managers and others of the organisation during the development and implementation of the ZBB model:

2.1.3.1 Defining the organisation's mission and goals: -

Although the organisation may already have a set of established mission and goal statements, it may be necessary to redefine them or create new ones if there were major changes in the internal and/or external environments.

2.1.3.2 Identification of decision units and decision packages: -

A ZBB decision unit can also be described as a cost or budget centre for which decision packages, i.e. discrete activities, functions, operations, or programs to be operated in the next fiscal year(s), are to be developed and analysed. Each decision package usually will have three or more alternative ways of achieving the decision package objectives, and each alternative should contain as a minimum, goals and/or objectives, activities, resources, and their costs. Each decision package should also indicate how it contributes towards the organisation's mission and goals. The basic formulation process of decision packages is shown in Figure 2.3.

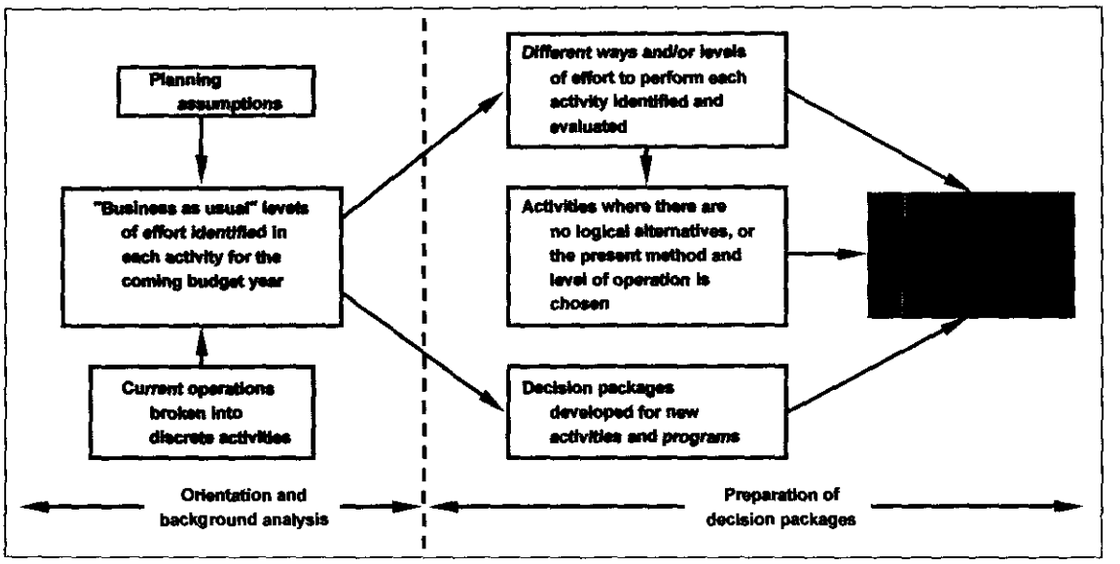


Figure 2-3: Formulating decision packages

Source: Pyhrr (1973:13)

2.1.3.3 Analysis of each decision package: -

The analytical process allows the manager of the decision package, including its alternatives, to assess and justify its operation. During the analytical process the following typical questions should be asked:

- Does the decision package support and contribute to the organisation's goals?
- How would the organisation be impacted upon with the elimination of the decision package?
- Can the objectives of the decision package be achieved more effectively?

2.1.3.4 Ranking decision packages: -

According to Pyhrr (1973:15) the ranking process is a technique allowing management to select the one alternative that has the greatest potential for achieving the objective(s) of the decision package and allocating resources effectively to it by asking:

- How much should be spent?
- Where should it be spent?

There are various methods of ranking and managers will no doubt employ them, but the main point is that ranking of decision packages is an important process of ZBB. The ranking process is shown in Figure 2.4.

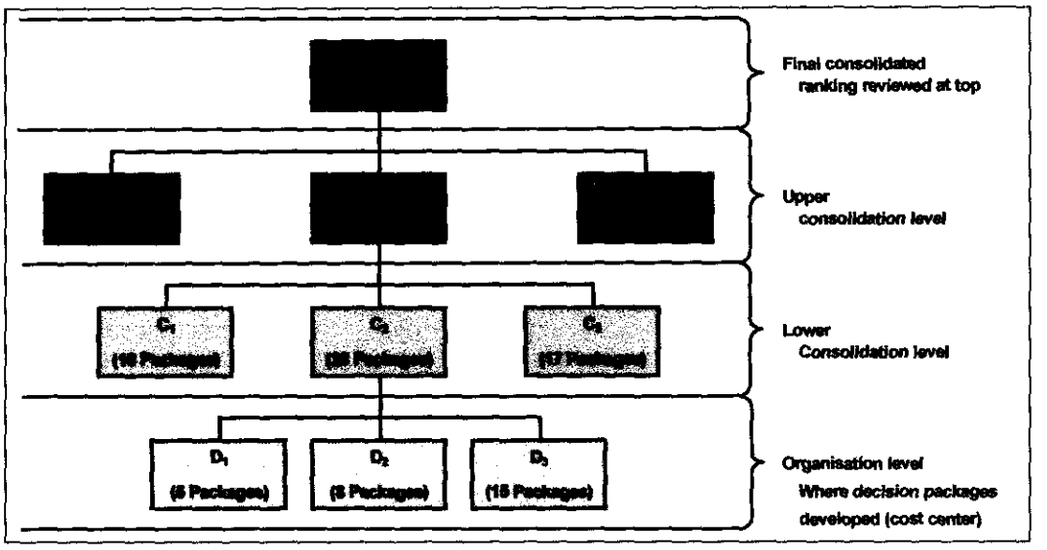


Figure 2-4: Ranking process for decision packages

Source: Pyhrr (1973:16)

The managers preparing the packages at organisational level first rank the decision packages D_1, D_2 and D_3. These managers would then submit their rankings to their next higher level manager, the manager of decision unit C_2, who would then consolidate the 28 packages (5 from D_1, 8 from D_2, and 15 from D_3) into one overall ranking. An iterative process of consolidation is then followed through all levels within the company. Theoretically, one ranking of decision packages can be obtained for the entire company, i.e. decision package A, and judged by its top management.

2.1.3.5 Acceptance and allocation of resources: -

After all decision packages were reviewed and analysed, managers will determine resource level allocation to each decision package. Managers at different levels of responsibility in the organisation, who normally perform this review and analysis, are often requested by executives to revise and resubmit their decision packages if it's not aligned with the company's strategies.

2.1.3.6 Budget preparation: -

Once all the decision packages have been approved, the organisation's budget will be prepared and submitted for final approval. Once the budget is approved, decision unit managers will implement all approved decision packages during the next financial year.

2.1.3.7 Monitoring and evaluation: -

The final process of ZBB is that of monitoring and evaluation. Pyhrr (1973:177) indicates that ZBB affects all aspects of the management process. He also states that the four basic components of the process, i.e. planning, budgeting, implementation, and control, are an integrated series of events as illustrated by Figure 2.5.

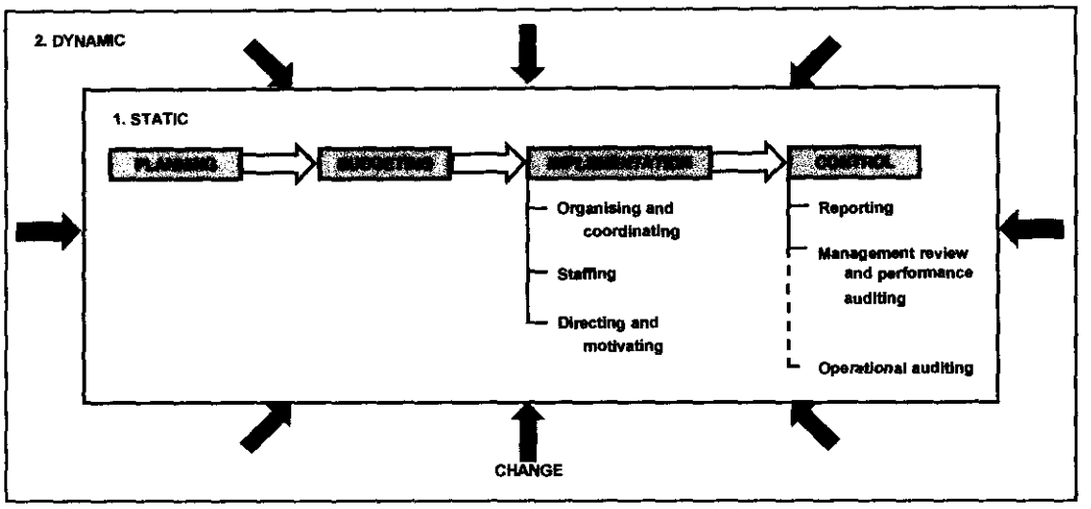


Figure 2-5: The management process

Source: Pyhrr (1973:178)

In the static environment the basic assumptions and planning guidelines remain constant during the planning and budgeting process, which proves to be reasonably accurate when compared with the actual situation experienced during the operating year of the budget. During the financial year managers can readily adjust their operations for reasonable fluctuations experienced within the external and internal operating environments, allowing them to control programmed modifications within allowable budget variances (Pyhrr, 1973:179). However, when changes in the external environment beyond acceptable and manageable limits occur, and/or substantial internal operating problems or changes in personnel occur, management is forced to react in a continually changing dynamic environment. This may force management to completely revise their plans and budgets, implement major changes to current activities or establish new programs and operations, and revise controls to match the new operating scenario.

The monitoring and evaluation process of ZBB needs the following to be included in the overall design and implementation of decision packages:

- Measurable performance objectives.
- Appropriate activities supporting achievement of performance objectives.
- Essential resource allocation supporting activities.
- Methods for conducting planned activities.
- Objective achievement evaluation during and at the end of the activity plan.
- Reporting procedures for communicating performance to managers of the company.

From the above literature review on ZBB the single most important benefit of ZBB is that it is an approach that avoids building on the inefficiencies and inaccuracies of previous years' performance because all future expenditures must be re-justified during each budgeting cycle. However, managers do experience the following problems with ZBB (Neely *et al*, 2001:10):

- It is too time consuming to be repeated annually.
- It still results in "game" playing.
- It adds little value after its first application.

2.1.4 Using the quality function deployment approach

Nogueira (2003:333) states that one of the problems in budgetary planning is that there is a lack of structure of the process, and usually policies or strategies are determined at the political level, but the implementation of such policies or strategies are done at lower levels. Budgetary requirements done by experts suffer cuts at the political level without a clear understanding of the consequences. Quality function deployment (QFD) assesses the impact of decisions made at the various levels and it supports the incremental development of a budget that reduces the communication difficulties within the organisation. According to Nogueira (2003:334) QFD gives the support for the transition from "what-to-do" into "how-to-do-it".

An iterative budgetary planning process starts with a top-down waterfall approach of which the first two steps are done at the political level (Nogueira, 2003:334). First the

goals are identified where after a set of strategies is developed to achieve the goals, or mitigate the threats. Then at the technical level the strategies determine the set of forces that should be arranged and translated into activities that require a certain amount of assets; consequently, a preliminary budget is derived. Figure 2.6 shows this top-down part of the process expressed by the following conditional propositions:

Figure 2-6: Conditional propositions
Source: Nogueira (2003:334)

After this primary top-down phase, the direction of the process flow is inverted. The budget determined at the technical level flows to the upper levels where it usually gets cut due to economical constraints. The process iterates and finally after many negotiations, a definitive budget emerges and rules usually for the next five-year period.

It is also stated by Nogueira (2003:335) that this process unfortunately has an inherent flaw caused by a lack of holistic vision at the technical level. There are also other important issues to be considered, such as:

- Firstly, the method is informal and there is no way to prove that the solution is optimal or even correct.
- The method relies on a great deal of negotiations and human communication, which could result in decisions being based on power rather than reason.
- Lastly, there is no method to estimate the impact of cutting a program or a project mainly because the relations stated in Figure 2.6 are not bi-directional.

The QFD model is an attempt to solve the problems stated above and also to put structure in the decision process. The matrix in Figure 2.8 indicates the relationship between the "what-to-do" with the "how-to-do-it", the rows containing the "what's" (w_i) and the columns containing the "how's" (h_j). The matrix is intrinsically bi-directional as indicated by Figure 2.7, i.e. if there is a relationship from a row to a column; there is also an inverse relationship from the column to the row.

Figure 2-7: Bi-directional relationships

Source: Nogueira (2003:336)

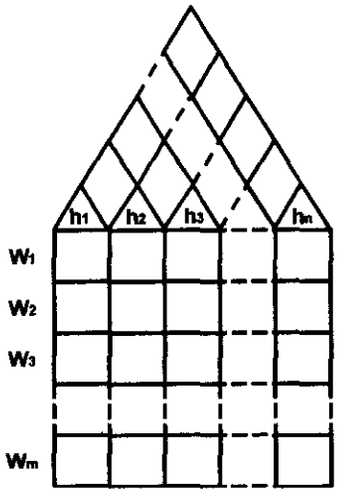


Figure 2-8: A QFD matrix

Source: Nogueira (2003:335)

According to Nogueira (2003:336) the transformation from the goals to budgets requires three steps represented by three matrices as indicated by Figure 2.9. For each matrix (M_1, M_2 and M_3), the concepts used as the "what's" are the concepts stated as the "how's" for the previous one. The first matrix relates goals to strategies. The second matrix decomposed the strategies into forces.

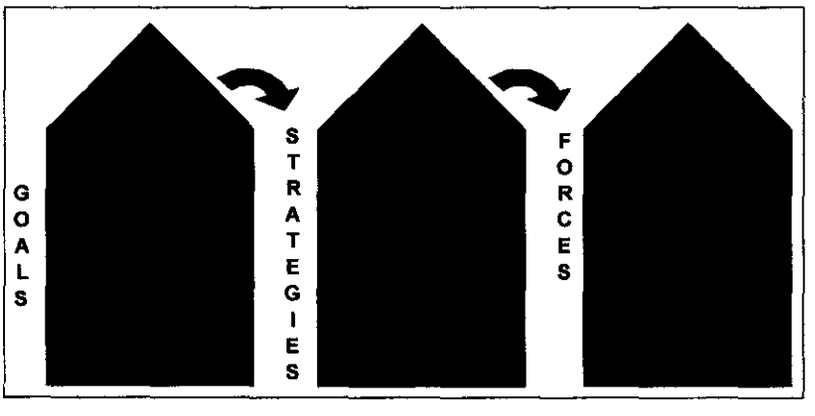


Figure 2-9: Decomposition process using three QFD matrices

Source: Nogueira (2003:336)

The third matrix decomposes forces into activities that have associated budgets. The h_j of each matrix could be complementary or even redundant. The correlation between different systems or alternatives is expressed by the triangular upper part of the matrix shown in Figure 2.10. For example, the c_{ij} represents the correlation coefficient between h_i and h_j. By knowing the correlation between alternatives it is possible to determine an appropriate mix with minimal cost. Thus, before cutting an alternative from the budget, the correlation coefficient determines if the original goal is still supported by the other alternatives, and for this reason it is necessary to express the value added by each alternative. Therefore each matrix element contains the expected effect e_{ij} of each h_j over each w_i. The expected effect is a real number between 0 and 1.0, and denotes the relative importance of each h_j for a given w_i in Figure 2.10 (Nogueira, 2003:337). That is:

$$0 \leq e_{ij} \leq 1.0 \tag{1}$$

$$\sum_{j=1}^{n} e_{ij} = 1.0 \tag{2}$$

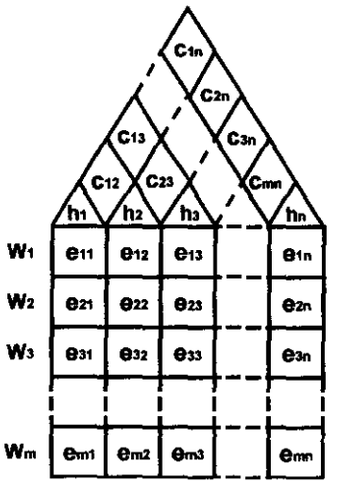


Figure 2-10: Matrix showing expected effects and correlation coefficients

Source: Nogueira (2003:337)

By multiplying the matrices M_1, M_2 and M_3 in Figure 2.9, a fourth matrix M_4 is obtained that relates goals to activities directly. That is:

$$M_4 = M_1 \times M_2 \times M_3 \tag{3}$$

Consequently M_4 transforms the conditional propositions presented by Figure 2.6 into the bi-directional relationship supporting the material equivalence represented by Figure 2.11.

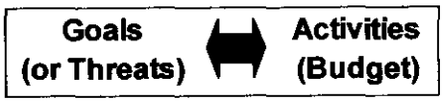


Figure 2-11: Fourth matrix's bi-directional relationship
Source: Nogueira (2003:338)

According to Nogueira (2003:339) this model gives rationality to the budgetary process providing quantitative evidence of the consequences of each decision resulting in an improved negotiation process. The use of correlation coefficients make it possible to find a way to mitigate the negative effect of budget cuts by choosing a better mix of complementary activities.

From the above literature review on QFD the following benefits are noted:

- It provides a formal structure to the budgetary planning process.
- It reduces the communication difficulties at the various management levels within the company through an improved process of decision-making.
- It reduces difficulties in estimating future changes in the environment.
- It allows having a method to estimate the impact of cutting a program or a project from the proposed budget.

However, the disadvantage discovered of the QFD process is that it is a very elaborate process, which when used on its own, is not conducive to competitiveness within a fast changing environment.

2.1.5 The target budgeting approach

Lewis (1988:15) states that an element missing from most enterprise management systems (EMS) is a method by which chief executives can influence the content and size of business unit budgets prior to preparation of detailed estimates. It is a waste of valuable time and finances if an individual business unit is allowed to prepare detailed

estimates that add up to an unacceptable total or are based on policies that executives will not approve. There is thus a need for a top-down as well as a bottom-up budgeting approach. Alternative budgets, sometimes called "target budgeting" (TB) are a popular method of meeting this need. Therefore according to Lewis (1988:15) TB is a workable and useful supplement to, but not a substitute for "traditional budgeting".

Several weeks prior to preparation of detailed estimates, business units are required to submit broad-brush skeleton estimates for the coming financial year. This submission is analysed and discussed with each business unit concerned. Issues requiring further study or that require advance policy guidance from the chief executive are identified. Tentative budget targets are set for all business units based on this preliminary review. These targets add to a company-wide total acceptable to the chief executive. Business units are then requested to prepare detailed "A" budgets which do not exceed the assigned targets. Business units are also permitted to submit "B" budgets that contain items they would like to have but cannot squeeze into the "A" budget. "C" and "D" budgets may also be prepared if more priority indications are wanted.

According to Lewis (1988:16) the TB approach has the following advantages:

- The chief executive prior to preparation of detailed proposals establishes targets after taking into account changes in price levels, workloads, legislation, executive policy and other factors that impact the budgetary scene.
- It has a priority setting feature in that business units are required to formulate a budget within the constraints of a target figure set by higher authority. In this manner the TB approach focuses attention on incremental analysis at the margins, which Schick and Hatry (1982:86) deem to be the heart of ZBB.
- It contains a process of advance policy guidance to the business units. Thus, a business unit might be instructed to make provision in the budget for starting a new research program, constructing new infrastructure, or phasing out a program.
- TB can be used by all business units and at various levels of hierarchy. Both micro and macro issues can be handled.

the maintenance management information system (MMIS), evaluation of the LCC, and conducting sensitivity analysis to identify maintenance cost drivers.

Barringer (1998:3) states that in general, cost details for the acquisition tree shown in Figure 2.13 are usually identified and collected correctly, however the collection of costs for the sustaining tree shown in Figure 2.14 is the major problem!

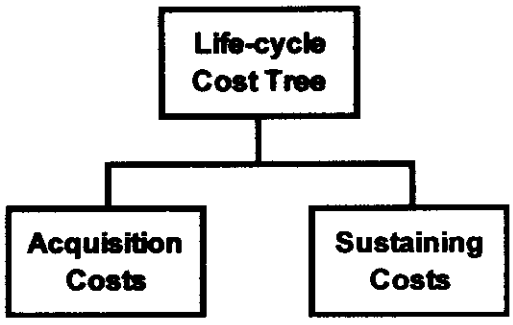


Figure 2-12: LCC = Acquisition + Sustaining costs with time considerations

Source: Barringer (1998:3)

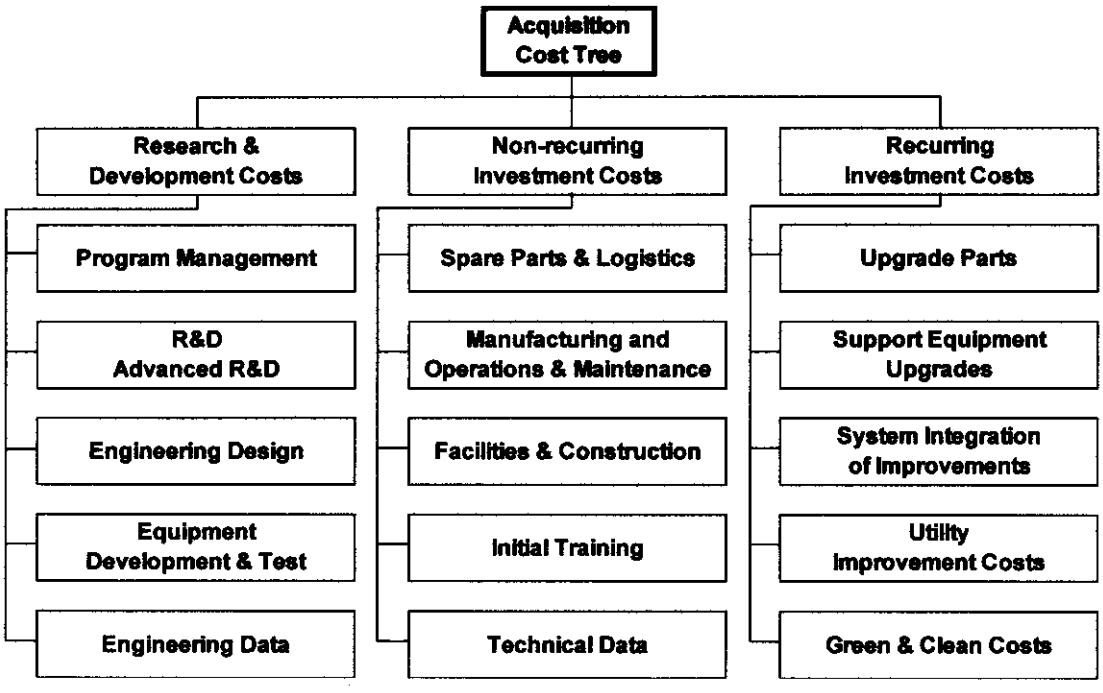


Figure 2-13: Acquisition cost tree

Source: Barringer (1998:4)

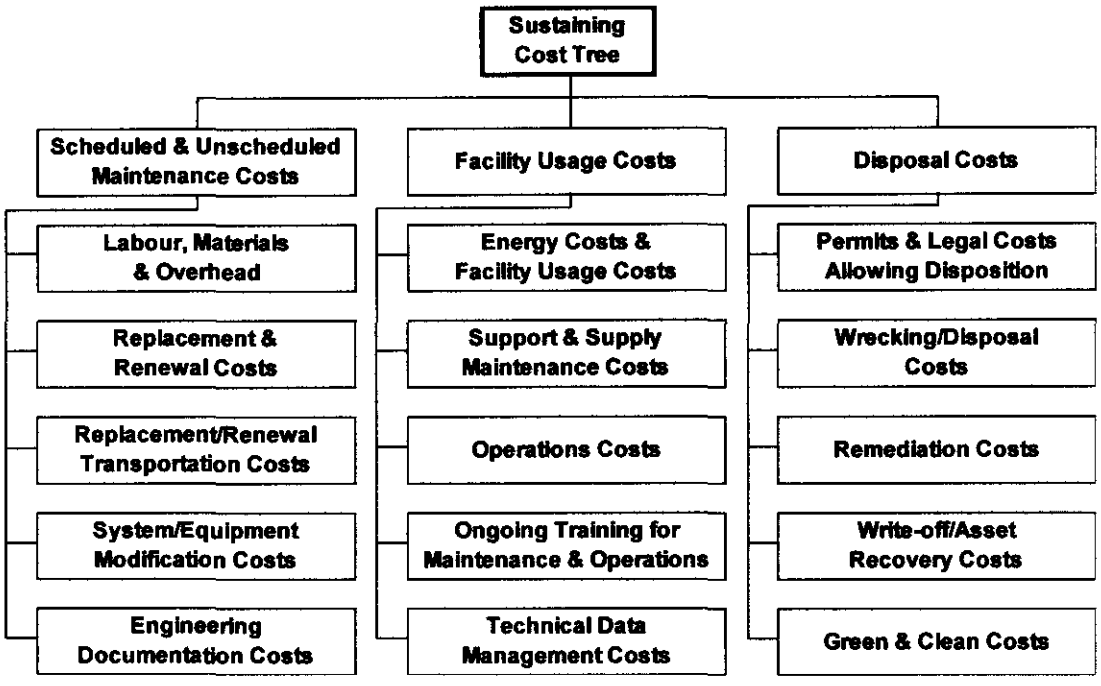


Figure 2-14: Sustaining cost tree

Source: Barringer (1998:4)

According to Barringer (1998:4) the cost of sustaining/maintaining equipment is, in general, 2 to 20 times the initial cost of acquiring an asset. This cost is usually the smallest amount that will be spent during the life of the asset. The four most difficult items in the sustaining tree to be collected are: (i) replacement/renewal costs, (ii) replacement/renewal transportation costs, (iii) support/supply maintenance costs, and (iv) operating costs – particularly electrical costs because of varying loads on the equipment.

Most capital equipment authorisations ignore major parts of the sustaining cost tree because they lack funds for sustaining/maintaining the asset, and are usually based on some "justifications". Failure costs that are included appear as a percentage of the initial costs and are spread evenly over every year of the typical 20-year life of an asset.

A complication arises in the sustaining tree that is driven by planned costs in the acquisition tree. Approximately 65 – 75% of the total LCC is set when the equipment is specified, and most decisions are based on the acquisition tree which is the smallest portion of the LCC (Barringer, 1998:5)! Figure 2.15 shows the LCC process for including appropriate costs.

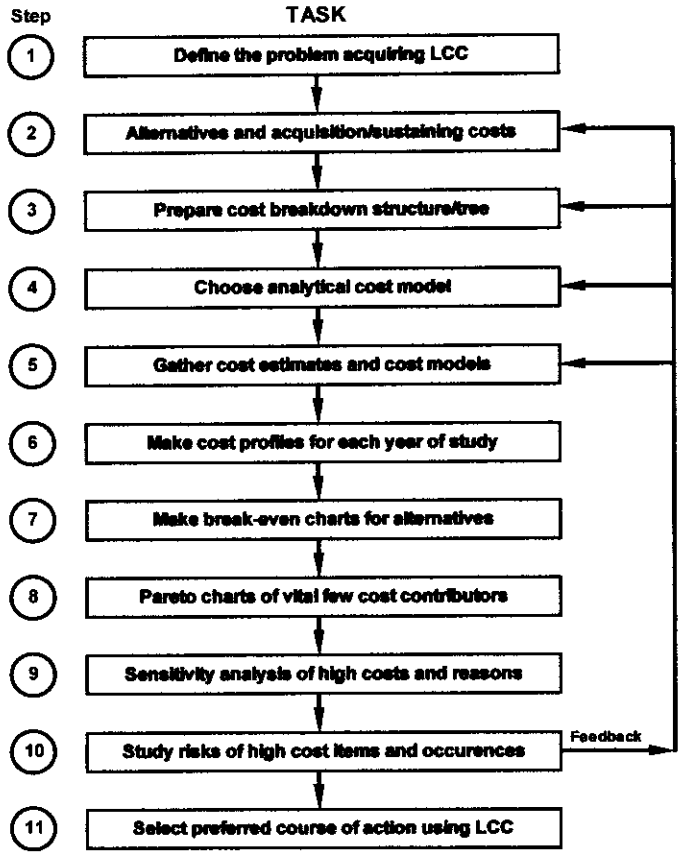


Figure 2-15: Process flow for LCC calculations

Source: Barringer (1998:5)

From the above LCC literature review the following benefits are apparent:

- It fosters long-term considerations, typically over the life of the equipment/machinery and helps avoid myopic decisions.
- It necessitates total cost visibility by focussing on the lowest total cost of ownership of the equipment/machinery.
- It helps identify potential "high-risk" or high cost areas within the life cycle of equipment/machinery.
- It allows for better overall resource management.
- It acknowledges that operational usage also have a significant influence on the life-cycle costs of equipment/machinery.

2.1.7 The rolling budgeting approach

According to Myers (2001:42) many companies are recognising that the conventional static budget, which is produced annually near yearend and then used as a guide for the following year, even though it's outdated, is just not good enough anymore. Instead, they are turning to rolling budgets (RB) – forecasts that are updated every few months – in effect, reassessing the company's outlook several times a year. The result: an always-current financial forecast that not only reflects a business's most recent monthly results but also any material changes to its business forecast or the economy.

The implementation of rolling budgets does not necessarily require any fundamental change in the way a company has been doing its budgets, except of course it no longer does budgeting just once a year. However, companies that decide to implement rolling budgets may want to take advantage of the decision to make changes in the way they approach the budgeting task. They may search for new ways to speed up the budgeting process and to make it more useful.

Many accountants view traditional budgets often as useless because they are hopelessly outdated soon after they were approved and implemented (Myers, 2001:42). When a company uses a traditional static budget process and finds that it misses its sales targets in the first month, it typically pushes those projected sales into subsequent quarters, acting as if the forecast for the full year remains unchanged.

For RB to work management must access and process information more quickly, because the time between budgets has been compressed. To do that, line managers must become more involved in the process and the company/organisation/business unit must embrace technology that will allow it to quickly capture and disseminate the raw data needed for decision making and forecasting. That often means acquiring special software that does the job (Myers, 2001:42). Most organisations today rely on Microsoft Excel spreadsheets to do their budgeting. They work, but they can be laborious, requiring finance managers to piece together input from all the operations managers throughout the organisation. In this way managers can spend a lot of time allocating expenses among different segments of the business, but with the help of special

software the process will be automated, allowing managers to spend more time analysing the data.

Although no budgeting technique can predict the future, this technique allows companies to get much closer to the ideal. The only holdback is the willingness of a company's managers to use the new technology tools that are now available (Myers, 2001:46).

From the above literature review on RB the following benefits are evident:

- It allows a company to have an always-current financial forecast, which helps them to keep pace with changing circumstances.
- It does not necessarily require any fundamental change in the way a company has been doing its budgets.
- This technique allows companies' financial forecasting to get much closer to market reality.
- The implementation of special software supporting RB allows managers to spend more time analysing data than collecting it.

However, according to Neely *et al* (2001:10) the disadvantage of RB is that it can result in more costs to the company due to the higher frequency of putting budgets together.

The next sub-section of this research report will define the competitive advantage that a company/organisation can expect when using realistic budgeting principles.

2.2 Defining competitive advantage using realistic budgeting principles

The second phase of the research involved a review of the relevant available literature on the subject of competitive advantage. This sub-section makes use of this material to define and explore a competitive advantage gained through the use of realistic budgeting principles.

According to Porter (1998:155) national prosperity is created, not inherited. It does not

grow from a country's natural endowments, its labour pool, its interest rates, or its currency's value, as classical economics insists. The capacity that a nation's industry has to innovate and upgrade, determines the nation's competitiveness. Companies competing with the world's best competitors, gain advantage because of the pressures and challenges they experience during this struggle with the best. Many benefits become evident from having strong domestic rivals, aggressive home-based suppliers and demanding local customers. Competitive advantage is created and sustained through a highly localised process.

Kotler and Armstrong (2001:270) states that a company gains an advantage over competitors by offering consumers/customers more value than what the competitor's can. Burgelman, Maidique and Wheelwright (2001:365) also state that a company gains a competitive advantage over competitors through the development of distinctive competencies. Jehle (1999:56) points out that competitive advantage is all about understanding what your business needs to achieve to differentiate itself, gain market share, or somehow leave its competitors in the dust.

According to Jehle (1999:54) a good budget is more than just a process of collecting and consolidating numbers, and states further that it is a map that can guide a company to competitive advantage. Budgets have to be flexible and revised as the business changes. The faster the industry that the business is in moves, the faster the company has to shift its priorities, the more often plans need to be adjusted and hence the more often the budget has to be adjusted. As the competitive landscape changes, organisations need to plan and re-plan quickly. Jehle (1999:55) states that fast, efficient budgeting, rolling forecasts, and effective management reporting and analysis are key to managing changing conditions or deviations from planned performance.

Successful companies see budgeting as the cornerstone to a closed-loop system for management planning and control (MPC). Such a system drives a company's quest for competitive advantage and consists of interlinked management processes. These processes, as shown in Figure 2.16, are the methods by which strategic initiatives are turned into plans and budgets that deliver the expected results.

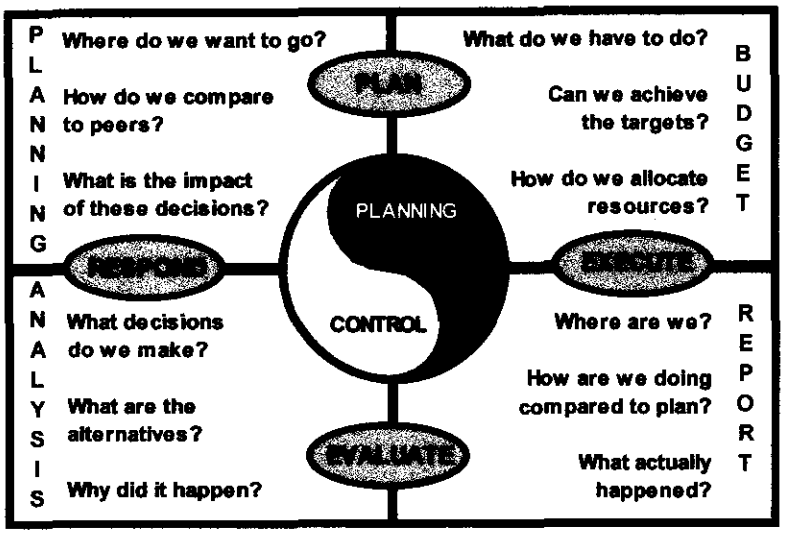


Figure 2-16: Closed-loop processes for management planning and control

Source: Jehle (1999:57)

The management planning process takes key strategic initiatives and supports a top-down and bottom-up planning process, including goal setting, budgeting, and rolling forecasts. The management control process supports planning by providing organisational insight, communication, and focus. It includes the monitoring of planned performance, support for analysing alternatives, and taking corrective actions.

An effective MPC system harnesses the best thinking and collective knowledge of all individuals who are most intimate with the maintenance function of the operation. Linking the strategic plan to the maintenance plans, making resource allocation decisions based on the strategic plan that are reflected in the budget and providing solid analysis when results deviate from the plan are all value-added benefits of an effective MPC system.

Over the past few years many companies have implemented Enterprise Resource Planning (ERP) systems, which were designed to improve operational business processes such as general ledgers, order processing, procurement and inventory management. Modern MPC software applications address the processes of planning, budgeting, financial consolidation, reporting and analysis. These applications transform data from an organisation's business transaction systems or ERP systems into business-critical information that can be used to make sound planning and management

decisions on a continuous basis (Jehle, 1999:56).

In the next sub-section of this research report the most advantageous and applicable parts of the abovementioned budgeting approaches will be integrated into a theoretical budgeting model that will give a company a competitive advantage when implemented.

2.3 Integrating the different budgeting approaches into a theoretical model

The third phase of the research involves an integration of the most advantageous and applicable parts of the abovementioned budgeting approaches into a theoretical model. This sub-section makes use of the research material to develop a proposed theoretical budgeting model, which will ensure that the budget will be matched with market reality, giving a company a competitive advantage.

Figure 2.17 shows the model as generated by the author of this research report to integrate the researched material on the different budgeting approaches, i.e. rolling budgeting (RB), activity based budgeting (ABB), zero-base budgeting (ZBB), life cycle costing (LCC), quality function deployment (QFD), and target budgeting (TB), into a theoretical budgeting model which will reduce/eliminate the current frustrations and weaknesses experienced with traditional budgeting approaches and it will give a company/organisation a competitive advantage when implemented. A discussion on the functioning of the proposed model will now follow.

2.3.1 Goals

As with the TB and ZBB approaches, the proposed model starts off with a top-down approach whereby the company's executive group sets the expected performance targets for the company to be achieved during the next 12 to 18 months. Business units will revise the logics of their budgeting databases annually to confirm its alignment with updated strategic plans – organisational and asset management strategic plans.

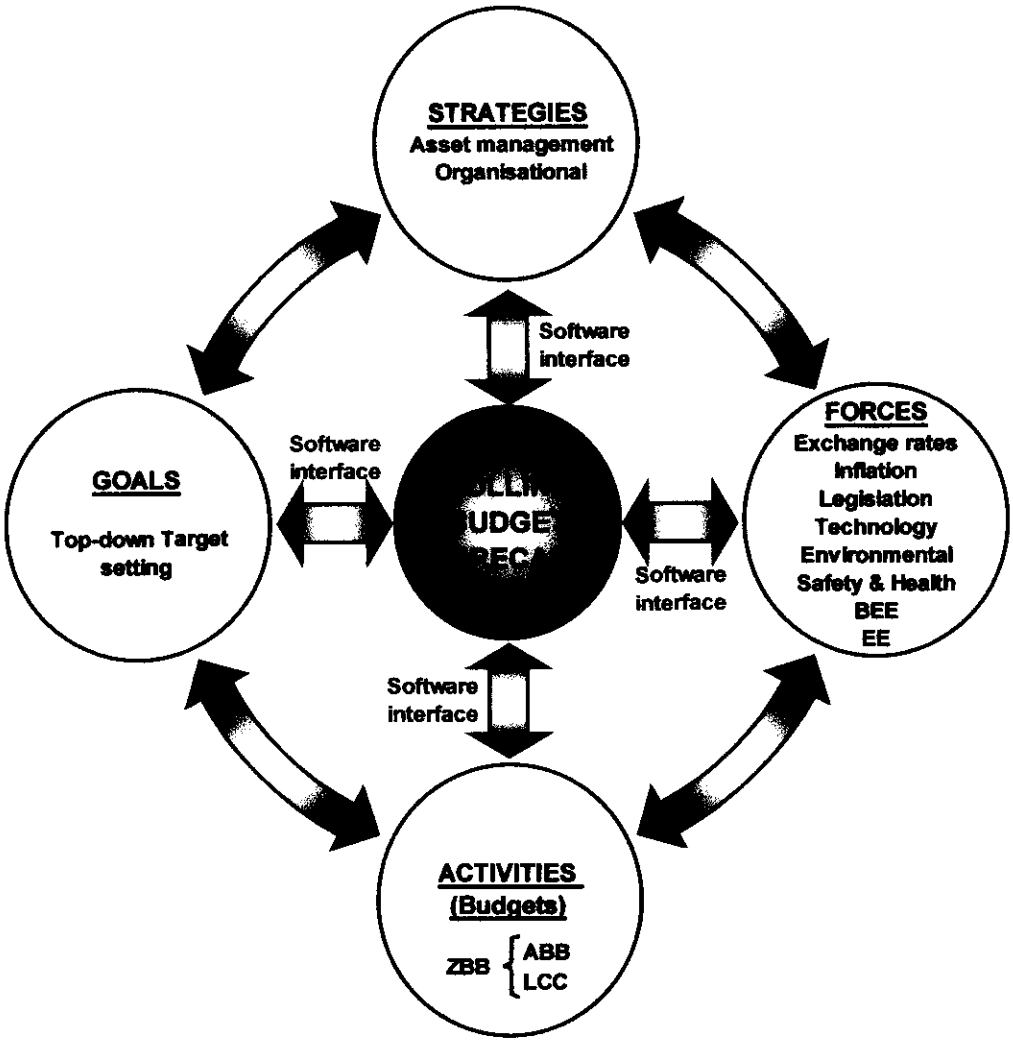


Figure 2-17: An integrated theoretical budgeting model

Source: Developed by the author of this research report

2.3.2 Strategies

The success of the maintenance function is dependant on the quality of an asset management strategy as well as its implementation. Peterson (2000:1) defines asset management as: *"completely align plant resources to achieve the business goals of the organisation at the lowest cost".* The asset management strategy is a holistic approach towards maintaining the assets of an organisation. It also includes an equipment/machinery maintenance strategy, which addresses the maintenance specifics of each type of equipment/machinery.

The maintenance strategy would typically address the various maintenance activities that make up the maintenance "mix" the maintenance function would apply to a specific piece of equipment or plant or physical asset. Maintenance activities such as condition-based maintenance, scheduled maintenance, breakdown maintenance and opportunity maintenance would typically make up the maintenance "mix", but it is also dependant on the weighting of each activity.

The asset management strategic plan should also be aligned with the organisational strategic plans, which are supporting the goals and targets set by the chief executive of the company. Thus, a bi-directional interdependency also exists between the setting of goals and the development of strategies.

2.3.3 Forces

Forces influencing both the strategies and the budgeting activities include exchange rate fluctuations, inflation rate and indices, legislation, technological innovation, environmental controls, health and safety issues, black economic empowerment (BEE), and employment equity (EE), to name but a few. These forces also have a bi-directional interdependency with the strategies and the budgeting activities.

2.3.4 Activities

Detailed budgets are based on the ZBB principles and applied to the various business activities of which each activity includes equipment, which is budgeted for using the LCC approach. These three budgeting approaches ZBB, ABB, and LCC are highly integrated into the annual revised budget. The integration process followed will now be discussed at the detail level using the following three steps:

STEP 1: - Prepare a cost breakdown structure for each type of equipment or machinery.

Prepare a cost breakdown structure for each equipment/machinery type. Table 2.1 presents an extract from a cost breakdown structure for a typical maintenance budget at

one's plant. It is important to note that the list as presented in column A, should include all the components the equipment/machinery is made up of; typically one can use the bill of materials supplied by the original equipment manufacturer (OEM) in the parts manuals. The costs listed in column D should be dictated by the maintenance strategy to be followed and sourced from the OEM or the contracted service provider. This information will represent the base of the budget, and typically the ***zero basis***. This step can be applied to any equipment/machinery, independent of its age, whether it is new equipment/machinery or whether it was in operation for some time.

Table 2-1: Extract from a cost breakdown structure

Machine Number:	**BF 002**		
Machine Type:	**CAT 789**		
Current Exch Rate (R/$):	**6.30**		
Remain Budget Hours	**1,354**		
Description (A)	**Expected Life (Hours) (B)**	**Current Life (Hours) (C)**	**Current Cost (Rand) (D)**
Responsible Code:	**470512**		
Cylinders			
Steer Cylinder L/H	15,000	10,575	14,270
Steer Cylinder R/H	15,000	1,020	14,270
Hoist Cylinder L/H	15,000	8,759	26,850
Hoist Cylinder R/H	15,000	12,228	26,850
Steering Ball Stud L/H	7,500	541	7,115
Steering Ball Stud R/H	7,500	541	7,115
Steering Line Boring	5,000	541	3,500
Hoist Cyl Bearing Set	7,500	541	9,200
Hoist Cyl Line Boring	7,500	541	3,500

Source: Syferfontein Strip-mine (2000)

STEP 2: - Determine the long-term maintenance plan.

For each component listed in Table 2.1 an expected service life has to be determined. This process will be discussed in more detail in subsection 2.4 below. The expected life or norm is usually expressed in equipment/machine hours used, production tons produced or even in calendar time. Table 2.2 shows an extract of the first three years of a 10-year maintenance plan. Column B represents the expected life of a component, measured in machine hours. For a machine that has been in operation for some time, a "snap-shot" of it's current status has to be determined. This is represented by column C, which reflects the current life each of the components has achieved to the date of the

"snap-shot". Depending at which point during the financial year the "snap-shot" is taken, the remaining budgeted machine hours for the financial year has to be determined and added to the current life (column C) in order to determine the starting point for the next financial year. This is shown in column G under the heading Period 1. The machine hours budgeted for this financial year (Period 1) is now added to its start life (column G), which will then result in the starting point for the next financial year labelled Period 2, shown in column K. This iterative process should be followed to develop the long-term (typically 5- or 10-years) maintenance plans for the maintenance function of the business. All the figures highlighted in red represents a maintenance activity's expected cost. The process described above is nothing else but the process of determining the ***life cycle cost*** of each component of a machine over the longer term (typically for the expected life of the equipment/machinery), using the ***zero-base budgeting*** principles.

Table 2-2: Extract of the first three years of a 10-year maintenance plan

Machine Number:	BF 002							
Machine Type:	CAT 789							
Current Exch Rate (R/$):	6.30		Period 1 Exch Rate:	Budget Hours: 3836 Hrs	Period 2 Exch Rate:	Budget Hours: 3836 Hrs	Period 3 Exch Rate:	Budget Hours: 3836 Hrs
Remain Budget Hours	1,354							
Description (A)	Expected Life (Hours) (B)	Current Life (Hours) (C)	Start Life (G)	Budget Cost (I)	Start Life (K)	Budget Cost (M)	Start Life (O)	Budget Cost (Q)
Responsible Code:	470512							
Cylinders								
Steer Cylinder L/H	15,000	10,575	11929	14,466	765	0	4335	0
Steer Cylinder R/H	15,000	1,020	2374	0	6210	0	9780	0
Hoist Cylinder L/H	15,000	8,759	10113	0	13949	27,219	2519	0
Hoist Cylinder R/H	15,000	12,228	13582	27,219	2418	0	5988	0
Steering Ball Stud L/H	7,500	541	1895	0	5731	7,115	1801	0
Steering Ball Stud R/H	7,500	541	1895	0	5731	7,115	1801	0
Steering Line Boring	5,000	541	1895	3,693	731	0	4301	3,693
Hoist Cyl Bearing Set	7,500	541	1895	0	5731	9,200	1801	0
Hoist Cyl Line Boring	7,500	541	1895	0	5731	3,693	1801	0
Sub-total				45,378		54,342		3,693

Source: Syferfontein Strip-mine (2000)

STEP 3: - Divide the production process into activities.

In order to explain the mechanism of activity based costing, a working colliery will be used to explain the concepts. At a colliery, each step/activity of the coal mining process requires different types of equipment/machinery. The coal mining process in a strip-mine can typically be divided into four activities namely; topsoil stripping and placing, drilling and blasting, overburden removal, and coaling. Each of these activities will utilise different types of equipment/machinery. For example bowl scraper machines will be

used for removing the fertile topsoil layer covering the rock layer, which covers the coal seam. Drilling machines will be used to drill through the rock layer (overburden) to the top of the coal seam, in a predetermined pattern of drill holes, which will be charged with explosives. The overburden will be blasted into a pile of fractured rock material which will be removed by either a truck and shovel operation or by means of draglines. Lastly the exposed coal seam will once again be drilled, blasted and loaded by means of a truck and shovel operation.

Therefore, for this example, once all equipment/machinery have been budgeted for by using the processes explained in STEPS 1 and 2 above, all the equipment/machinery have to be divided into the various activities of the coal mining process. This process is called ***activity based budgeting*** which enables tracking of unit cost of production per activity.

Once again the activities, goals and forces all have a bi-directional interdependency with each other.

2.3.5 Rolling budget (forecast)

Rather than creating an annual financial forecast that remains static for the year, a base budget reflecting long-term planned maintenance activities is produced, which is updated on a monthly basis. A long-term (typically 10-years) maintenance plan would be developed due to the long-term life expectancy of capital-intensive physical assets used at a plant. Budget planning and analysis software is utilised to update and replace the monthly projected performance figures of the business with the actual performance figures achieved, and the budget is then rolled forward one more month, thus resulting in a rolling 10-year plan. This updating process is typically initiated by the maintenance planning function and coordinated by the accountants.

This rolling budget, as shown by the proposed theoretical model in Figure 2.17, drives a target-based detail budget, which is a key financial component of the organisation's strategic planning process. An enterprise resource planning (ERP) software enables the rolling budget that is fully integrated with the setting of goals, strategies, forces, and

budgeting activities. The rolling budget is continuously updated as events (e.g. component replacements, exchange rate changes, inflation rate changes, etc.) occur. This timeliness and relevancy of the rolling budget will give the company a competitive advantage in the fast changing economic environment of today.

Now that the content and structure of a proper general maintenance budgeting process has been defined, it can now be tested. Therefore, in chapter 3 of this research report the extent to which the maintenance practitioners of collieries within the South African coal mining sector apply the elements of the proposed theoretical model in current practice, will be tested. This sector was chosen because of the highly mechanised nature of collieries and the impact the South African maintenance practitioner may have on a colliery's unit cost of production within the South African market.

Specific questions will be designed and included in the questionnaire for this purpose. The results of these questions will be discussed in chapter 5.

In the next sub-section of this research report the proposed theoretical budgeting model will be discussed as it is applied to the maintenance budget.

2.4 Applying the integrated budgeting model to the maintenance budget

Due to the holistic nature of asset management, the proposed theoretical budgeting model can be applied to the business as a whole, i.e. covering all of its functions such as the maintenance, financial, procurement and supply management, human relations, safety, health and environment functions. The fourth phase of the research therefore involves the application of the proposed theoretical budgeting model to the maintenance budgeting process, as this function can account for up to two thirds of the total cash cost budget for physical asset and capital-intensive operations such as coal mining. This sub-section will deal with the budgeting activities of this model at the detail level, when the maintenance practitioner has to apply it to the maintenance budget to ensure it is realistically aligned with market reality, giving the company a competitive advantage.

When judging the financial efficiency of a maintenance system, many maintenance practitioners adopt a simplistic (and very outdated) average hourly maintenance cost per machine as the sole indicator of cost performance (Edwards, Holt and Harris, 1998:60). A more accurate maintenance cost estimation system applied to equipment and machinery includes an integrative approach to maintenance budgeting with ZBB, LCC and ABB, as is proposed by the theoretical model shown in Figure 2.17. In order to apply the proposed theoretical budgeting model to a maintenance budget, the following steps should be followed:

STEP 1: Setting goals and objectives

A top-down approach is followed where the maintenance executive of the company sets both technical and financial goals and objectives for the maintenance department, which should be aligned with the goals and objectives of the company.

STEP 2: Developing a maintenance strategy

Develop an asset management strategy that will support the goals and objectives of the company. Financial success of an asset management strategy can be determined realistically only when actual costs are compared with target "predicted" values. The cost to utilise equipment and machinery includes not only the more "obvious" capital cost of equipment and machinery ownership, but also the ongoing cost of maintenance and subsequent disposal. It is therefore essential to maintain equipment and machinery in a safe and operationally optimum condition, for which the maintenance practitioner is responsible. The operationally optimum condition refers to the required condition of the equipment/machinery to perform at the design intended productivity and maintenance and operational cost levels. As was discussed earlier in subsection 2.3.2, the maintenance strategy is a very important component of an asset management strategy. The development of the maintenance strategy is thus a critical exercise, which should be completed diligently because the successful execution of the maintenance budget will be dependant on the maintenance strategy.

STEP 3: Prepare a cost breakdown structure

Fixed-time-to maintenance (FTTM), frequently called scheduled maintenance (Edwards *et al*, 2000:428), forms the basis of the LCC approach. With the proposed theoretical budgeting model the LCC of equipment and machinery is developed from ground zero, i.e. supporting the ZBB principles. A cost breakdown structure has to be developed, which takes into account all labour requirements (man-hours per scheduled task), components (sub-assemblies such as motors, gearboxes, hydraulic cylinders, etc.), consumables (oils, grease, filters, etc.), miscellaneous maintenance materials (bolts, nuts, globes, lugs, etc.), and structural repairs (welding, cutting, steel, etc.). An example of a typical cost breakdown structure developed by the author of the research report for a CAT 789 rear dump truck is shown in Table 2.1. A list of all the components of each type of equipment and machinery gets drawn up by the maintenance-planning department (column A), which is then costed by the OEM or contracted service provider (column D). It is recommended to do such an exercise annually to verify pricing reality.

STEP 4: Develop expected component lives

To develop the expected life for each component of each machine type to be budgeted for, is the most important step of the budgeting process, which is often underestimated by many maintenance practitioners (Edwards *et al*, 1998:60).

Table 2.3 shows the expected lives (column B) for each of the components listed in the cost breakdown structure.

Table 2-3: Listing expected component lives

Machine Number:	BF 002	
Machine Type:	CAT 789	
Current Exch Rate (R/$):	6.30	
Remain Budget Hours	1,354	
Description (A)	Expected Life (Hours) (B)	Current Cost (Rand) (D)
Responsible Code:	470512	
Cylinders		
Steer Cylinder L/H	15,000	14,270
Steer Cylinder R/H	15,000	14,270
Hoist Cylinder L/H	15,000	26,850
Hoist Cylinder R/H	15,000	26,850
Steering Ball Stud L/H	7,500	7,115
Steering Ball Stud R/H	7,500	7,115
Steering Line Boring	5,000	3,500
Hoist Cyl Bearing Set	7,500	9,200
Hoist Cyl Line Boring	7,500	3,500

Source: Syferfontein Strip-mine (2000)

The process for determining the equipment and machinery component expected lives will now be discussed in much more detail.

In order to develop the expected component lives it is assumed that the various historical lives achieved by these components up to the point they failed, fits the normal probability distribution. The normal distribution is used because of its wide use in business and management decision-making, which underpins the area of statistical inference (Wisniewski, 2002:150). Therefore, if the source data to be used does not comply with such requirements, the data should be cleaned up first.

Normally the component failure distribution for equipment and machinery has a large standard deviation (widely spread-out) as depicted by the blue curve in Figure 2.18. This relates to ad-hoc failures with very low predictability – a typical symptom of "breakdown maintenance".

The preferred situation is to have a much smaller standard deviation (compressing the widely spread-out curve) as depicted by the red curve in Figure 2.18, which relates to a much higher degree of component failure predictability. This will enable proactive component change outs, which can be planned/scheduled for execution just in time (JIT) before failure (Masaaki, 1997:2).

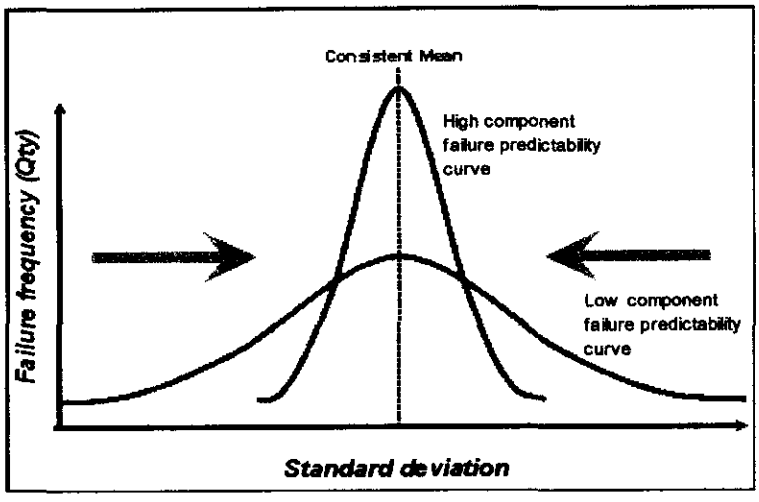


Figure 2-18: Component failure Normal distribution

Source: Adapted from Wisniewski (2002:150)

The optimal point for replacing a component proactively is depicted by the JIT point in Figure 2.19. The interval between inspection points 1 and 2 represents the scheduled condition monitoring tasks as well as any other scheduled/planned activity related to a maintenance intervention. At point 2 deterioration of the component is detected and the inspection interval shortened as depicted between points 2 and 3, and between points 3 and 4. Point 4 represents a proactive JIT replacement of the component just before it fails. The objective of this proactive maintenance approach is to achieve a planned vs. unplanned downtime ratio of better than 85%:15%, which is also the benchmark for world-class companies (Mitchell, 2002:99).

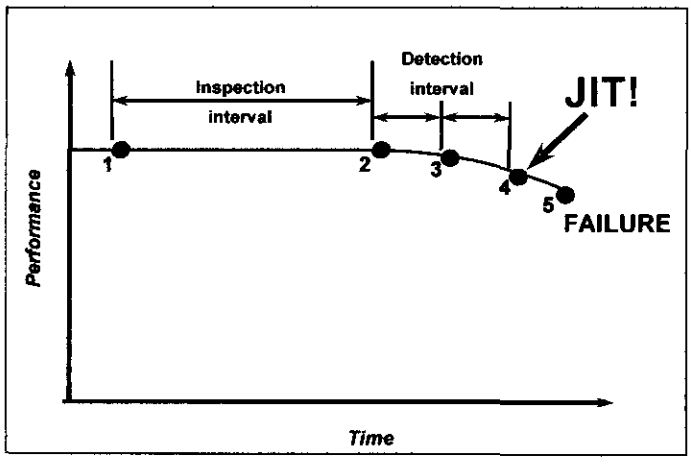


Figure 2-19: Optimal component replacement point

Source: Adapted from Moubray (1997:60)

The result of planned, proactive JIT component replacements is expected to increase component lives in general. From Figure 2.20 the shift of mean B, depicted by the red normal distribution curve, to the right of mean A, depicted by the blue normal distribution curve, shows this expected increase in component life. This increase creates an opportunity gap, which should be determined and built into the maintenance budget annually to ensure continuous life improvement of components, which should be managed rigorously. This highlights the bi-directional interaction of the strategy with the actual budgeting activity and how the one can be used to determine the other as explained in section 2.3.2. For example Figure 2.20 the opportunity gap represents a 70% increase (i.e. moving the mean from 50% of the population to a mean of 85% of the population) in component life!

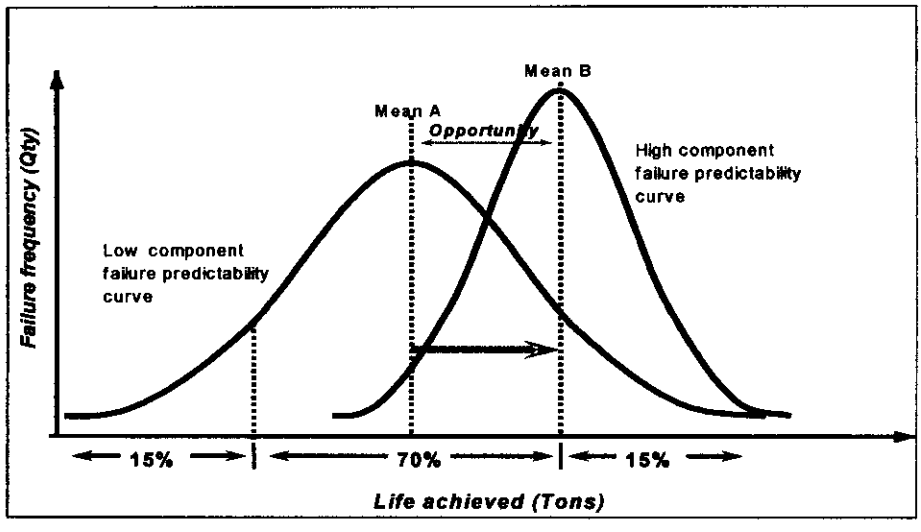


Figure 2-20: Component expected life improvement

Source: Developed by the author of this research report

When component replacements are managed on a JIT principle, huge savings can be generated. The costs associated with a failed component can vary anything from two to five times more than that associated with a proactive component replacement (Moubray, 1997:109). It is thus imperative to make extensive use of condition based monitoring techniques where applicable, to realise maintenance related cost savings through proactive component replacement management.

From Figure 2.21 the shift of mean C, depicted by the green normal distribution curve,

to the left of mean A, depicted by the blue normal distribution curve, shows the opportunity gap with the associated expected decrease in component repair/replacement costs which should be built into the maintenance budget annually ensuring continuous component repair/replacement cost improvement, again highlighting the bi-directional interaction as described in 2.3.2. It is also important to note that the OEM plays a major role in repair cost reductions, e.g. the company and the OEM must agree to a scope of repair for each component, returning it to an "as new" condition, which should result in the minimum repair cost of the component, but still within a 100% warranty coverage by the OEM. Otherwise the next life cycle for that component will have to be handled and budgeted for differently than the first, as the entry condition of the equipment will have been changed. From Figure 2.21 this opportunity gap for example is indicating a 70% reduction (i.e. moving the mean from 50% of the population to a mean of 15% of the population) in component repair costs.

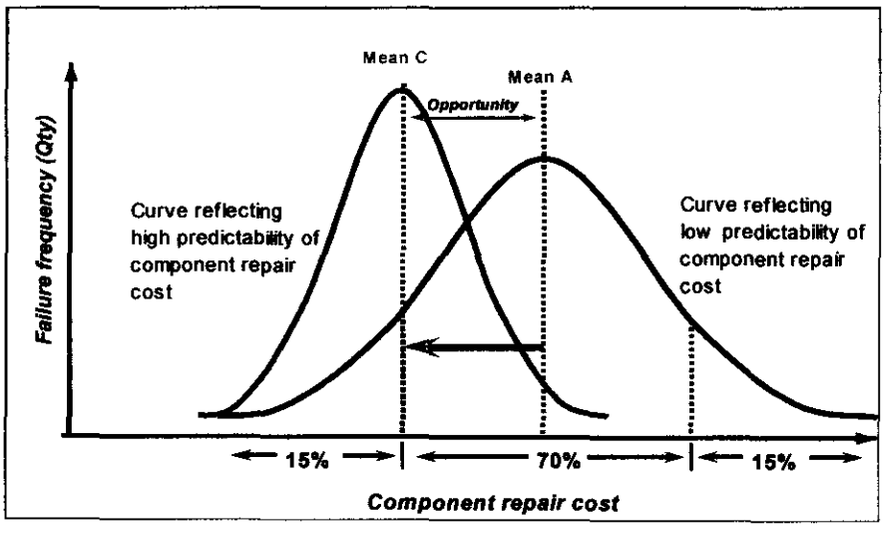


Figure 2-21: Component expected repair/replacement cost improvement

Source: Developed by the author of this research report

Once the two actions are synchronised, i.e. the proactive component replacement management and the minimising of component repair costs, a quantum leap in maintenance cost reduction may be achieved. This is represented in Figure 2.22.

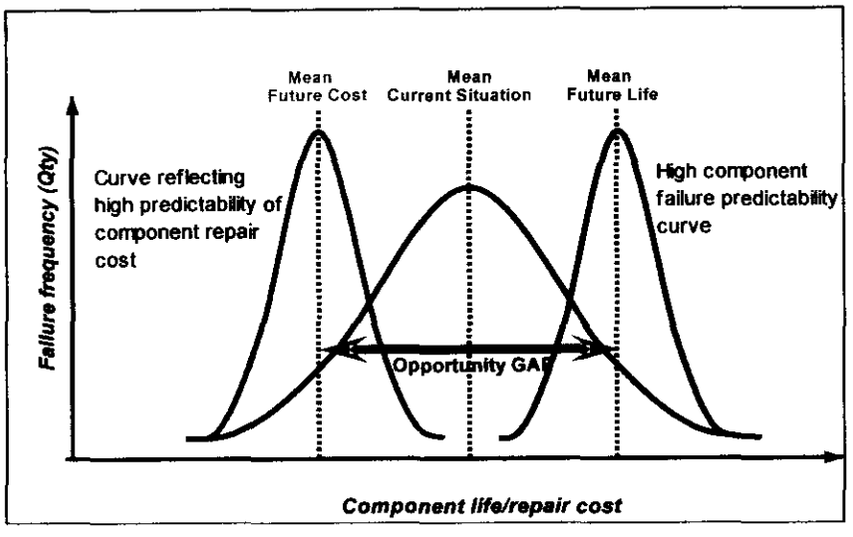


Figure 2-22: Total expected maintenance cost reduction

Source: Developed by the author of this research report

The opportunity gap, as measured between the mean future life (depicted by the red normal distribution curve) and the mean future cost (depicted by the green normal distribution curve) is the result of what can be achieved with a rigorous drive to implement the proactive maintenance principles. In addition, if this opportunity gap is included in a proper budgeting process as part of an improvement strategy, this improvement drive will be embedded and managed.

STEP 5: Establish the starting point for the scheduler

For the scheduling software to be effective, a "snap-shot" of the component status at the time has to be determined. This requires the recording of the current age, in an applicable unit of measure such as machine hours, of each component and using it as the starting point for the scheduling software to start scheduling the next component replacements from. This is shown in column C of Table 2.4. Again the CAT 789 rear dump truck is used as the example.

STEP 6: Scheduling component future repairs/replacements

Once the expected production time is fed in, i.e. budget hours highlighted in blue in Table 2.5, the scheduler will schedule future component repairs/replacements (figures

highlighted in red in Table 2.5), which is totalled for each financial year (period). This then becomes the budget for the following financial year(s).

Table 2-4: Establish starting point for the scheduler

Machine Number:	**BF 002**	
Machine Type:	**CAT 789**	
Current Exch Rate (R/$):	**6.30**	
Remain Budget Hours	**1,354**	
Description (A)	**Expected Life (Hours) (B)**	**Current Life (Hours) (C)**
Responsible Code:	**470512**	
Cylinders		
Steer Cylinder L/H	15,000	10,575
Steer Cylinder R/H	15,000	1,020
Hoist Cylinder L/H	15,000	8,759
Hoist Cylinder R/H	15,000	12,228
Steering Ball Stud L/H	7,500	541
Steering Ball Stud R/H	7,500	541
Steering Line Boring	5,000	541
Hoist Cyl Bearing Set	7,500	541
Hoist Cyl Line Boring	7,500	541

Source: Syferfontein Strip-mine (2000)

Table 2-5: Budgeted expenditure for the first period

Machine Number:	**BF 002**								
Machine Type:	**CAT 789**								
Current Exch Rate (R/$):	**6.30**					**Period 1**		**Budget Hours:**	**3836**
Remain Budget Hours	**1,354**					**Exch Rate:**	**6.30**	**PPI:**	**0.055**
Description (A)	**Expected Life (Hours) (B)**	**Current Life (Hours) (C)**	**Current Cost (Rand) (D)**	**R/Hr Rate (E)**	**Import Factor (F)**	**Start Life (G)**	**Exp. Repair Cost (Rand) (H)**	**Budget Cost (I)**	**R/Hr (J)**
Responsible Code:	**470512**								
Cylinders									
Steer Cylinder L/H	15,000	10,575	14,270	0.95	0.75	11929	14,466	**14,466**	3.77
Steer Cylinder R/H	15,000	1,020	14,270	0.95	0.75	2374	14,466	0	0.00
Hoist Cylinder L/H	15,000	8,759	26,850	1.79	0.75	10113	27,219	0	0.00
Hoist Cylinder R/H	15,000	12,228	26,850	1.79	0.75	13582	27,219	**27,219**	7.10
Steering Ball Stud L/H	7,500	541	7,115	0.95	1	1895	7,115	0	0.00
Steering Ball Stud R/H	7,500	541	7,115	0.95	1	1895	7,115	0	0.00
Steering Line Boring	5,000	541	3,500	0.70	0	1895	3,693	**3,693**	0.96
Hoist Cyl Bearing Set	7,500	541	9,200	1.23	1	1895	9,200	0	0.00
Hoist Cyl Line Boring	7,500	541	3,500	0.47	0	1895	3,693	0	0.00
Sub-total			112,671					**45,378**	11.83

Source: Syferfontein Strip-mine (2000)

STEP 7: Have the maintenance budget approved

Once the maintenance budget is completed it follows the bottom-up approach for approval. This budget developed for a typical ten-year period (a ten-year period may

seem too long but it is typical of LCC to view a machine's maintenance and operational costs over its useful life, which may exceed a ten-year period), forms the zero basis from which annual adjustments will be made. The executive group of the company will also use this budget for their top-down target setting for the company.

STEP 8: Continuous updating of maintenance budget

Software for budgeting and planning makes it easier for managers throughout the company to access, enter and share data on a real-time basis, using the Internet as a communications medium. A fully integrated enterprise management system (EMS) enables continuous updating of the financial reporting system should a maintenance event (component, system or machine repair or replacement) be registered within the computerised maintenance management system (CMMS). This updating could include one or more adjustments such as component actual life achieved, component repair/replacement price, component expected life, exchange rate and inflation rate adjustments. These adjustments should be made within the EMS as they occur, thus ensuring a rolling budget and forecast in real-time, which is not updated only once per year.

By applying the integrated theoretical budgeting model, companies can typically expect to realise the following benefits:

- More accurate maintenance cost estimations for equipment and machinery.
- Less time wasted during the budgeting process, as targets are set prior to developing the budget.
- The maintenance budget is supported by a well thought through maintenance strategy.
- The cost breakdown structure ensures the elimination of budgeting oversights due to the "forgetting" of important maintenance activities.
- The required budgets are auditable and each amount can be traced to functional requirements. This transforms the budget discussion from "How much can I get?" to "What functional outputs does one require?" If the costs are linked to the function in an auditable form, then cost cutting becomes function trimming.
- All component/machinery replacement decisions are based on statistical analysis ensuring consistency in replacement decision-making.

- The special scheduling software enables sensitivity analysis on the various cost drivers of the maintenance function (i.e. exchange rates, PPI, and other indices).
- A fully integrated EMS enables real-time cost forecasting through continuous updating of the financial reporting system.
- It will enable a company to match its maintenance budget with market reality thus ensuring a competitive advantage.

In the next sub-section of this research report the maintenance budget will be linked with competitive advantage.

2.5 Linking competitive advantage and maintenance budgeting

In this sub-section, and fifth phase of the research, the author of this research report will discuss how the maintenance budget and the competitive advantage of an organisation is linked.

Wireman (1998:1) states that nearly all maintenance and engineering decisions are cost benefit or ROI decisions, which means that all decisions involving maintenance should be considered based on the financial impact it would have on the company. The maintenance or engineering perspective is typically expressed in extended useful life of assets, increased throughput or availability, or improved product or service quality. The problem maintenance and engineering personnel face is how to convert these benefits into financial terms so the entire organisation can quantify them and benefit from them.

Maintenance decisions are normally based on component life cycles and they have a long-term impact on the company's profits. This is typically the case when a company only owns a few very expensive but identical capital assets that were acquired at the same time. This means that the forecasted replacement times of their components are synchronised, which will result in some periods having extremely high replacement costs and some periods with extremely low replacement costs. Thus, maintenance practitioners will have to be trained to identify these peaks and valleys in the life cycle costing curves of equipment/machinery types, so that they can smooth them out if it is required. This will ensure equipment/machinery maintenance costs that are evenly

distributed over at least a ten-year period. This concept developed by the author of this research report, is shown in Figure 2.23.

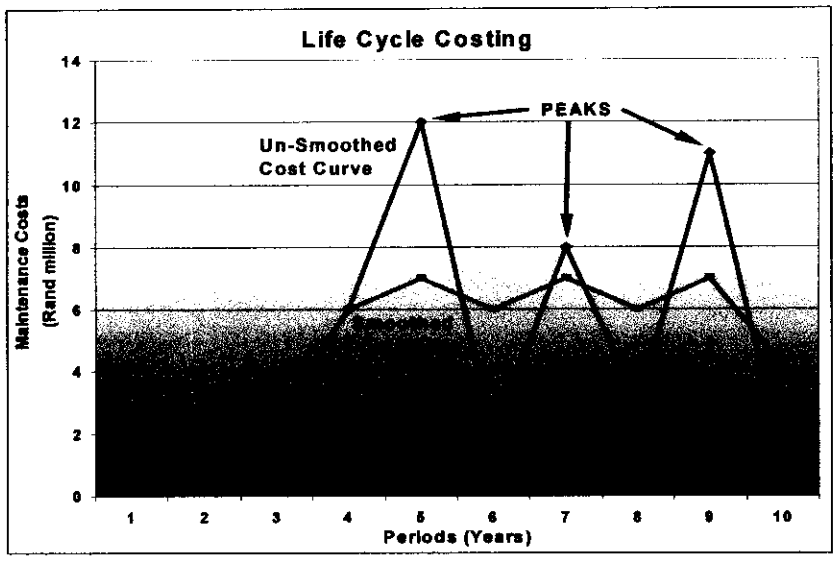


Figure 2-23: Example of life cycle cost smoothing

Source: Developed by the author of this research report

Operational decisions, on the other hand, have a short-term but smaller impact on the company's profits, although it is included in the LCC of equipment/machinery. However, asset management takes both maintenance and operational decisions into account ensuring that maintenance decisions are based on what the lowest combined cost for the company is. This concept is shown in Figure 2.24.

This is the effective "bottom line" for the company and its shareholders, indicating that this is the type of decision-making expected by companies if they are to optimise their resources and securing a competitive advantage. Obviously opportunity costs will have to be taken into account, for if only real costs are considered, incorrect conclusions may be drawn.

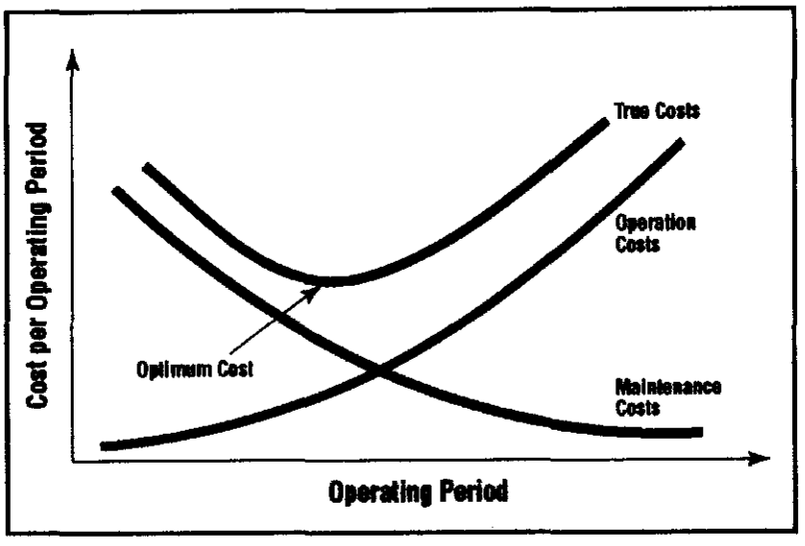


Figure 2-24: Maintenance decisions based on lowest combined cost

Source: Wireman (1998:5)

The "vehicle" for achieving this competitive advantage is thus the application of the proposed theoretical maintenance budgeting model as explained in section 2.4 above. This model provides for the application of any changes that may occur in the external market environment that may have a direct impact on financial performance of the company, such as changes in the following areas: (i) exchange rate, (ii) inflation rate, (iii) fuel price, (iv) taxation, (v) price of steel, etc. to name a few.

The areas highlighted in blue in Table 2.6, indicates that provision for these changes is made in the maintenance budget's RB software so that their real-time impacts can be visible in the rolling forecast for the company. This valuable information will allow a company to know in real-time how its financial performance compares with the targets set by senior management. It also enables senior management to know how the maintenance department performs against the expected optimum cost of maintenance, as depicted by Figure 2.24.

Table 2-6: Allowance for changes in the external market environment

Machine Number:	BF 002								
Machine Type:	CAT 789								
Current Exch Rate (R/$):	6.30					Period 1		Budget Hours:	3836
Remain Budget Hours	1,364					Exch Rate:	6.30	PPI:	0.055
Description (A)	Expected Life (Hours) (B)	Current Life (Hours) (C)	Current Cost (Rand) (D)	R/Hr Rate (E)	Import Factor (F)	Start Life (G)	Exp. Repair Cost (Rand) (H)	Budget Cost (I)	R/Hr (J)
Responsible Code:	470612								
Cylinders									
Steer Cylinder L/H	15,000	10,575	14,270	0.95	0.75	11929	14,466	14,466	3.77
Steer Cylinder R/H	15,000	1,020	14,270	0.95	0.75	2374	14,466	0	0.00
Hoist Cylinder L/H	15,000	8,759	26,850	1.79	0.75	10113	27,219	0	0.00
Hoist Cylinder R/H	15,000	12,228	26,850	1.79	0.75	13582	27,219	27,219	7.10
Steering Ball Stud L/H	7,500	541	7,115	0.95	1	1895	7,115	0	0.00
Steering Ball Stud R/H	7,500	541	7,115	0.95	1	1895	7,115	0	0.00
Steering Line Boring	5,000	541	3,500	0.70	0	1895	3,693	3,693	0.96
Hoist Cyl Bearing Set	7,500	541	9,200	1.23	1	1895	9,200	0	0.00
Hoist Cyl Line Boring	7,500	541	3,500	0.47	0	1895	3,693	0	0.00
Sub-total			112,671					45,378	11.83

Source: Syferfontein Strip-mine (2000)

Thus, the link between the maintenance budget and competitive advantage resides in the maintenance department's ability and the speed at which they can adapt to the changes in the external market environment (exchange rate, inflation rate, etc.), preferably on a proactive basis rather than reactive basis.

The following chapter will deal with an empirical research within the South African coal mining industry to test whether a need does exist for a maintenance budget, which is aligned with market reality giving a company a competitive advantage. The South African coal mining industry is chosen because collieries are highly mechanised and capital-intensive and based on experience the maintenance function of a colliery is also the function that controls about half of the direct mining costs. The empirical research will include defining the research parameters, the sampling method and the design of the questionnaire.

3. EMPIRICAL RESEARCH IN THE SA COAL MINING SECTOR

The literature research in the previous chapter revealed that managers experience many frustrations with the "traditional" budgeting approaches, which result in unrealistic budgets being drawn up. This is particularly true for maintenance budgets, which create the perception among senior management that maintenance budgeting at large depends on a process of "thumb sucking". The literature review also revealed that none of the various budgeting approaches, when applied on their own, are conducive to a fast changing environment and therefore it does not provide a company with a competitive advantage. For this reason it was decided to integrate the various budgeting approaches discussed in section 2.1 above into a theoretical budgeting model, which will allow a company to have its maintenance budget aligned with market reality, giving it a competitive advantage. This theoretical budgeting model and its application was also discussed in great detail in the previous chapter. The benefits of applying this integrated theoretical budgeting model were also highlighted. The link between the maintenance budget and competitive advantage was also shown to be the speed at which the maintenance department can proactively adapt to the changes in the external market environment (i.e. exchange rate, PPI, and other indices).

Therefore, to enable the research to answer the question of what can be done to change the perceived status of the maintenance budget from something based on a "thumb suck" to something more scientific, it is wise to sample an industry sector where the maintenance budget makes up the larger portion of a company's cost base. The development of an integrated theoretical budgeting model, which allows a company to match its maintenance budget with market reality for a competitive advantage, has been discussed in chapter 2. This makes it suitable for use in a deductive approach to define whether a need exists for having a maintenance budget that is matched with market reality giving a company a competitive advantage. In this regard, a purposive sampling method will be appropriate because the integrated theoretical budgeting model that has been developed, enables suitable judgement regarding the selection of areas that will best enable answering the research question and meeting research objectives.

The development of the integrated theoretical budgeting model prior to testing in the

industry which elements it should be made up of poses somewhat of a risk because some important issues relevant to the compilation of the model could have been overlooked. This aspect should therefore also be tested. In addition, the extent to which the various business units' maintenance practitioners apply the various elements of the integrated theoretical budgeting model in practice will also be tested. This will also assist in determining the relevancy of the integrated theoretical budgeting model at a colliery.

Therefore, should the research show that the expectations from the integrated theoretical budgeting model are not aligned with the answers given by the targeted group; the research approach should be revised.

3.1 Defining the sample

According to Wisniewski (2002:195) statistical inference is based on the following two key assumptions about the sample data:

- the sample is a properly representative subset of the statistical population, and
- that the data collected is reliable and accurate.

It is thus clear that the sample area must be chosen correctly to maximise the value and insights to be gained from it. Norden (2003:34) developed a very practical set of sample area requirements, which according to him if they are complied with most of the learning should then be transferable to a more general model. Table 3.1 represents these sample area requirements. According to Norden (2003:34) the requirements in Table 3.1 narrow the choice of sample down to an environment wherein proper maintenance is almost a prerequisite. These requirements are aligned with the requirements for a deductive approach, capturing the information through a purposive sampling approach as is applicable for this research.

Table 3-1: Sample area requirements to be complied with

REQUIREMENT	DESCRIPTION	REASONING
High maintenance cost	Must be a sector wherein maintenance costs make up a significant portion of the total budget.	This indicates that current maintenance actions are taking place and that this is a source of cost.
Capital intensive	Must be a sector that uses high capital value equipment.	This would indicate a need for maintenance.
Commodity product	In a commodity product sector, the main source of competitive advantage is lowest sales price.	The focus on price puts pressure on cost structures.
Larger businesses	Larger businesses are more likely to have better maintenance due to resource availability.	Based on research done by Mitchell *et al* (2002).
Access to researcher	Access must be gained by the researcher into the required area.	Without access, no research is possible.
Serious breakdown consequences	If a breakdown could result in a significant loss of income through a loss in production.	Based on work done by Jonsson (1999).

Source: Norden (2003:34)

3.1.1 Evaluating the coal mining sector as a sample area

In order to determine the suitability of the sampling area, Hill (2000:368) discovered a useful method that helps to gain proper insight into what is required from a product in that market. An important requirement of this method is the clarity of description of each of the important product dimensions as required by the market. Two types of dimensions are allowed for, which are defined as order winners and qualifiers. Order winning dimensions are the ones that ensure that the order is won and qualifying dimensions are those that get a product into the market place or on the customer's short list.

Table 3.2 represents Norden's (2003:34) application of Hill's method of linking the operational process requirements to the coal market. From Table 3.2 it is thus clear that the unit price is the most important order-winning dimension that is dictated by the coal market. This is expected from commodity products because they compete mainly on unit price.

Table 3-2: Relevant order winners and qualifiers for coal

PRODUCT DIMENSION	CLASSIFICATION	REASONING
Unit price	✓✓✓	Price ultimately secures the order
Coal quality (Calorific energy value)	✓	Specific coal qualities are required by certain customers
Volume guarentee	QQ	Must be able to deliver the volume required
On-time delivery	Q	Must deliver on time
Delivery capability	QQQ	Must be able to ship or rail product to customer
Delivery speed		Not as important a dimension
		Legend: ✓- depicts the order winners Q - depicts the qualifiers Multiple Q's or ✓ depicts importance

Source: Norden (2003:35)

Due to the mechanised nature of coal mining, a number of large corporate coal mining groups have to use high value capital equipment in their coal mining methods, whether it is underground or on surface (Norden, 2003:35). According to research done by Norden (2003:35) the direct maintenance cost as a percentage of operational cost for the mining industry is in the region of 37%. This makes the mining sector the sector wherein the maintenance component of operational cost is the highest. It outstrips its nearest rival by at least 15%. Norden (2003:35) also discovered that the majority of respondents in his research indicated that the direct maintenance cost which includes maintenance material and maintenance labour, constitutes more than half of the production cost of a colliery.

Pressure is put on the operational cost of a colliery due to coal's commodity status and its price sensitivity. Research also indicates that maintenance is a key process in this sector (Norden, 2003:35). Therefore, if the research is focussed on the South African corporate coal mining industry, to which the author can gain access, all the requirements, as set out in Table 3.1 will be met. This implies that by choosing a sample area where these practices should be in place, there is a good chance that a need exists for having a realistic maintenance budget that is aligned with market reality, giving the business a competitive advantage. Furthermore, there will also be a good

chance that the majority of the elements of the integrated theoretical budgeting model are not yet evident in the budgeting processes of collieries. In short, the expectation is that if the need for a realistic maintenance budget that is aligned with market reality, does exist, then the extent to which the elements of the integrated theoretical model are in use, will be low.

According to Norden (2003:36) there are some aspects regarding maintenance execution that are peculiar to the coal mining sector. Even though these aspects, which are listed in Table 3.3, do not disqualify the corporate coal mining sector as an appropriate sample area, they have to be taken into account (Norden, 2003:36).

Table 3-3: Aspects of concern

ASPECT	IMPACT	DISQUALIFIER?	REASONING
Geographically spread out	Decentralized maintenance structures & execution.	No	All higher order maintenance strategies rely on some form of central control or governance. If this can be achieved in a geographically spread out environment, the findings will be conservative.
Different type of work ethic.	The mining culture is very different from the culture in other sectors.	No	Different organizational cultures exist even between different mines in the same mining group; this should be similar to sectoral culture differences.
Most equipment assets are physically moving about.	Maintenance needs to be administered to equipment that is constantly moving around.	No	If track can be kept of the relocation of the equipment, then the conservative view will have been incorporated. Moving equipment is also more prone to degradation as the external conditions will vary all the time. Again this is conservative.
Maintenance is done in less than perfect surroundings.	Most maintenance is done in the field and not in workshops.	No	Many assets cannot be moved to "ideal" maintenance environments in order to be maintained.

Source: Norden (2003:36)

The aspects listed in Table 3.3 might affect the extent to which the research findings can be generalised and extrapolated to other industries. However, Norden (2003:36) states that company wide integrated maintenance and longer term maintenance

strategies may be important to most firms, regardless of their production environments. Therefore, the findings from research data collected and interpreted regarding the need for a realistic maintenance budget that is aligned with market reality and the extent to which the elements of the integrated theoretical model are in use in the coal mining sector should be applicable to other sectors as well.

In the next subsection the questions for use in the questionnaire will be determined. A discussion regarding the sampling method and the questionnaire will also be included.

3.2 Determining the questions to be asked

In the previous sections of this research report various budgeting approaches were investigated, which revealed that various frustrations or weaknesses are evident with the traditional budgeting approaches. An integrated theoretical budgeting model was developed in an attempt to reduce/eliminate these frustrations and weaknesses and to ensure that the maintenance budget will be matched with market reality, giving a company a competitive advantage. Therefore, the frustrations experienced with traditional budgeting, the extent to which the various elements of the integrated theoretical budgeting model are already applied, and whether a need for such a model exists in the South African coal mining sector, have to be tested and confirmed. Table 3.4 represents the issues and statements, which have to be verified.

Finally, the issues and statements represented by Table 3.4 have to be tested and confirmed under the following conditions:

- within the coal mining sector of South Africa,
- all collieries to be included (i.e. underground, strip-mines, plants and services), and
- a stratified sample is required to test for differences in opinion at the different levels of the organisations as proposed by Norden (2003:38).

Table 3-4: Issues and statements to be verified

ISSUE/STATEMENT	WHAT TO BE VERIFIED?
1. The maintenance budget is a significant portion of the total cost of a colliery	• Confirm the magnitude of the maintenance budget as a portion of the total cost of a colliery
2. Frustrations experienced with traditional budgeting	• Confirm whether maintenance budgets constrain responsiveness and whether they are a barrier to change • Confirm whether maintenance budgets are strategically focused • Confirm whether maintenance budgets add only little value given the time to prepare them • Confirm whether maintenance budgets focus on cost reductions rather than value creation • Confirm whether maintenance budgets strengthen vertical command-and-control • Confirm whether budgeting follows a process of "horse trading" • Confirm whether maintenance budgets are time consuming to put together • Confirm whether maintenance budgets are developed and updated mostly annually • Confirm whether Excel spreadsheets are still used as the primary software for developing maintenance budgets
3. Budgeting approaches in use at the collieries	• Confirm whether the colliery follows the traditional budgeting approach • Confirm whether the colliery follows the activity based budgeting approach • Confirm whether the colliery follows the zero-based budgeting approach • Confirm whether the colliery follows quality function deployment as a budgeting approach • Confirm whether the colliery follows a target budgeting approach • Confirm whether the colliery follows a life-cycle costing approach • Confirm whether the colliery follows a rolling budgeting approach
4. Extent to which the elements of the integrated theoretical budgeting model are already in use	• Confirm whether a cost breakdown structure is developed during the maintenance budgeting process • Confirm how often maintenance budgets are updated • Confirm whether collieries use enterprise management systems • Confirm whether the maintenance departments develop lists of expected component lives for each machine/equipment type • Confirm whether the maintenance departments use statistical software for developing expected component lives and pricing • Confirm whether the maintenance department makes use of condition monitoring techniques for achieving optimal component lives • Confirm whether the maintenance departments make use of scheduling software for scheduling component change outs • Confirm whether all future component repairs or replacements are scheduled for determining annual expected costs • Confirm whether the maintenance budget is linked directly to exchange rate and PPI • Confirm whether collieries have well-document and implemented maintenance strategies
5. A need for an integrated theoretical budgeting model exists	• Confirm whether a need for a maintenance budgeting model, which is synchronised with prevailing market reality, exists • Confirm whether a continuously updated maintenance budget would assist the maintenance management team to become more cost effective • Confirm whether it is accepted that the maintenance budget can influence a colliery's competitiveness either positively or negatively

Source: Adapted and applied from Norden (2003:37)

3.2.1 The sampling method

The South African coal mining sector consists of a number of corporate coal mining companies. These companies consist of a number of collieries, each having a number of maintenance practitioners. The population of maintenance practitioners (colliery engineers) is estimated from the database of the South African Colliery Engineer's Association (SACEA). Membership of SACEA consists of 140 persons (SACEA, 2003:2). It is estimated that about 80 percent of the colliery engineers are affiliated to SACEA and that 75% of the population of colliery engineers are practising as maintenance practitioners, i.e. estimated that 25% of the population of colliery engineers are not in charge of production machinery and thus not managing the maintenance budget of equipment/machinery/plant used directly in the production or beneficiation of coal. The population of colliery managers and divisional engineers was estimated from the amount of collieries as well as the amount of large mining companies within the South African coal mining sector. Table 3.5 represents the populations and required minimum sample sizes for the two categories: colliery managers and divisional engineers, as well as the practising maintenance practitioners within the South African coal mining sector.

Table 3-5: Population and required minimum sample size

CRITERIA	COLLIERY MANAGERS & DIVISIONAL ENGINEERS	PRACTISING MAINTENANCE PRACTITIONERS
Estimated total population (N)	49	131
Proportion belonging to the specified category (p%)	99%	95%
Proportion not belonging to the specified category (q%)	1%	5%
Confidence level required (z)	90% (z = 1.65)	90% (z = 1.65)
Margin of error required (e)	± 5%	± 5%
Minimum sample size required (n)	11	52
Adjusted minimum sample size (n') for populations < 10,000	**9**	**37**

However, according to Wisniewski (2002:199) for the sampling distribution to

approximate to the Normal distribution, a "sufficiently large" sample (i.e. a sample size of at least 30) must be taken. This however does not pose a problem due to the exploratory nature of the research.

It was thus planned that the various organisational levels (divisional engineer, colliery manager, engineering manager and section engineer) would be sampled by means of an e-mailed questionnaire. According to Saunders, Lewis and Thornhill (2003:159) an expected response rate of approximately 30 percent may be seen as reasonable. Table 3.6 shows the amount of respondents that has to be polled.

Table 3-6: Actual sample sizes required

CRITERIA	COLLIERY MANAGERS & DIVISIONAL ENGINEERS	MAINTENANCE PRACTITIONERS
Estimated response rate (re%)	65%	30%
Actual sample size required (n^a)	**14**	**123**

The author of the research report gained access to the respondents within the South African coal mining sector via the contacts network developed by being a council member of SACEA.

The questionnaires were e-mailed to the respondents as an attachment to a covering letter, which is presented as *"(First cover letter)"* within Appendix C. Questionnaires were e-mailed a second time to those respondents not responding within the required period under another covering letter, which is presented as *"(Second cover letter – reminder)"* within Appendix C. Respondents were given a choice of replying either by e-mail or facsimile.

3.2.2 The questionnaire

The questionnaire was developed according to the guidelines proposed by Sanders *et al* (2003:280). Chapter 2 of this research report together with Neely *et* al (2001:6) were used as a basis for developing the questions and statements used in the questionnaire.

Against this basis the questionnaire was developed to test the questions posed in Table 3.4. A data requirements table, Appendix A, was drawn up to ensure that the data collected will enable the research questions and statements to be answered and the objectives achieved. An extract of the data requirements table presented by Appendix A is shown in Table 3.7.

A questionnaire for doing descriptive research (Saunders *et al*, 2003:281), Appendix B, was used in collecting primary data only. The questionnaire consists of closed-ended statements and questions. The Likert or summated scale (Huysamen, 2001:125) was used to measure the opinions of the respondents regarding the closed-ended statements. The statements were scaled from 1 to 10, increasing in intensity of agreement. The following rule was applied to determine the levels of agreement:

- **Disagree:** For any number selected from 1 to 3
- **Unsure:** For any number selected from 4 to 5
- **Agree:** For any number selected from 6 to 10

Some true (**Yes**) or false (**No**) closed-ended questions and statements were also included where only one response had to be chosen. In addition some list statements were also included to offer the respondents some responses to choose from in order to determine some background information of the respondents.

The questionnaire consists of 36 questions and statements of which the first seven questions and statements are relevant to the population background. However, 29 questions and statements explore the extent to which the integrated theoretical budgeting model is already in use, confirming the frustrations experienced with traditional budgeting approaches, and confirmation of the need for an integrated theoretical budgeting model.

Each question of the questionnaire was coded, grouped and placed in a spreadsheet matrix to ensure ease of response data capturing and analysis thereof.

The questionnaire was presented to expert maintenance practitioners to evaluate the validity (clear wording of questions using terms that are likely to be familiar to, and

understood by respondents) and intent of the questions and statements.

Table 3-7: Extract from the data requirements table in Appendix A

Research objective is twofold: *(1) To determine whether a need exists, among coal mines within the South African coal mining sector, for having a realistic maintenance budget that is aligned with market reality, giving the business a competitive advantage. (2) Extent to which the elements of the integrated theoretical budgeting model is used in the coal mining sector.*				
Type of research: *Predominantly descriptive, although wish to determine the extent to which the proposed theoretical maintenance budgeting model is used by maintenance practitioners.*				
Investigative questions	**Variable(s) required**	**Detail in which data measured**	**Category**	**Check included in questionnaire**
Maintenance budgets are time consuming to put together (behaviour)	*Maintenance budgets are time consuming*	*Yes, No*	Frustrations	✓
Maintenance budgets constrain responsiveness and are often a barrier to change (behaviour)	*Opinion whether maintenance budgets constrain responsiveness*	*Degree of agreement on a scale of 1 to 10. Disagree = 1, Agree = 10.*	Frustrations	✓
Maintenance budgets are rarely strategically focused and often contradictory (behaviour)	*Opinion whether maintenance budgets are rarely strategically focussed*	*Degree of agreement on a scale of 1 to 10. Disagree = 1, Agree = 10.*	Frustrations	✓
Maintenance budgets add little value, especially given the time to prepare them (behaviour)	*Opinion whether maintenance budgets add little value*	*Degree of agreement on a scale of 1 to 10. Disagree = 1, Agree = 10.*	Frustrations	✓

Source: Adapted from Saunders et al (2003:290)

The results of the empirical research will be presented in the next chapter of this research report.

4. THE RESULTS

The goal of this chapter of the research report is to present the facts discovered by the research questionnaire presented by Appendix B. In section 3.2.2 of the previous chapter a rule was applied to the first 13 statements of the "Questions/Statements" section of the questionnaire for all the replies received from the respondents in order to present the factual results of the research in a sensible manner.

4.1 The number and distribution of respondents

4.1.1 Sample size

The respondents were divided into two groups, namely: practising maintenance practitioners, and colliery managers and divisional engineers. Of the 165 questionnaires e-mailed, only 63 were returned, of which 6 were either incomplete or not completed at all. This equates to a response rate of 34.5%. The respondents of the population, as represented by Figure 4.1 (statement 2 of the background information section of the questionnaire), were made up of mine managers (4%), divisional engineers (12%), assistant resident/section engineers (35%) and resident engineers/engineering managers (41%).

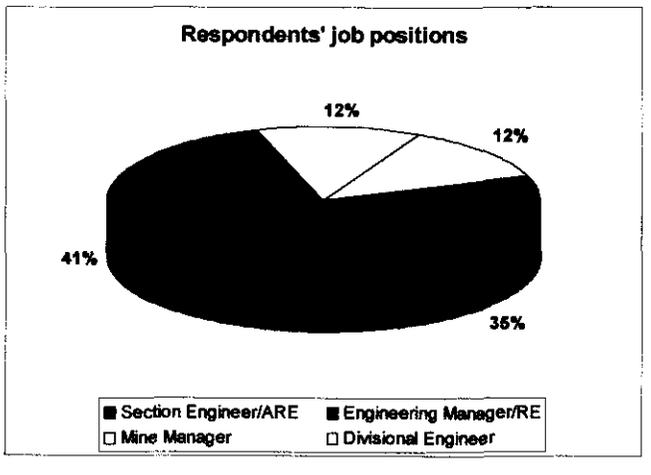


Figure 4-1: Percentage of population of respondents

4.1.2 Distribution of respondents

From Table 4.1, the 57 respondents represent the six major coal mining groups within the South African coal mining sector. These coal mining groups are presented as Company A, B, C, D, E and F. It is also important to note that 43 responses were received from the practising maintenance practitioners compared to an expected minimum sample size of 37. Further more, it is also important to note the 14 responses were received from the colliery managers and divisional engineers compared to an expected minimum sample size of nine.

Table 4-1: Distribution of respondents per company

COMPANY	COLLIERY MANAGERS & DIVISIONAL ENGINEERS		PRACTISING MAINTENANCE PRACTITIONERS		TOTAL	
	QTY	%	QTY	%	QTY	%
Company A	1	2%	5	9%	6	11%
Company B	2	4%	10	18%	12	21%
Company C	3	5%	3	5%	6	11%
Company D	0	0%	9	16%	9	16%
Company E	8	14%	15	26%	23	40%
Company F		0%	1	2%	1	2%
TOTAL	14	25%	43	75%	57	100%

4.2 Background information

4.2.1 Type of colliery represented

The research was intended to include the different types of operations within the South African coal mining sector. From Figure 4.2 (question 1 of the background information section of the questionnaire) the split of the actual responses received indicates that 14% of the respondents are from beneficiation plants, 16% are from strip-mines, 19% are from service operations and 51% are from underground mining operations.

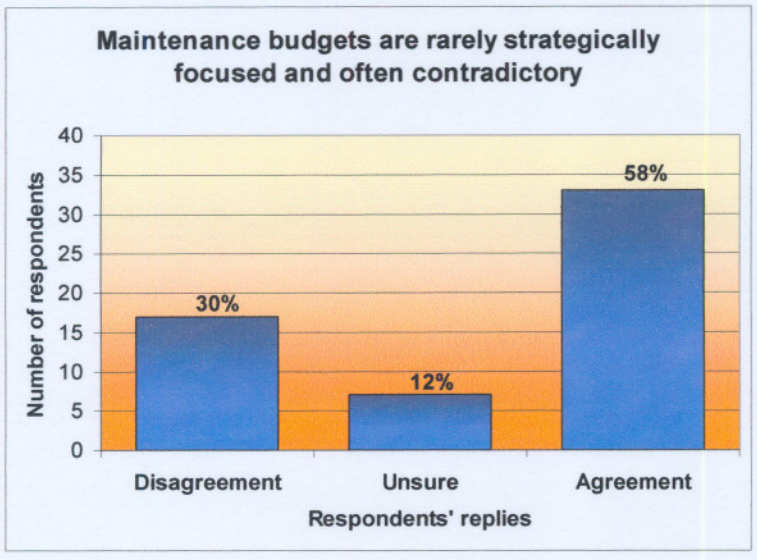


Figure 4-9: Rarely strategically focused and often contradictory

4.3.3 Adds little value for the time to prepare

Figure 4.10 presents the responses to the statement (statement 3 of the questions/statements section of the questionnaire) that maintenance budgets add little value, especially given the time to prepare them.

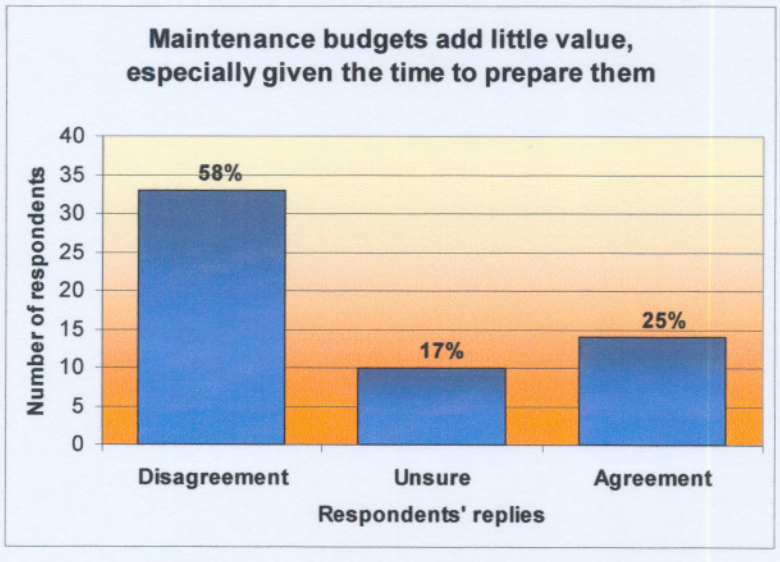


Figure 4-10: Adds little value for the time to prepare

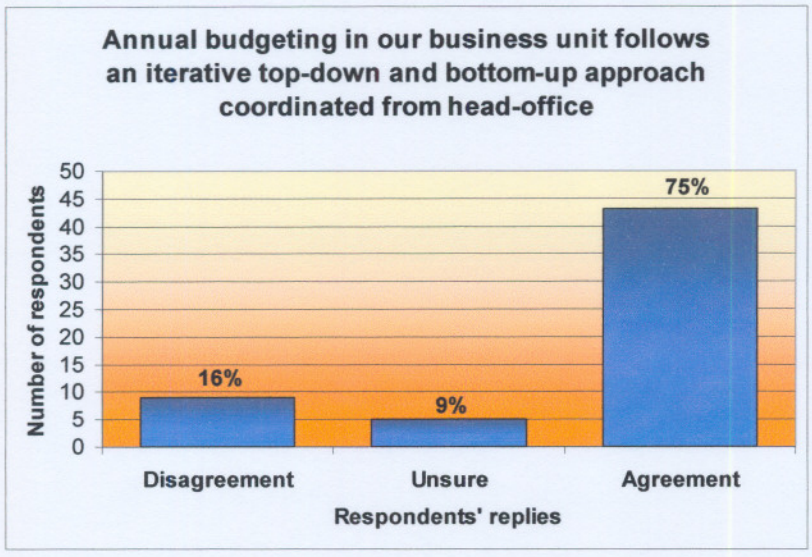


Figure 4-17: Traditional budgeting approach

4.4.2 The activity based budgeting approach

Figure 4.18 presents the responses to the statement (statement 17 of the questions/statements section of the questionnaire) that budgets in the business unit consist of information based on activity and resource consumption rates.

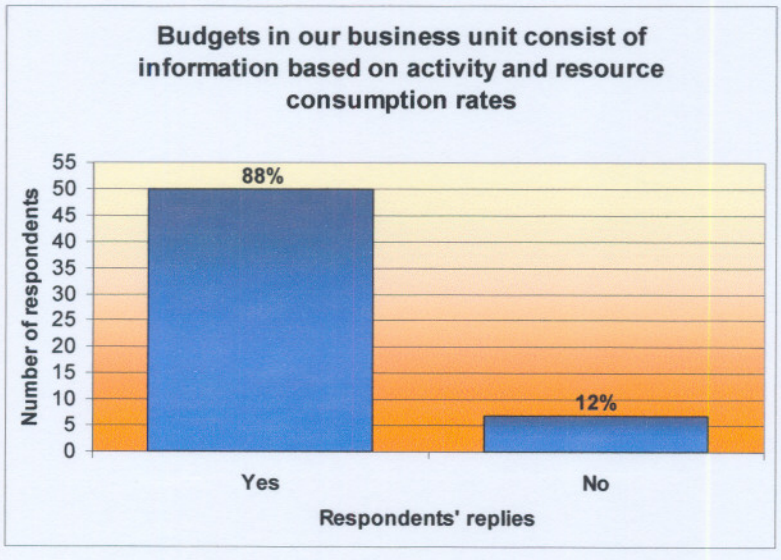


Figure 4-18: The activity based budgeting approach

From all the responses received, 88% of the respondents confirmed that the statement is true for their business unit, but 12% of the respondents confirmed that the statement is not true for their business unit.

4.4.3 The zero-based budgeting approach

Figure 4.19 presents the responses to the statement (statement 18 of the questions/statements section of the questionnaire) that annual budgeting in the business unit is based on first principles (as if it was prepared for the first time, from "scratch"). From all the responses received, 47% of the respondents confirmed that the statement is true for their business unit, but 53% of the respondents confirmed that the statement is not true for their business unit.

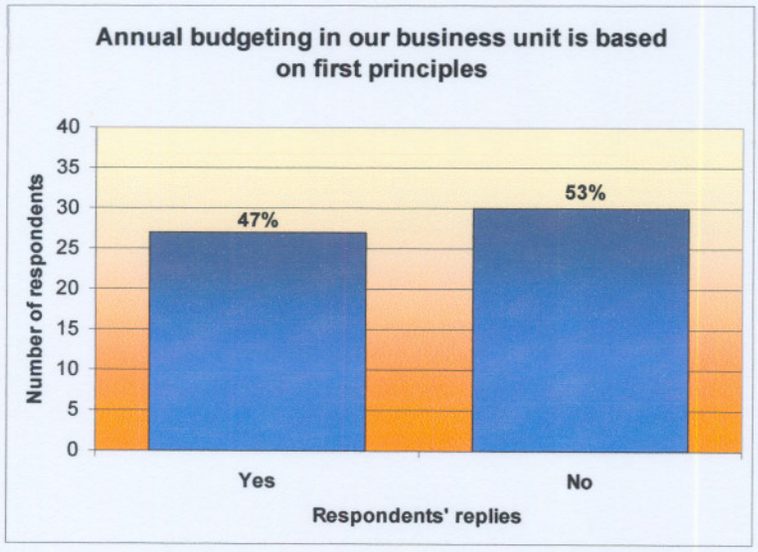


Figure 4-19: The zero-based budgeting approach

4.4.4 The quality function deployment budgeting approach

Figure 4.20 presents the responses to the statement (statement 19 of the questions/statements section of the questionnaire) that budgeting within the business unit follows a process of evaluating the impact that each of the different equipment/machinery/component replacement scenarios has on the profit of the

business unit. From all the responses received, 67% of the respondents confirmed that the statement is true for their business unit, but 33% of the respondents confirmed that the statement is not true for their business unit.

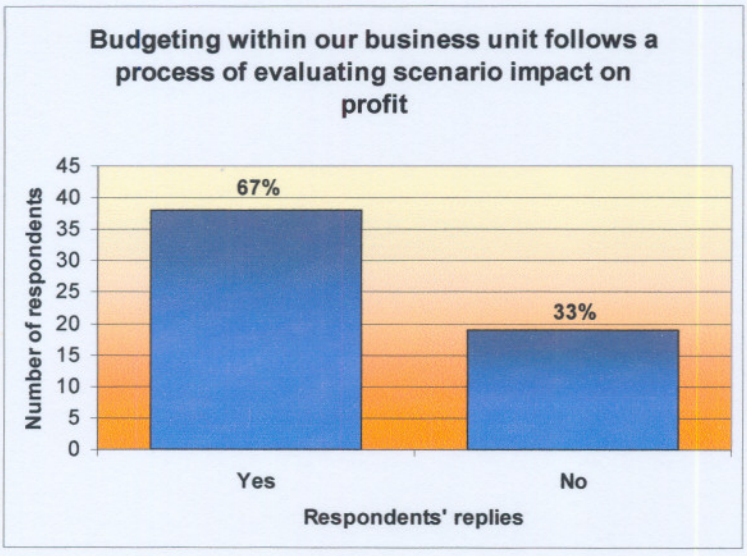


Figure 4-20: The quality function deployment budgeting approach

4.4.5 The target budgeting approach

Figure 4.21 presents the responses to the statement (statement 20 of the questions/statements section of the questionnaire) that prior to developing an annual budget within the company, the CEO sets targets and objectives with which budgets have to be aligned.

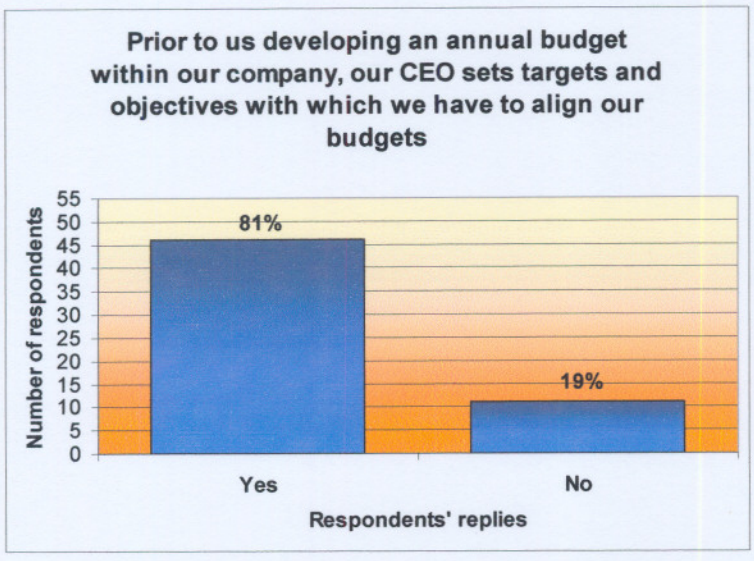


Figure 4-21: The target budgeting approach

From all the responses received, 81% of the respondents confirmed that the statement is true for their company, but 19% of the respondents confirmed that the statement is not true for their company.

4.4.6 The life cycle costing approach

Figure 4.22 presents the responses to the statement (statement 21 of the questions/statements section of the questionnaire) that budgets in the company are focused on finding the lowest long-term total cost of ownership of equipment/machinery. From all the responses received, 63% of the respondents confirmed that the statement is true for their company, but 37% of the respondents confirmed that the statement is not true for their company.

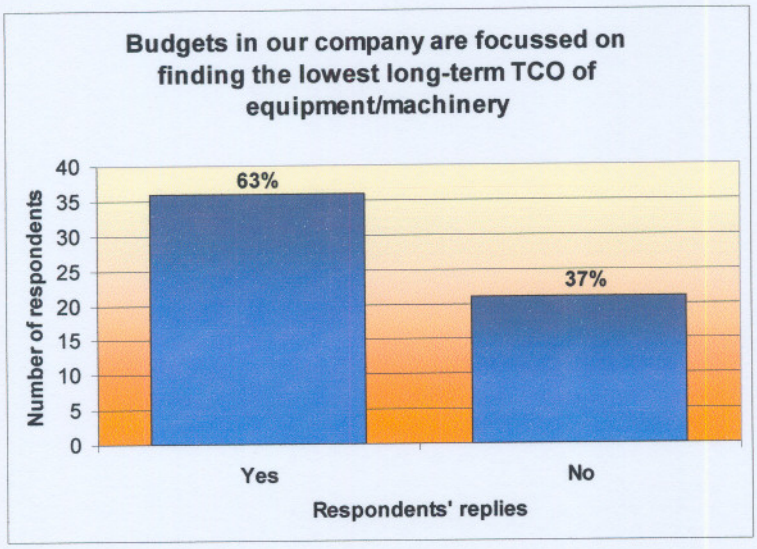


Figure 4-22: The life cycle costing approach

4.4.7 The rolling budgeting approach

Figure 4.23 presents the responses to the statement (statement 8 of the questions/statements section of the questionnaire) that budgets in the business unit are updated every few months in an attempt to reassess the business unit's outlook several times per year. From all the responses received, 60% of the respondents disagreed with the statement, 6% of the respondents were unsure and 34% of the respondents agreed with the statement.

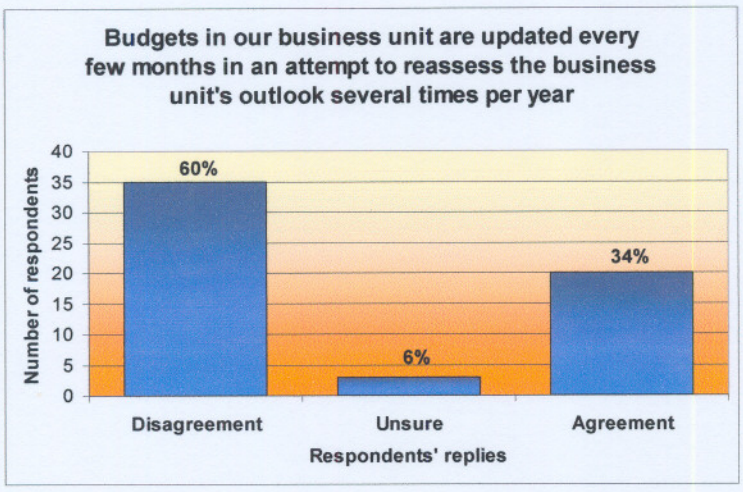


Figure 4-23: The rolling budgeting approach

4.5 *Extent to which the theoretical model is used*

4.5.1 Goals

- The same responses as confirmed in subsection 4.4.5 (statement 20 of the questions/statements section of the questionnaire) for the target budgeting approach are also valid for this element.

4.5.2 Strategies

- The same responses as confirmed in subsection 4.2.6 (statement 7 of the background information section of the questionnaire) whether the business unit is making use of an EMS, are also valid for this element.

- Figure 4.24 presents the responses to the statement (statement 28 of the questions/statements section of the questionnaire) that the business unit has a well-documented and implemented maintenance strategy. From all the responses received, 68% of the respondents confirmed that the statement is true for their business unit, but 32% of the respondents confirmed that the statement is not true for their business unit.

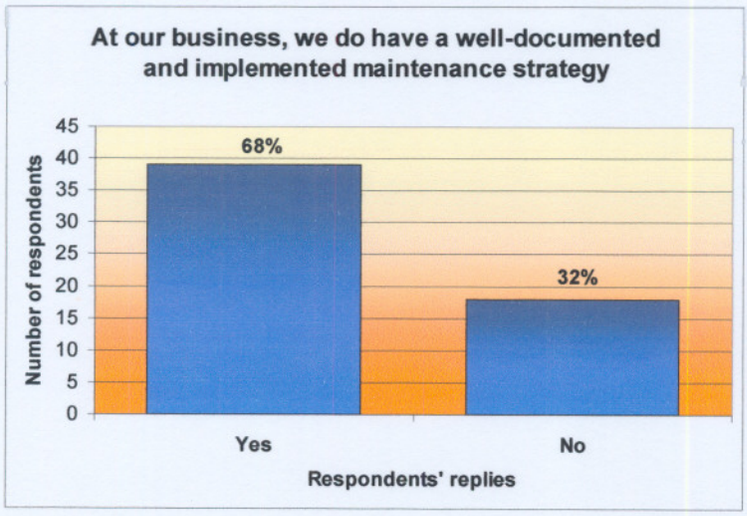


Figure 4-24: A well-documented and implemented maintenance strategy exists

4.5.3 Forces

- Figure 4.25 presents the responses to the statement (statement 27 of the questions/statements section of the questionnaire) that the maintenance budget for the business is linked directly with the exchange rate and the PPI, as it affects specific equipment/machines.

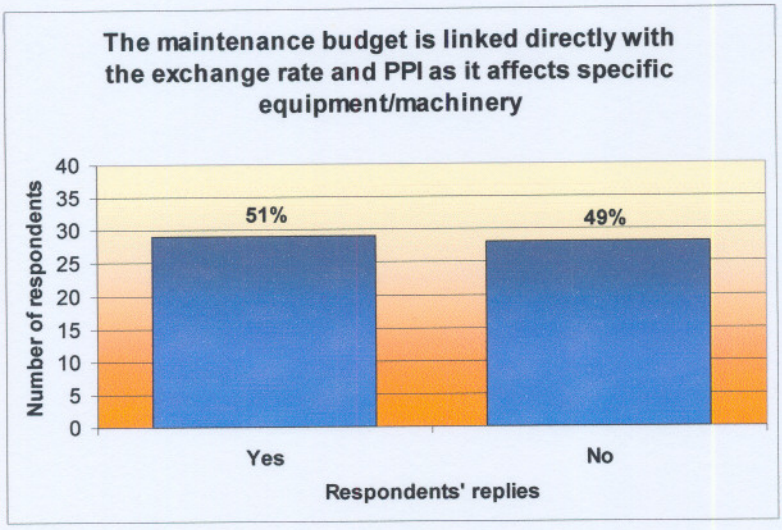


Figure 4-25: The budget is linked with the exchange rate and PPI

From all the responses received, 51% of the respondents confirmed that the statement is true for their business units, but 49% of the respondents confirmed that the statement is not true for their business units.

4.5.4 Activities

- The same responses as confirmed in subsection 4.4.2 (statement 17 of the questions/statements section of the questionnaire) for the activity based budgeting approach are also valid for this element.

- The same responses as confirmed in subsection 4.4.3 (statement 18 of the questions/statements section of the questionnaire) for the zero-based budgeting approach are also valid for this element.

- The same responses as confirmed in subsection 4.4.6 (statement 21 of the questions/statements section of the questionnaire) for the life cycle costing approach are also valid for this element.

- Figure 4.26 presents the responses to the statement (statement 9 of the questions/statements section of the questionnaire) that during the budgeting process a cost breakdown structure (bill of materials) is developed to avoid "forgetting things".

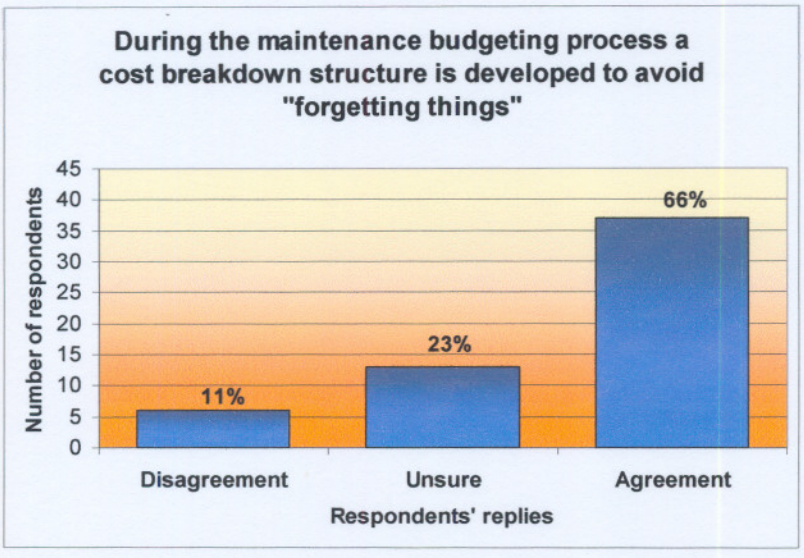


Figure 4-26: A cost breakdown structure is developed

From all the responses received, 11% of the respondents disagreed with the statement, 23% of the respondents were unsure and 66% of the respondents agreed with the statement.

- Figure 4.27 presents the responses to the question (question 22 of the questions/statements section of the questionnaire) whether the maintenance department develop a list of expected component lives for each machine/equipment type.

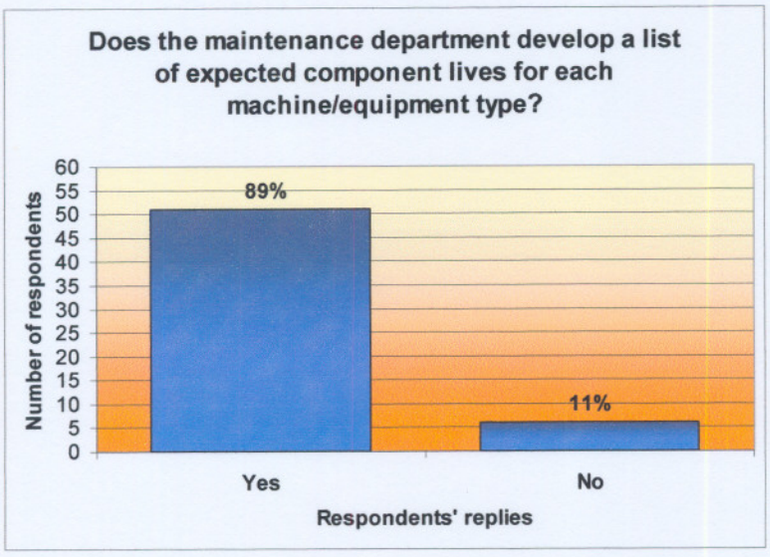


Figure 4-27: Develop a list of expected component lives

From all the responses received, 89% of the respondents confirmed that the maintenance departments do develop a list of expected lives, but 11% of the respondents confirmed that their maintenance departments do not develop these lists.

- Figure 4.28 presents the responses to the question (question 23 of the questions/statements section of the questionnaire) whether the maintenance department use statistical software for developing expected component lives and component pricing for equipment and machinery. From all the responses received, 35% of the respondents confirmed that their maintenance departments do use statistical software for developing component lives and component pricing, but 65% of respondents confirmed that their maintenance departments do not use statistical software.

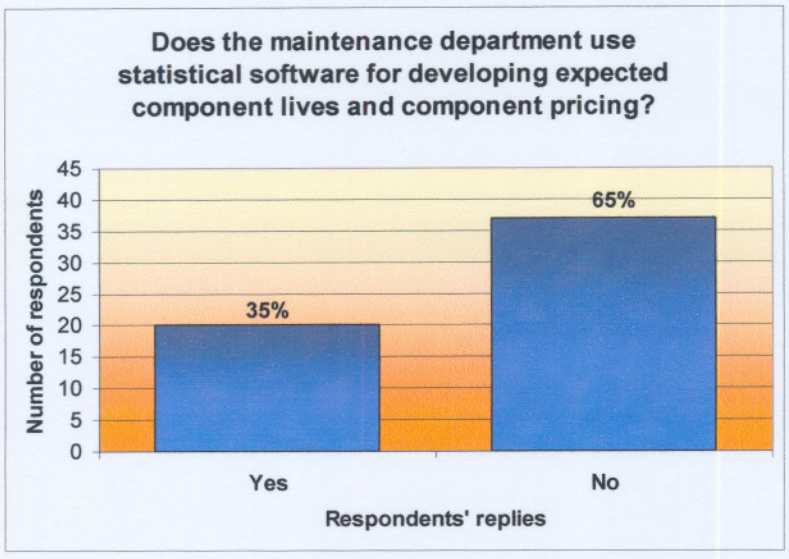


Figure 4-28: Statistical software is used

- Figure 4.29 presents the responses to the question (question 24 of the questions/statements section of the questionnaire) whether the maintenance department use condition monitoring techniques for achieving optimal component lives.

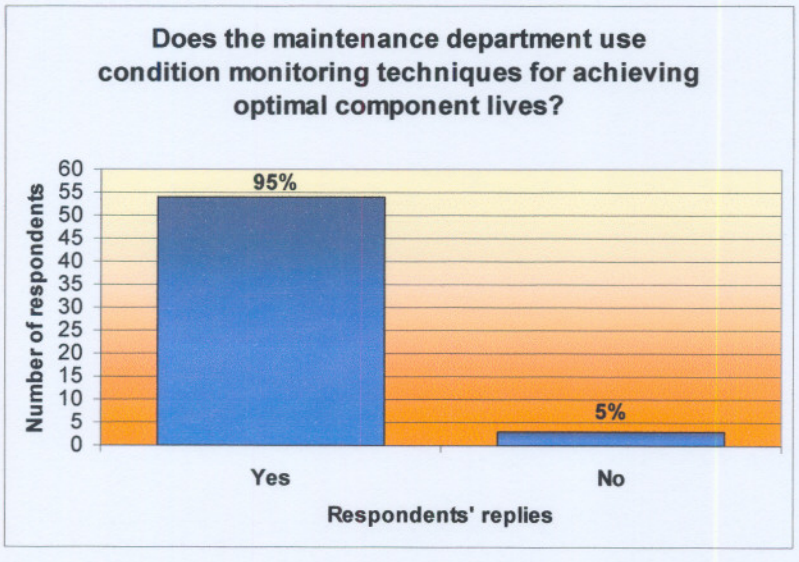


Figure 4-29: Condition monitoring techniques are used

From all the responses received, 95% of the respondents confirmed that the statement is true for their maintenance departments, but 5% of respondents

confirmed that the statement is not true for their maintenance departments.

- Figure 4.30 presents the responses to the statement (statement 25 of the questions/statements section of the questionnaire) that the maintenance department make use of scheduling software for scheduling component changeouts. From all the responses received, 56% of the respondents confirmed that the statement is true for their maintenance departments, but 44% of the respondents confirmed that the statement is not true for their maintenance departments.

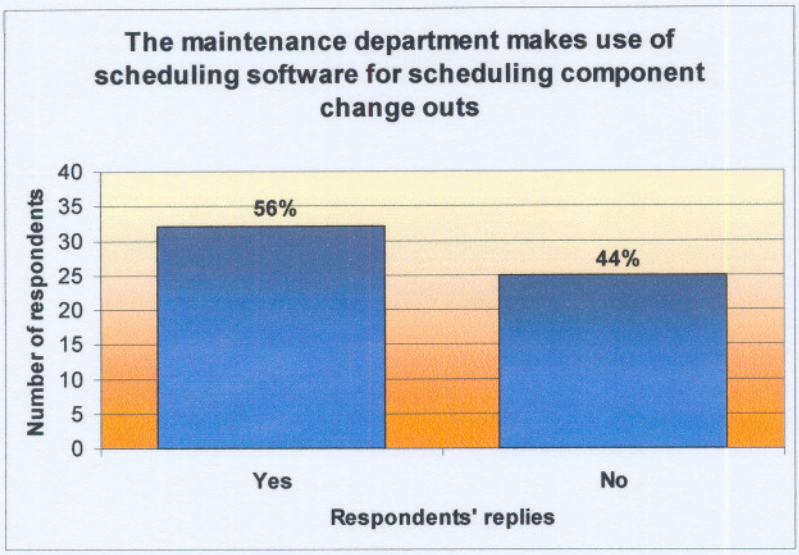


Figure 4-30: Scheduling software is used

- Figure 4.31 presents the responses to the statement (statement 26 of the questions/statements section of the questionnaire) that all component repairs or replacements are scheduled to determine annual expected expenditures. From all the responses received, 70% of the respondents confirmed that the statement is true for their business units, but 30% of the respondents confirmed that the statement is not true for their business units.

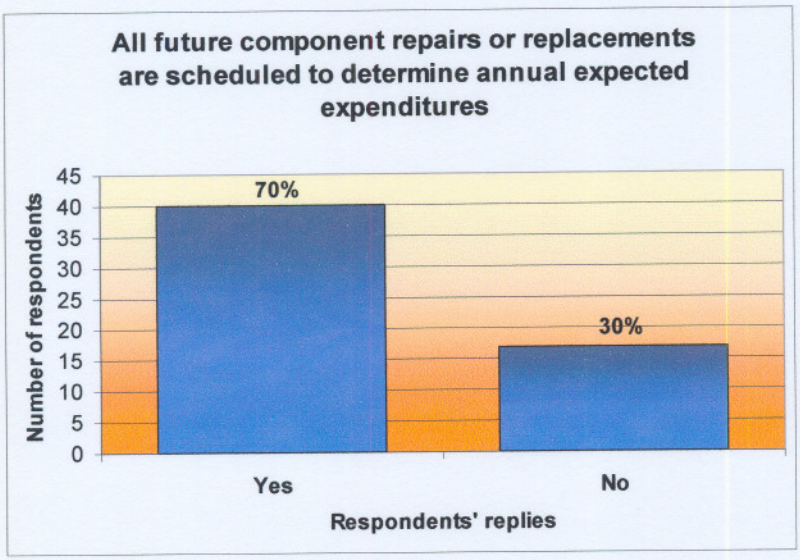


Figure 4-31: Component repairs or replacements are scheduled

4.5.5 Rolling budget (forecast)

- The same responses as confirmed in subsection 4.2.5 (question 6 of the background information section of the questionnaire) for the maintenance budget updating frequency are also valid for this element.

4.6 Need for an integrated theoretical budgeting model

4.6.1 The maintenance budget can influence competitiveness

Figure 4.32 presents the responses to the statement (statement 13 of the questions/statements section of the questionnaire) that the maintenance budget can influence the company's competitiveness either positively or negatively. From all the responses received, 4% of the respondents disagreed with the statement, 1% of the respondents were unsure and 95% of the respondents agreed with the statement.

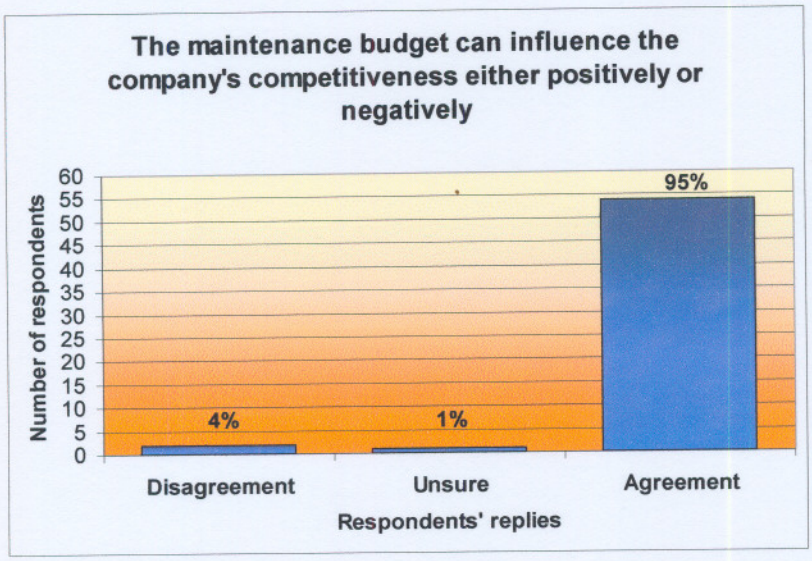


Figure 4-32: The maintenance budget can influence competitiveness

4.6.2 Continuously updated budgets assist in becoming more cost effective

Figure 4.33 presents the responses to the statement (statement 11 of the questions/statements section of the questionnaire) that a continuously updated maintenance budget would assist the maintenance management team to become more cost effective.

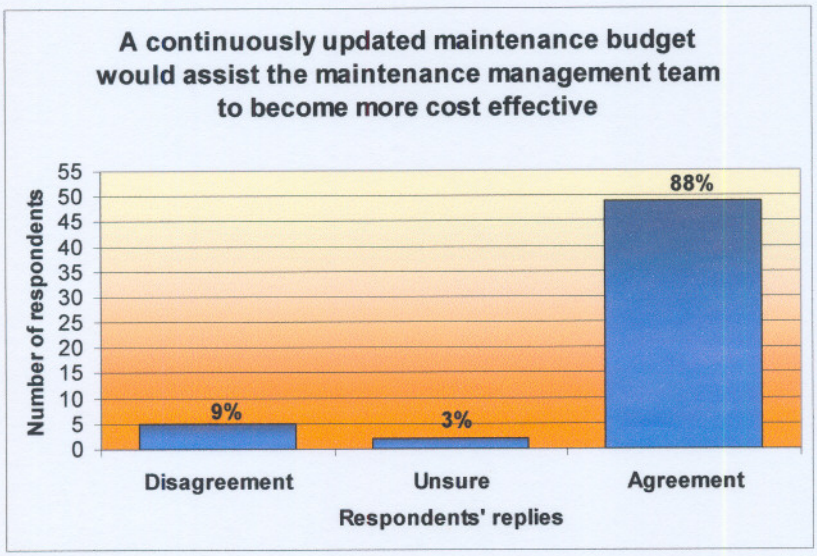


Figure 4-33: Continuously updated budgets assist in becoming more cost effective

From all the responses received, 9% of all the respondents disagreed with the statement, 3% of the respondents were unsure and 88% of the respondents agreed with the statement.

4.6.3 Need for a maintenance budgeting model

Figure 4.34 presents the responses to the statement (statement 29 of the questions/statements section of the questionnaire) that respondents do have a need for a maintenance budgeting model ensuring that the maintenance budget is synchronised with prevailing market reality, giving the business a competitive advantage. From all the responses received, 89% of the respondents confirmed that they do have a need for a maintenance budgeting model, but 11% of the respondents confirmed that they do not need a maintenance budgeting model.

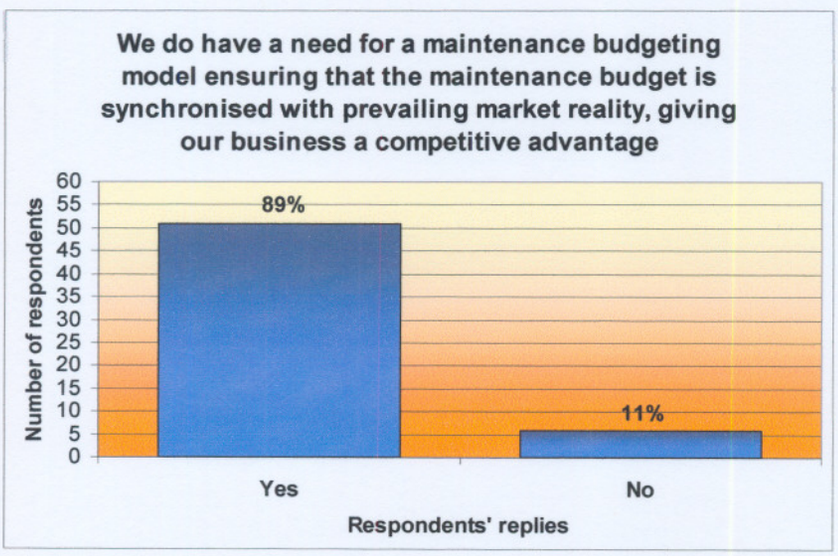


Figure 4-34: Need for a maintenance budgeting model

This chapter was a factual presentation of the research findings, but in the next chapter the statistical results presented will be interpreted in terms of the research problem introduced at the beginning of the report.

5. DISCUSSION, CONCLUSION & RECOMMENDATIONS

The data collected by means of the questionnaires were presented as findings in the previous chapter, which also highlighted some important issues. These issues will be discussed individually, after which it will be concluded and recommendations made. This chapter will be closed with suggestions about further research, which may be pursued in some areas that could possibly benefit from further research.

5.1 Representativeness of the data

For the sample data to be representative of the population it needs to conform to the statistical minimum representative sample size as presented by Table 3.5. Furthermore, the sample has to be more than 30.

When testing the representativeness of the sample it can be seen that the sample is representative of the total population of practising maintenance practitioners, i.e. 43 respondents versus a minimum requirement of 37. This claim can be made with a confidence level of 90% and a 5% margin of error. However, even though it can also be said with the same confidence level and margin of error that the colliery managers and divisional engineers' group sample is representative of the population, i.e. 14 respondents versus a minimum requirement of nine, the minimum sample size of 30 is not complied with.

This implies that the data cannot be generalised because part of it is not statistically significant, i.e. less than 30 in the sample. It should however be noted that it was previously stated that the data will be used in a deductive approach in order to explore this subject further. Furthermore, the South African coal mining sector was chosen as an area where the theoretical budgeting model should be applied to the maintenance budget due to the reasons listed in Table 3.1. However, the concerns listed in Table 3.3 are all reasons in support of the generalisation of the data as well as the need for the implementation of a maintenance budgeting model, which is synchronised with prevailing market reality giving a business a competitive advantage. It can thus be

concluded that the data can be generalised and applied to other functions within a business, e.g. the financial, human relations, procurement and supply, projects, etc.

Although Table 4.1 shows that one of the six coal mining groups only had one respondent who replied to the questionnaire, a fairly equal distribution of respondents from the other five coal mining groups was received.

Furthermore, Figure 4.2 illustrates that the types of collieries the respondents are employed at, comply with a general ratio of the types of collieries that can be expected in the South African coal mining sector. This ratio is typically three underground collieries to one strip-mine (i.e. 3:1), (COMSA, 2003:9). Beneficiation plants and other services (central workshops, bulk material handling facilities, etc.) could be part of either an underground colliery or strip-mine.

Figure 4.3 confirms that 34 of the respondents (i.e. 60%) are employed at large collieries with an annual production of coal between 4.0 and 12.0 million tons. This is typical of the large corporate type collieries within the South African coal mining sector.

Lastly, Figure 4.4 shows that 43 of the respondents (i.e. 75%) indicated that their maintenance departments control more than 40% of the total budget of their collieries. This is typical of the highly mechanised nature of collieries. This supports the argument as presented in section 3.1.1 wherein the South African coal mining sector is chosen as a sample area due to its need for better maintenance practices based on the high cost of maintenance in this sector.

From the above discussion it can be concluded that the data is representative of the South African coal mining sector.

5.2 Frustrations experienced with traditional budgeting

Figure 5.1 presents a summary of the results given in section 4.3 to the respondents' replies regarding the frustrations experienced with the traditional budgeting approach. It is thus evident from Figure 5.1 that the respondents overwhelmingly confirmed these

frustrations. Except for statement 3 from the "Questions/Statements" section of the questionnaire, these results are totally in line with the results achieved from the research completed by Neely *et al* (2001:6).

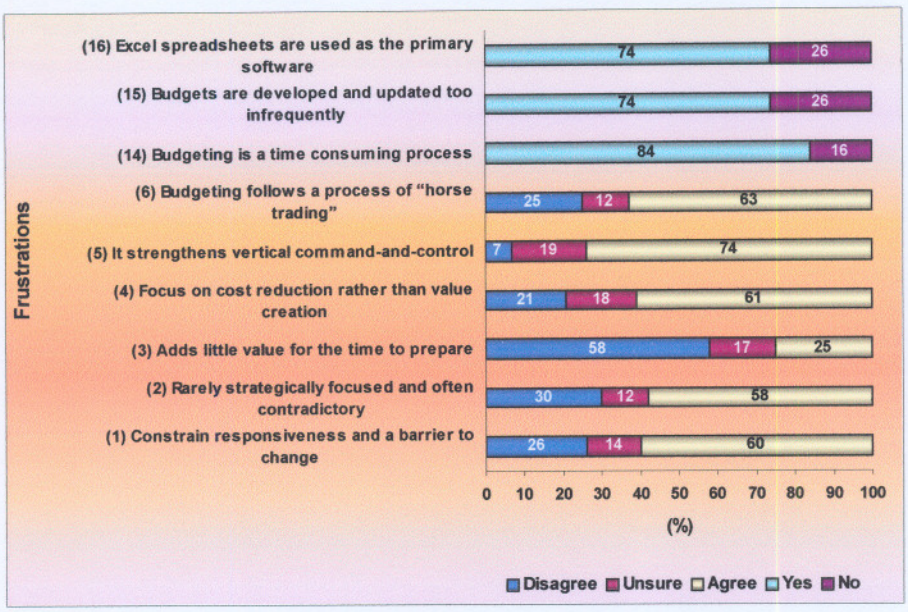


Figure 5-1: Frustrations experienced with traditional budgeting

Therefore, it can be concluded that colliery managers, divisional engineers and maintenance practitioners within the South African coal mining sector widely criticise the traditional budgeting approach and that it is not enhancing synchronisation with an ever changing competitive environment.

5.3 Budgeting approaches in use at the collieries

Figure 5.2 presents a summary of the results given in section 4.4 to the respondents' replies regarding the budgeting approaches currently in use at the collieries. The respondents confirmed the use of some of the budgeting approaches at their collieries. The research shows that the budgeting approaches least used by the collieries were that of ZBB (statement 18 of the questions/statement section of the questionnaire) and RB (statement 8 of the questions/statements section of the questionnaire).

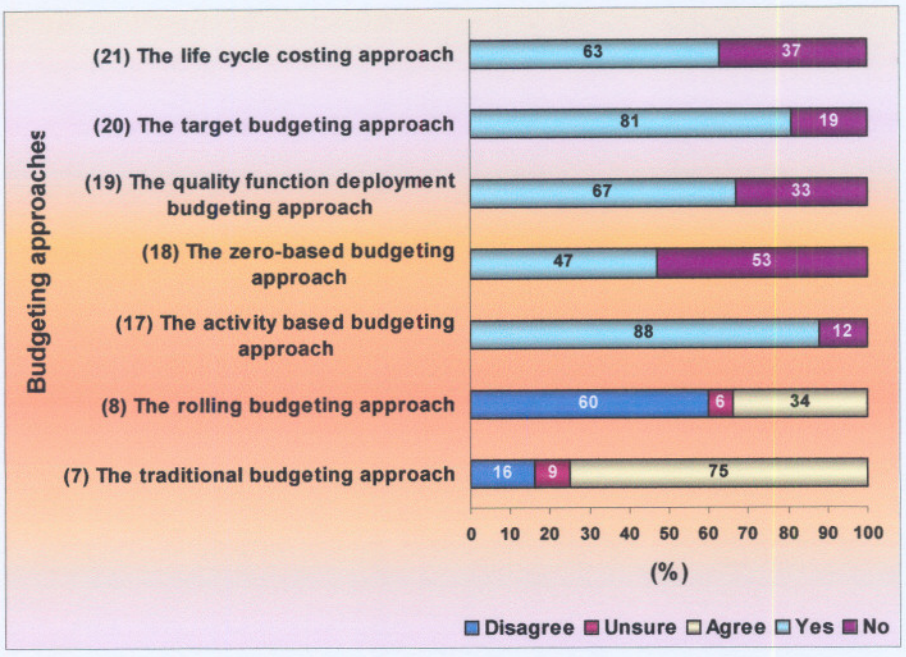


Figure 5-2: Budgeting approaches in use at collieries

Therefore, it can be concluded that colliery managers, divisional engineers and maintenance practitioners within the South African coal mining sector use the different traditional budgeting approaches very inconsistently and that these approaches are not used to enhance the colliery's competitive advantage.

5.4 Use of an integrated budgeting model

Figure 5.3 presents a summary of the results given in section 4.5 to the respondents' replies regarding the extent to which the elements of the integrated theoretical budgeting model are already in use at the collieries. It is evident that the respondents confirmed the use of some of the elements of the integrated theoretical budgeting model at their collieries, some to a large extent and some to a lesser extent. However, the elements of the model least used by the collieries were that of ZBB (statement 18 of the questions/statement section of the questionnaire), RB (statement 8 of the questions/statements section of the questionnaire), extent to which statistical software is used (question 23 of the questions/statement section of the questionnaire) and whether the maintenance budget is linked directly to the exchange rate and PPI (statement 27 of the questions/statements section of the questionnaire).

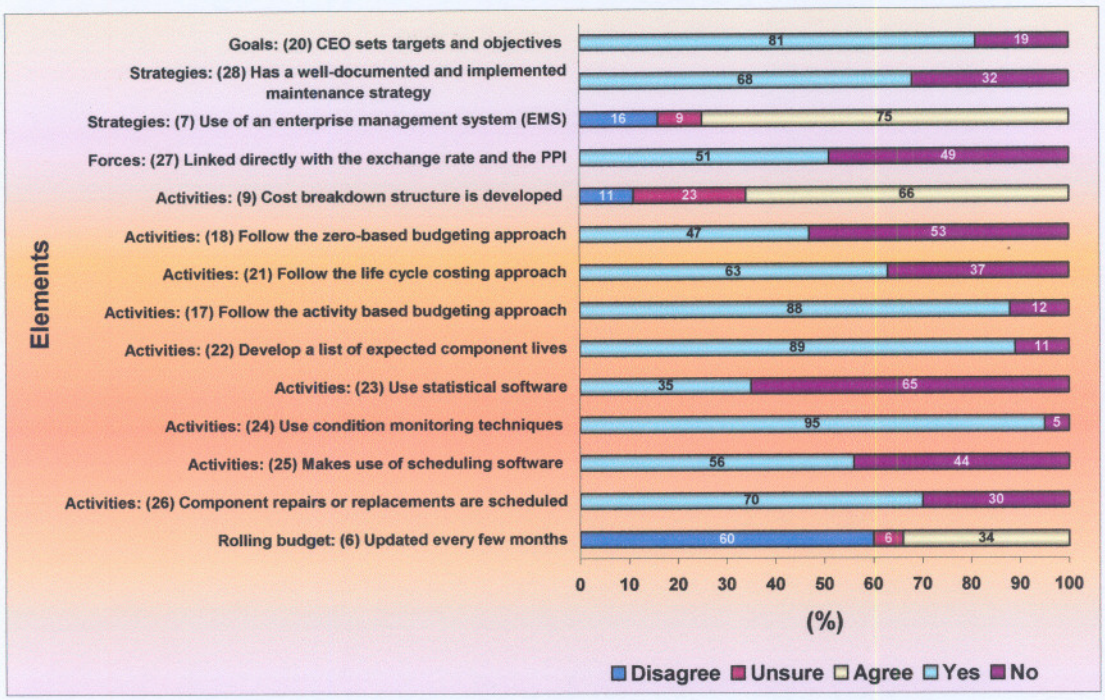


Figure 5-3: Extent to which the model is in use

Therefore, it can be concluded that colliery managers, divisional engineers and maintenance practitioners within the South African coal mining sector are using some of the elements of the integrated theoretical budgeting model, although very inconsistently. It is further concluded that the collieries within the South African coal mining sector do not make use of an integrated budgeting model to enhance their competitive advantage.

5.5 Need for an integrated budgeting model

Figure 5.4 presents a summary of the results given in section 4.6 to the respondents' replies regarding the need for an integrated theoretical budgeting model. It is thus evident from Figure 5.4 that the respondents overwhelmingly confirmed that they do have a need for an integrated theoretical budgeting model.

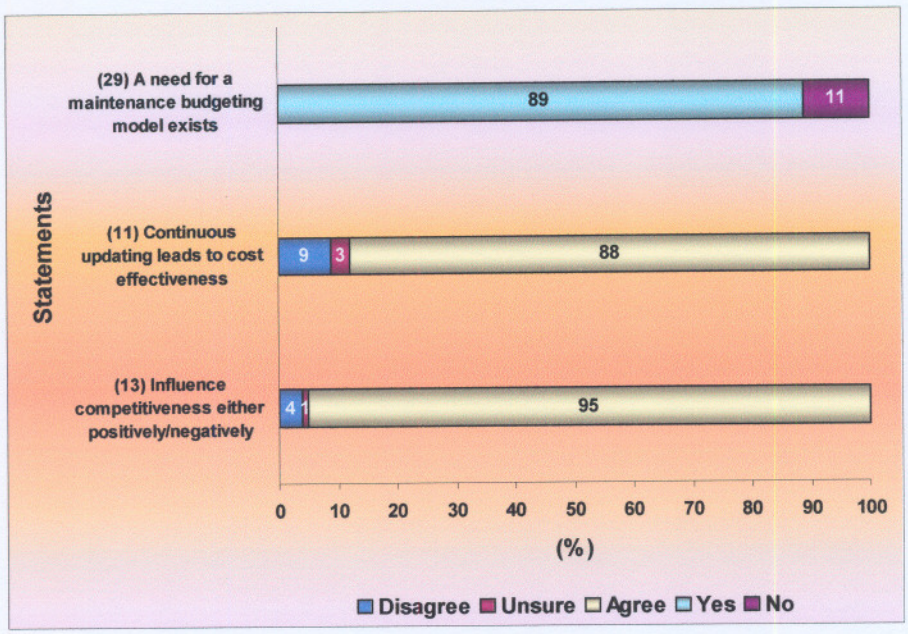


Figure 5-4: The need for an integrated budgeting model

Therefore, it can be concluded that colliery managers, divisional engineers and maintenance practitioners within the South African coal mining sector do have a need for an integrated theoretical budgeting model. It is further concluded that when this model is applied to the maintenance budget it will ensure synchronisation with prevailing market reality, giving a colliery a competitive advantage.

5.6 Conclusions

From the preceding discussions the following conclusions can be drawn:

- That the data is representative of the South African coal mining sector.
- That the conclusions drawn and recommendations made can be generalised and applied to other functions within a business.
- That colliery managers, divisional engineers and maintenance practitioners within the South African coal mining sector widely criticise the traditional budgeting approach and that it is not enhancing synchronisation with an ever changing competitive environment.
- That due to the time consuming character of the annual development of budgets,

maintenance personnel's focus on their maintenance function get distracted when they spend too much time on this.

- That the majority of collieries do not develop their budgets from first principles, i.e. budgets are not prepared as if it was done for the first time.
- That two thirds of the collieries do not update their budgets more frequent than once per year. In fact, the remaining one third do not update their budgets more frequently than twice per year.
- That colliery managers, divisional engineers and maintenance practitioners within the South African coal mining sector use the traditional budgeting approach very inconsistently. None of the collieries involved in this research had adopted any of the approaches researched in the literature, in its purest form. All of them implemented some customised approach.
- That at least two thirds of all maintenance budgets developed at collieries are not done scientifically, i.e. making use of statistical software for determining optimal component repair/replacement lives and costs.
- That the success of the maintenance function depends on a well-documented and implemented maintenance strategy, which reflects in the financial performance of a colliery. A maintenance strategy's function is to ensure that the maintenance opportunity gaps are closed in the most economically optimal way.
- That the collieries within the South African coal mining sector do not make use of an integrated budgeting model to enhance their competitive advantage. This also leads to the conclusion that this link is not as evident as could have been expected.
- That an intense need was expressed for an integrated budgeting model, which can be applied to the maintenance budget to ensure a competitive advantage.

These conclusions support the objective set at the beginning of this research report to determine whether a need exists for having a realistic maintenance budget that is aligned with market reality, giving the business a competitive advantage.

Finally, the integrated theoretical budgeting model, which was developed to assist the maintenance practitioner in compiling a realistic maintenance budget, which is aligned with the current market reality, will give any colliery (and for that matter any business) a competitive advantage when applied.

5.7 *Recommendations*

From the above discussions and conclusions the following recommendations can be made:

- That collieries and other capital-intensive businesses in general that are in pursuit of operational excellence, should implement the integrated theoretical budgeting model as a strategic tool in maintaining and sustaining a long-term competitive advantage.
- That maintenance budgets have to be aligned with maintenance strategies and that strategic planning and management processes have to be introduced in support thereof. These processes need to be value-based and focussed on continuous improvement. The true drivers of shareholder value have to be identified, focused on and managed.
- Although the research did not explicitly investigate how collieries manage the evolution of their budgeting systems, many might have a predicament because they have never adapted their budgeting processes and systems to suit the fast changing competitive environment. It is thus recommended to establish processes now so that they can evolve their budgeting processes and systems over time in order to catch up with their competitors.
- That collieries and other capital-intensive businesses should make better use of the huge amounts of data stored in the memory banks of their EMS servers. However, the challenge remains to be that of real-time updating of budgeting and other business performance information. An integrated approach should be followed, linking supplier pricing, exchange rates and PPI to the LCC of equipment/machinery/plant, ensuring the lowest total cost of ownership (TCO).
- That collieries and other capital-intensive businesses should embrace technology that will allow them to quickly capture and disseminate raw data required for decision making and forecasting. This means acquiring special software to be interfaced with an existing EMS (e.g. SAP, MIMS, etc.), allowing managers to spend more time analysing data rather than attempting to update forecasts manually.
- That change management principles be incorporated in the business processes to form an integral part of any change induced to the business.

If a colliery, or any other capital-intensive business implements these recommendations in a controlled and structured manner as proposed by the change management process, the maintenance budget will be matched with market reality ensuring that the colliery or business gain a competitive advantage over its competitors.

5.8 Future research areas

Since the inception of globalisation, competitiveness is not a matter of choice anymore but a matter of survival. Focus will thus continue to be on maintenance cost optimisation and real-time budgeting will certainly enhance any business's competitiveness. Businesses should therefore be encouraged to implement the use of the integrated theoretical budgeting model in an attempt to secure a competitive advantage. The following list proposes possible research opportunities that can be conducted as follow up studies to the research presented in this research report.

- Investigate how world-class companies manage the evolution of their budgeting processes and systems.
- Follow a business over time as it implements the use of the integrated theoretical budgeting model to explore its competitiveness as a result of using the model.
- Study businesses that have considered implementing the integrated theoretical budgeting model and chosen not to implement it, in order to gain an understanding of differences between model adopters and non-adopters.
- Investigate the impact of trying to implement such a new budgeting model in the business, without having a comprehensive and applicable change management plan.

6. REFERENCES

BARRINGER, P.E. 2004. Life cycle cost analysis – Who does what? (In NPRA Maintenance Conference & Exhibition. A paper read at the Maintenance Conference held in San Antonio on 25 to 28 May 2004. San Antonio. p. 1-9.)

BARRINGER, P.E. 1998. Life cycle cost and good practice. (In NPRA Maintenance Conference. A paper read at the Maintenance Conference held in San Antonio on 19 to 22 May 1998. San Antonio. p. 1-26.)

BRIGHAM, E.F. & EHRHARDT, M.C. 2002. Financial Management: Theory and practice. Tenth Edition. London : South-Western. 1051 p.

BURGELMAN, R.A. & MAIDIQUE, M.A. & WHEELWRIGHT, S.C. 2001. Strategic management of technology and innovation. Third Edition. New York : McGraw-Hill. 356 p.

COMSA (Chamber of Mines of South Africa). 2003. Annual report 2002/2003. Johannesburg. 72 p.

EDWARDS, D.J. & HOLT, G.D. & HARRIS, F.C. 2000. Estimating life cycle plant maintenance costs. *Construction Management and Economics*, 18(4):427-435, Jun.

EDWARDS, D.J. & HOLT, G.D. & HARRIS, F.C. 1998. Financial management of construction plant: Conceptualising cost prediction. *Journal of Financial Management of Property and Construction*, 3(2):59-73.

ELLRAM, L.M. & SIFERD, S.P. 1998. Total cost of ownership: A key concept in strategic cost management decisions. *Journal of Business Logistics*, 19(1):55-84.

GARRISON, R.H. & NOREEN, E.W. 2000. Managerial accounting. Ninth Edition. New York. McGraw-Hill. 923 p.

HANSEN, S.C. & OTLEY, D.T. & VAN DER STEDE, W. A. 2003. Practice developments in budgeting: An overview and research perspective. *Journal of management accounting research*, 15:95-116.

HILL, T. 2000. Operations management: Strategic context and managerial analysis. First Edition. New York : Palgrave. 704 p.

HORNGREN, C.T. & FOSTER, G. & DATAR, S.M. & BLACK, T. & GRAY, P. 1996. Cost accounting in Australia: A managerial emphasis. Sydney : Prentice-Hall. 492 p.

HUYSAMEN, G.K. 2001. Methodology for the social and behavioural sciences. Cape Town : National Book Printers. 237 p.

JEHLE, K. 1999. Budgeting as a competitive advantage. *Strategic Finance*: 54-57, October.

KOTLER, P. & ARMSTRONG, G. 2001. Principles of marketing. Ninth Edition. New Jersey : Prentice-Hall. 270 p.

LEWIS, V.B. 1988. Reflections on budget systems. *Public budgeting & finance*, 14(1):4-19, Spring.

MASAAKI, I. 1997. Gemba Kaizen: A commonsense low-cost approach to management. New York : McGraw-Hill. 354 p.

MOUBRAY, J. 1997. Reliability-centred maintenance. Second edition. Oxford : Butterworth-Heinemann. 426 p.

MYERS, R. 2001. Budgets on a roll. *Journal of Accountancy*, 192(6):41-46, Dec.

NEELY, A. & SUTCLIFF, M.R. & HEYNS, H.R. 2001. Driving value through strategic planning and budgeting. A research report from Cranfield School of Management and Accenture. 47 p.

NOGUEIRA, J.C. 2003. A budgeting method using quality function deployment. *The Engineering Economist*, 48(4):333-339.

NORDEN, C.M. 2003. Exploring the need for and the implementation of maintenance strategy in the corporate coal mining sector. Johannesburg : GIBS. (Dissertation – MBA) 80 p.

PETERSON, S.B. 2000. The President's message: What is asset management? *The SAMI Times*, 1(2):1-4, Dec.

PORTER, M.E. 1998. On competition. Boston, MA : Harvard Business School Press. 155 p.

PYHRR, P.A. 1973. Zero-base budgeting: A practical management tool for evaluating expenses. New York : John Wiley & Sons. 231 p.

SACEA. 2003. Unpublished report: SACEA year-end report for 2003.

SACMA. 2003. Unpublished report: SACMA year-end report for 2003.

SAUNDERS, M. & LEWIS, P. & Thornhill, A. 2003. Research methods for business students. Third Edition. London : Prentice Hall. 504 p.

SCHICK, A. & HATRY, H. 1982. Zero base budgeting: The manager's budget. *Public budgeting & finance*, 2(1):72-87, Spring.

Syferfontein Strip-mine. 2000. Unpublished budget: Syferfontein Strip-mine budget F2000/1.

WIREMAN, T. 1998. Optimize maintenance/asset management policies. *Maintenance Technology*: 1-9.

WISNIEWSKI, M. 2002. Quantitative methods for decision makers. Third edition. London : Prentice Hall. 575 p.

7. APPENDICES

7.1 APPENDIX A: Data requirements table

Research objective is twofold: *(1) To determine whether a need exists, among coal mines within the South African coal mining sector, for having a realistic maintenance budget that is aligned with market reality, giving the business a competitive advantage. (2) Extent to which the elements of the integrated theoretical budgeting model is used in the coal mining sector.*

Type of research: *Predominantly descriptive, although wish to determine the extent to which the proposed theoretical maintenance budgeting model is used by maintenance practitioners.*

Investigative questions	Variable(s) required	Detail in which data measured	Category	Check included in questionnaire
Maintenance budgets are time consuming to put together (behaviour)	*Maintenance budgets are time consuming*	*Yes, No*	Frustrations	✓
Maintenance budgets constrain responsiveness and are often a barrier to change (behaviour)	*Opinion whether maintenance budgets constrain responsiveness*	*Degree of agreement on a scale of 1 to 10. Disagree = 1, Agree = 10.*	Frustrations	✓
Maintenance budgets are rarely strategically focused and often contradictory (behaviour)	*Opinion whether maintenance budgets are rarely strategically focussed*	*Degree of agreement on a scale of 1 to 10. Disagree = 1, Agree = 10.*	Frustrations	✓
Maintenance budgets add little value, especially given the time to prepare them (behaviour)	*Opinion whether maintenance budgets add little value*	*Degree of agreement on a scale of 1 to 10. Disagree = 1, Agree = 10.*	Frustrations	✓
Maintenance budgets focus on cost reduction rather than value creation (behaviour)	*Opinion whether focus is on cost reduction rather than value creation*	*Degree of agreement on a scale of 1 to 10. Disagree = 1, Agree = 10.*	Frustrations	✓
Maintenance budgets strengthen vertical command-and-control (behaviour)	*Opinion whether maintenance budgets strengthen vertical command-and-control*	*Degree of agreement on a scale of 1 to 10. Disagree = 1, Agree = 10.*	Frustrations	✓
Maintenance budgets are developed and updated too infrequently, usually annually (behaviour)	*Developed and updated too infrequently*	*Yes, No*	Frustrations	✓
Annual budgeting in our company follows an iterative top-down and bottom-up approach coordinated from head-office (behaviour)	*Opinion whether budgeting follows the traditional budgeting approach*	*Degree of agreement on a scale of 1 to 10. Disagree = 1, Agree = 10.*	Budgeting approaches	✓
Budgets in our company consist of information based on activity and resource consumption rates (behaviour)	*Follows the activity based budgeting approach*	*Yes, No*	Budgeting approaches	✓
Annual budgeting in our business unit is based on first principles (as if it was prepared for the first time, from "scratch") (behaviour)	*Follows the zero-based budgeting approach*	*Yes, No*	Budgeting approaches	✓

Investigative questions	Variable(s) required	Detail in which data measured	Category	Check included in questionnaire
Budgeting within our company follows a process of evaluating the impact that each of the different equipment/machinery/component replacement scenarios has on the profit of the business unit (behaviour)	*Follows quality function deployment as a budgeting approach*	*Yes, No*	Budgeting approaches	✓
Prior to us developing an annual budget within our company, our CEO sets targets and objectives with which we have to align our budget. (behaviour)	*Follows the target budgeting approach*	*Yes, No*	Budgeting approaches	✓
Budgets in our company is focussed on finding the lowest long-term total cost of ownership of equipment/machinery (behaviour)	*Follows the life cycle costing approach*	*Yes, No*	Budgeting approaches	✓
Budgets in our business unit are updated every few months in an attempt to reassess the business unit's outlook several times per year (behaviour)	*Opinion whether the business unit follows the rolling budgeting approach*	*Degree of agreement on a scale of 1 to 10. Disagree = 1, Agree = 10.*	Budgeting approaches	✓
Success of the maintenance function is dependant on the quality of the maintenance strategy and its implementation (behaviour)	*Opinion whether success of the maintenance function depends on the quality and implementation of a maintenance strategy*	*Degree of agreement on a scale of 1 to 10. Disagree = 1, Agree = 10.*	Need	✓
How often is the maintenance budget updated? (attribute)	*Time frequency*	*Real-time, monthly, 6-monthly, annually, more than annual*	Model	✓
During the maintenance budgeting process a cost breakdown structure (bill of materials) is developed to avoid "forgetting things" (behaviour)	*Opinion whether cost breakdown structures are drawn up*	*Degree of agreement on a scale of 1 to 10. Disagree = 1, Agree = 10.*	Model	✓
Does the maintenance department develop a list of expected component lives for each machine/equipment type? (behaviour)	*Set expected lives for components*	*Yes, No*	Model	✓
Does the maintenance department use statistical software for developing expected component lives and component pricing? (behaviour)	*Using statistical modelling to determine expected component lives*	*Yes, No*	Model	✓
Does the maintenance department use condition monitoring techniques for achieving optimal component lives? (behaviour)	*Using condition monitoring techniques*	*Yes, No*	Model	✓

Investigative questions	Variable(s) required	Detail in which data measured	Category	Check included in questionnaire
The maintenance department makes use of scheduling software for scheduling component change outs (behaviour)	*A scheduler exists*	*Yes, No*	Model	✓
All future component repairs or replacements are scheduled to determine annual expected expenditures (behaviour)	*Scheduler is used to determine annual expenditures*	*Yes, No*	Model	✓
A continuously updated maintenance budget would assist the maintenance management team to become more cost effective (behaviour)	*Opinion whether cost effectiveness improves with continuously updated maintenance budgets*	*Degree of agreement on a scale of 1 to 10. Disagree = 1, Agree = 10.*	Model	✓
The company makes use of an enterprise management system (EMS) (behaviour)	*EMS used*	*Yes, No*	Model	✓
The maintenance budget can influence the company's competitiveness either positively or negatively (behaviour)	*Opinion whether competitiveness is influenced by the maintenance budget*	*Degree of agreement on a scale of 1 to 10. Disagree = 1, Agree = 10.*	Need	✓
The maintenance budget in our business is linked directly with the exchange rate, PPI and other indices (behaviour)	*Linked with market reality*	*Yes, No*	Model	✓
What portion of the total budget of your business unit does the maintenance department control - including labour, materials, utilities, and depreciation? (attribute)	*Percentage of total budget*	*Actual number*	Background	✓
What is the annual coal production expressed in metric tons for the business? (attribute)	*Size of the business expressed in metric tons*	*Actual number*	Background	✓
At our business we do have a well documented and implemented maintenance strategy (behaviour)	*Maintenance strategy documented and implemented*	*Yes, No*	Model	✓
We do have a need for a maintenance budgeting model ensuring that the maintenance budget is synchronised with prevailing market reality, giving our business a competitive advantage (behaviour)	*A need exists*	*Yes, No*	Model	✓
In our company we still use Excel spreadsheets as the primary software for developing maintenance budgets (behaviour)	*Excel spreadsheets are used*	*Yes, No*	Frustrations	✓

Investigative questions	Variable(s) required	Detail in which data measured	Category	Check included in questionnaire
Budgeting within our company follows a process of "horse trading" (behaviour)	*Opinion whether the business unit's budgeting process follows a process of "horse trading"*	*Degree of agreement on a scale of 1 to 10. Disagree = 1, Agree = 10.*	Frustrations	✓
My job position within our company is . . .(attribute)	*Determine the position*	*Section Engineer/Assistant Resident Engineer, Engineering Manager/Resident Engineer, Mine Manager, Divisional Engineer*	Background	✓
How much time do maintenance personnel spend in man-uours (for the whole maintenance department) annually on preparing the new budget? (attribute)	*Total man-hours spent annually*	*Actual number*	Background	✓
The business unit I am currently employed in is a ... (attribute)	*Determine the business unit type*	*Beneficiation Plant, Underground Colliery, Strip-mine, Services*	Background	✓

7.2 *APPENDIX B: The survey questionnaire*

QUESTIONNAIRE

Developing a Maintenance budget for a competitive advantage

Procedure for completing the questionnaire

1. Always select the response on questions and statements, which is most applicable to you and/or your business unit.

2. Only tick the **one** tick box, which is most applicable.

Example 1:

The business unit I am currently employed in is a . . .

☐	☐	☒	☐
Beneficiation Plant	**Underground Colliery**	**Strip-mine**	**Services**

Example 2:

Usually the findings of one research project suggest problems, which may be pursued in further research projects.

DISAGREE **AGREE**

☐ ☐ ☐ ☐ ☐ ☐ ☒ ☐ ☐ ☐

1 2 3 4 5 6 7 8 9 10

3. Where you are required to type in a value, simply position the pointer inside the box and type in the required value.

Example 3:

What is the annual coal production expressed in metric tons for your business unit?

10.7	**Million tons**

BACKGROUND INFORMATION

1. The business unit I am currently employed in is a . . .

☐ Beneficiation Plant ☐ Underground Colliery ☐ Strip-mine ☐ Services

2. My job position within our business unit is . . .

☐ Section Engineer Assist. Res. Engineer ☐ Engineering Manager Resident Engineer ☐ Mine Manager ☐ Divisional Engineer

3. What is the annual coal production expressed in metric tons for your business unit?

☐ **Million tons**

4. What portion of the total budget of your business unit does the maintenance department control - including labour, materials, utilities, and depreciation?

☐ **%**

5. How much time do maintenance personnel spend in man-hours (for the whole maintenance department) annually on preparing the new budget?

☐ **Annual man-hours**

6. How often is the maintenance budget updated?

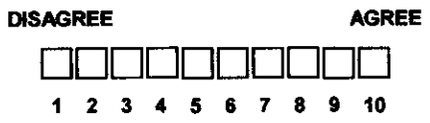
☐ Real-time ☐ Monthly ☐ 6-Monthly ☐ Annually ☐ > Annual

7. The company makes use of an enterprise management system (EMS) (e.g. SAP, MIMS, etc.).

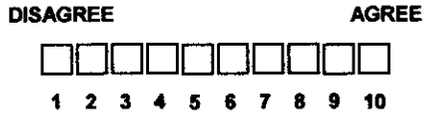
☐ Yes ☐ No

QUESTIONS / STATEMENTS

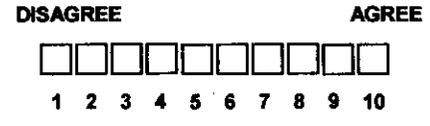
1. Maintenance budgets constrain responsiveness and are often a barrier to change.



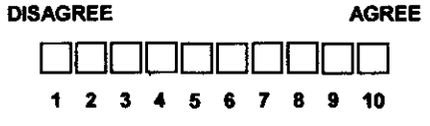
2. Maintenance budgets are rarely strategically focused and often contradictory.



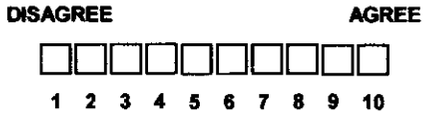
3. Maintenance budgets add little value, especially given the time to prepare them.



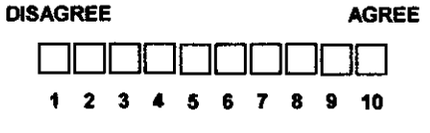
4. Maintenance budgets focus on cost reduction rather than value creation.



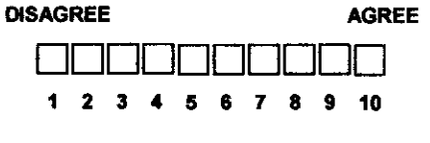
5. Maintenance budgets strengthen vertical command-and-control.



6. Budgeting within our business unit follows a process of "horse trading" (i.e. negotiating on a give-and-take basis between decision making levels).



7. Annual budgeting in our business unit follows an iterative top-down and bottom-up approach coordinated from head-office.



8. Budgets in our business unit are updated every few months in an attempt to reassess the business unit's outlook several times per year.

DISAGREE AGREE

☐☐☐☐☐☐☐☐☐☐

1 2 3 4 5 6 7 8 9 10

9. During the maintenance budgeting process a cost breakdown structure (bill of materials) is developed to avoid "forgetting things".

DISAGREE AGREE

☐☐☐☐☐☐☐☐☐☐

1 2 3 4 5 6 7 8 9 10

10. The maintenance department has an effective way of updating maintenance related information.

DISAGREE AGREE

☐☐☐☐☐☐☐☐☐☐

1 2 3 4 5 6 7 8 9 10

11. A continuously updated maintenance budget would assist the maintenance management team to become more cost effective.

DISAGREE AGREE

☐☐☐☐☐☐☐☐☐☐

1 2 3 4 5 6 7 8 9 10

12. Success of the maintenance function is dependant on the quality of the maintenance strategy and its implementation.

DISAGREE AGREE

☐☐☐☐☐☐☐☐☐☐

1 2 3 4 5 6 7 8 9 10

13. The maintenance budget can influence the company's competitiveness either positively or negatively.

DISAGREE AGREE

☐☐☐☐☐☐☐☐☐☐

1 2 3 4 5 6 7 8 9 10

14. Maintenance budgets are time consuming to put together. ☐ Yes ☐ No

15. Maintenance budgets are developed and updated too infrequently, usually annually. ☐ Yes ☐ No

16. In our business unit, we still use Excel spreadsheets as the primary software for developing maintenance budgets. ☐ Yes ☐ No

17. Budgets in our business unit consist of information based on activity and resource consumption rates. ☐ Yes ☐ No

18. Annual budgeting in our business unit is based on first principles (as if it was prepared for the first time, from "scratch"). ☐ Yes ☐ No

19. Budgeting within our business unit follows a process of evaluating the impact that each of the different equipment/machinery/component replacement scenarios has on the profit of the business unit. ☐ Yes ☐ No

20. Prior to us developing an annual budget within our company, our CEO sets targets and objectives with which we have to align our budget. ☐ Yes ☐ No

21. Budgets in our business unit are focussed on finding the lowest long-term total cost of ownership of equipment/machinery. ☐ Yes ☐ No

22. Does the maintenance department develop a list of expected component lives for each machine/equipment type? ☐ Yes ☐ No

23. Does the maintenance department use statistical software for developing expected component lives and component pricing? ☐ Yes ☐ No

24.	Does the maintenance department use condition-monitoring techniques for achieving optimal component lives?	☐ Yes	☐ No
25.	The maintenance department makes use of scheduling software for scheduling component change outs.	☐ Yes	☐ No
26.	All future component repairs or replacements are *scheduled to determine annual expected expenditures.*	☐ Yes	☐ No
27.	The maintenance budget in our business unit is linked directly to the exchange rate and PPI as it affects specific equipment/machines.	☐ Yes	☐ No
28.	In our business unit, we do have a well-documented and implemented maintenance strategy.	☐ Yes	☐ No
29.	We do have a need for a maintenance budgeting model ensuring that the maintenance budget is synchronised with prevailing market reality, giving our business a competitive advantage.	☐ Yes	☐ No

THANK YOU!

Thank you for taking the time to complete this questionnaire.
It is appreciated.

Please return the completed questionnaire electronically to schalk.vanwyk@sasol.com or fax it to (017) 614-5256.

7.3 APPENDIX C: Introducing a self-administered questionnaire

(First cover letter)

From: Van Wyk, Schalk (SWJ) [mailto:Schalk.VanWyk@sasol.com]
Sent: 03 September 2004 04:47
To: jarmstrong@coal.anglo.co.za
Subject: Budgeting Questionnaire
Importance: High

Dear Mr Armstrong,

I am doing a research project, which is part of my dissertation to be submitted in partial fulfilment of the requirements of the MBA degree. Attached is a research questionnaire with the purpose to determine whether a need exists at collieries within the South African coal-mining sector for having a realistic maintenance budget that is aligned with market reality, giving them a competitive advantage.

You are one of a small number of people who are being asked to give your opinion on this issue. You were selected from the SACEA and SACMA membership lists because of your South African coal-mining experience. In order that the results will truly represent people who have experience with the maintenance budgeting process, it is important that your questionnaire is completed and returned. It would take about 15 minutes of your time to complete the questionnaire.

All the information you provide will be treated with the highest confidentiality. Please answer **all** the questions and at a time when you are unlikely to be disturbed. Your answers are essential to building an accurate picture of the need for a maintenance budget, which is aligned with market reality, giving a colliery a competitive advantage.

Please return your completed questionnaire to me electronically at schalk.vanwyk@sasol.com or fax it to (017) 614-5256 on or before 10 September 2004.

I hope you find completing the questionnaire enjoyable, and thank you for taking the time to help me. If you have any queries, or would like to have more information about this research project, please call me on 082-454-7772.

Thank you for your help.

Yours sincerely

Schalk van Wyk
Manager: SCS

Sasol Mining (Pty) Ltd
Sasol Coal Supply
Private Bag X1015 Secunda 2302 South Africa
Telephone: +27 (0) 17 614 5041
Facsimile: +27 (0) 17 614 5256
Mobile: +27 (0) 82 454 7772
schalk.vanwyk@sasol.com www.sasol.com
SSM: 29

NOTICE: Please note that this eMail, and the contents thereof, is subject to the standard Sasol eMail disclaimer which may be found at:
http://www.sasol.com/disclaimer

If you cannot access the disclaimer through the URL attached and you wish to receive a copy thereof please send an eMail to disclaimer@sasol.com

This email was scanned and cleared by NetIQ MailMarshal.

(Second cover letter – reminder)

From: Van Wyk, Schalk (SWJ) [mailto:Schalk.VanWyk@sasol.com]
Sent: 13 September 2004 02:47 PM
To: Sichamba, David (South Witbank – XCSA)
Subject: Budgeting Questionnaire
Importance: High

Dear Mr Sichamba,

I have noticed that you have not yet returned your completed questionnaire. I am attaching another copy hoping that you would take 15 minutes of your valuable time to complete and return it to me. Please be so kind to return it on or before Thursday, 16 September 2004. Your opinion is valued greatly.

Thank you for your cooperation in this valuable survey.

Yours sincerely

Schalk van Wyk
Manager: SCS

Sasol Mining (Pty) Ltd
Sasol Coal Supply
Private Bag X1015 Secunda 2302 South Africa
Telephone: +27 (0) 17 614 5041
Facsimile: +27 (0) 17 614 5256
Mobile: +27 (0) 82 454 7772
schalk.vanwyk@sasol.com www.sasol.com
SSM: 29

NOTICE: Please note that this eMail, and the contents thereof, is subject to the standard Sasol eMail disclaimer which may be found at:
http://www.sasol.com/disclaimer

If you cannot access the disclaimer through the URL attached and you wish to receive a copy thereof please send an eMail to disclaimer@sasol.com

This email was scanned and cleared by NetIQ MailMarshal.